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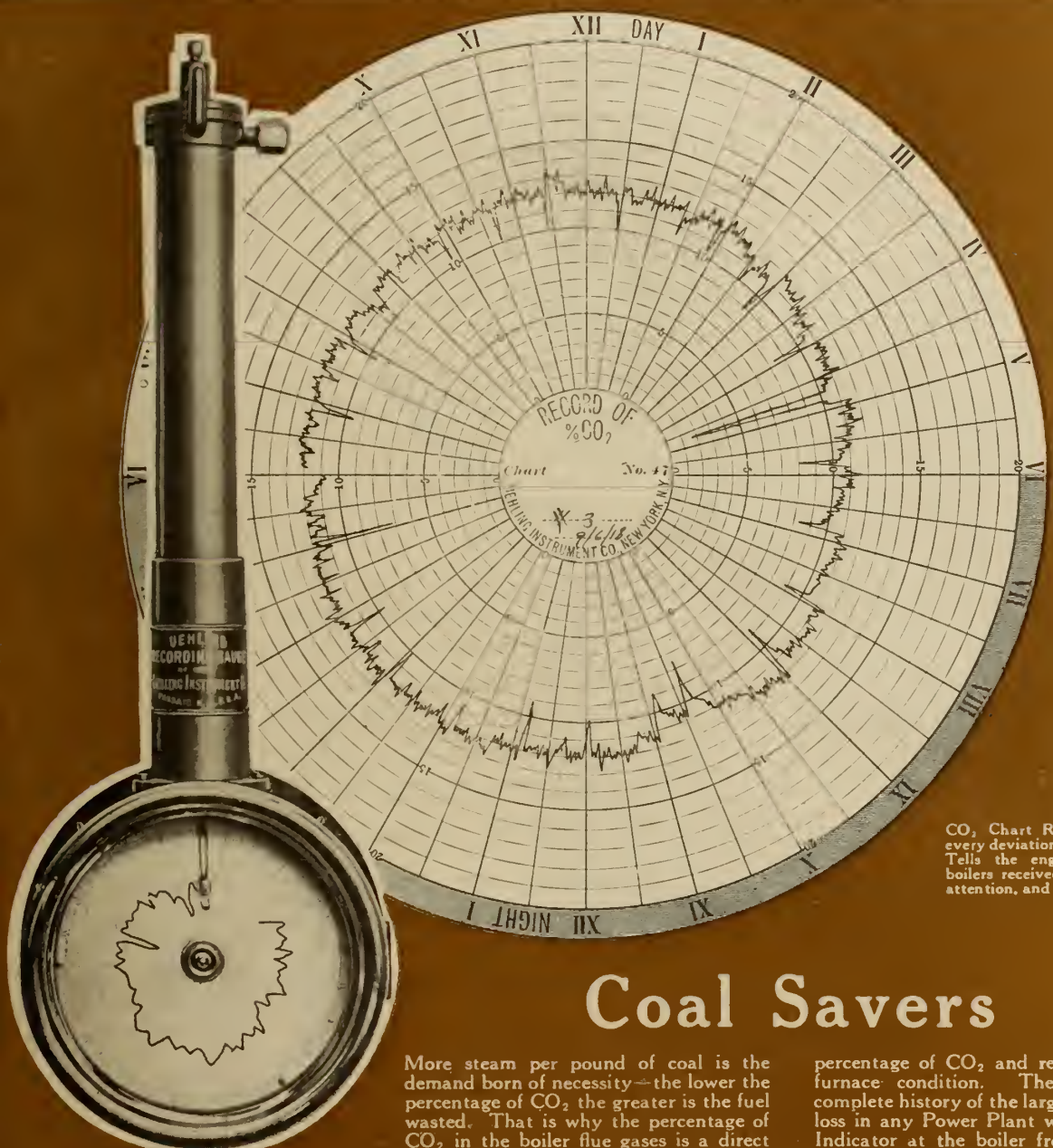
POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1207 Union Trust Bldg

Vol. XII.—No. 1. Publication Office, Toronto—January, 1919 Published Monthly $1.00 per Year.



CO_2 Chart Record shows every deviation in economy. Tells the engineer which boilers received insufficient attention, and when.

CO_2 Recorder for Office of Chief Engineer. May be installed at any distance from the boilers and will trace continuous records of the changes in CO_2 and show these changes exactly as they occur during every second of operation.

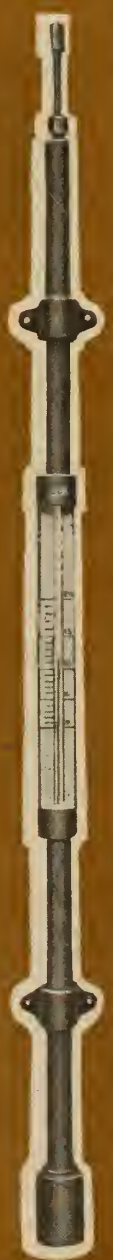
Coal Savers

More steam per pound of coal is the demand born of necessity—the lower the percentage of CO_2 the greater is the fuel wasted. That is why the percentage of CO_2 in the boiler flue gases is a direct indication of combustion economy.

Uehling CO_2 recorders furnish continuous (not intermittent) records of the percentage of CO_2 and reveal the true furnace condition. They provide a complete history of the largest individual loss in any Power Plant while the CO_2 Indicator at the boiler front holds the firemen responsible for the record produced.

Write for further details.

Uehling Instrument Co., 2018 Empire Bldg., New York City



CO_2 Indicator for mounting on the boiler fronts to guide the firemen. Shows the percentage of CO_2 and gives warning when improper furnace conditions prevail.

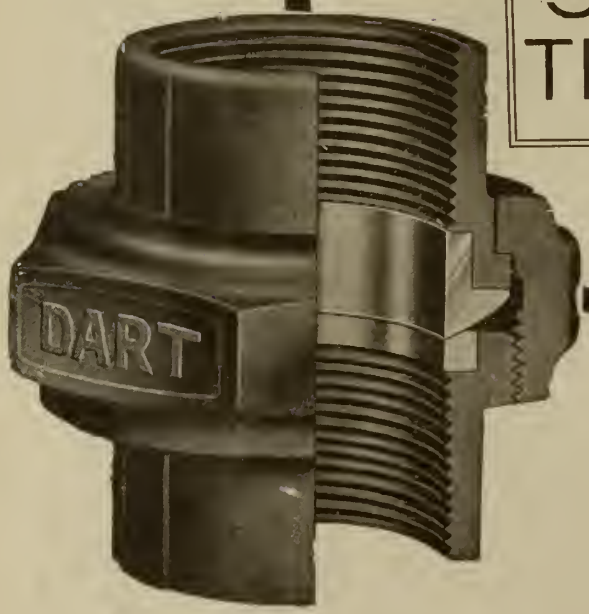
UEHLING

CO_2 RECORDERS

Dart Unions

EASILY CONNECTED

STAY TIGHT



THE Ball-Shaped Face and Seat make for easy connection, regardless of alignment of the pipes.
And the Face and Seat being of Bronze prevents deterioration at the vital part.
Heavy iron parts prevent stretching or pulling apart.

No upkeep cost. No replacement cost.
No loss from leaks.

ASK YOUR JOBBER FOR THEM

Made in Canada by
Dart Union Company, Limited
TORONTO, CANADA

BRONZE TO BRONZE AT THE JOINT CANNOT RUST OR CORRODE

STEEL TANKS AND BINS

We have made a success of building steel plate work by specializing in it.

The new additions and improvements to our boiler shops have placed us in a better position than ever before to do this work right.

Our facilities in every department have materially increased. We have the equipment and the experience to turn out this special work as it should be.

If you are confronted with any problem on this work send it in and let our Engineers give you the value of their experience.

We design and build:

CONVEYORS
SMOKE BREECHINGS
STEEL STACKS
SPARK ARRESTORS
STEEL BUCKETS
ELEVATORS
RIVETED TANKS
STEEL TANKS
STORAGE BINS
COOKERS AND DIGESTORS
STEEL GAS MAINS
REFUSE BURNERS
WELDED TANKS
SETTLING TANKS

Waterous

BRANTFORD, ONTARIO, CANADA

If any advertisement interests you, tear it out now and place with letters to be answered.

BOILERS IN STOCK

SUBJECT TO PRIOR SALE

2—72" x 18' H.R.T. Boilers, 125 lbs., W.P., Ontario Code.
2—54" x 14' H.R.T. " " " " "

VERTICAL TYPE

1—30 H.P., Ontario Code
1—25 H.P., " "
2—20 H.P., " "

LOCOMOTIVE TYPE

1—50 H.P., Standard Inspection
2—30 H.P., " "
1—20 H.P., " "

1—9" x 12" Double Cylinder Jenckes Cableway Hoist, complete with carriage, cable, sheaves, etc.
1—Open Top Tank, 10' long x 2' deep x 3' wide, ¼" plate.
1—Concrete Bucket, 24" x 24" x 30" deep, with open bottom.

We manufacture Marine, Horizontal Tubular, Vertical Tubular and Locomotive Type Boilers, also Smoke Stacks, Breechings, Tanks, Penstocks and CASTINGS up to 15 tons.

Send us your inquiries.

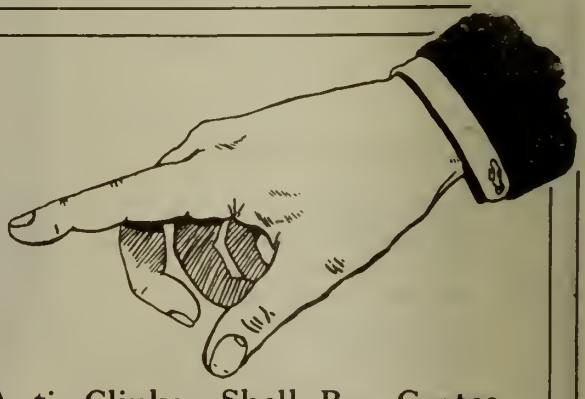
Engineering & Machine Works of Canada, Limited

Formerly
St. Catharines Works of
The Jenckes Machine Co., Ltd.

Head Office and Works
St. Catharines, Ont.

Eastern Sales Office:
Hall Machinery Company
Sherbrooke, Quebec

Clean Boiler Insurance



Boiler scale wastes tons of coal, makes disagreeable labor in being removed, causes shut-downs and a variety of other troubles. Are your boilers carrying scale? You can easily get rid of it. Get a barrel of

BOICO

It has a quick and certain action on all boiler scale. It loosens and brings down the hardest of old formations and keeps new scale from gathering—BOICO means Clean Boiler Insurance.

It will not carry over in the steam; it will not cause foaming or priming, and it is guaranteed not to injure packing or valves in the slightest. Write for Free Trial.

Anti-Clinker Shell Bar Grates

With these grates you can get more heat with less coal. They prevent clinker formation and maximum air space provides perfect combination. No wasted fuel where Anti-Clinker Shell Bar Grates are used.

One-Piece Jointless Furnace Lining

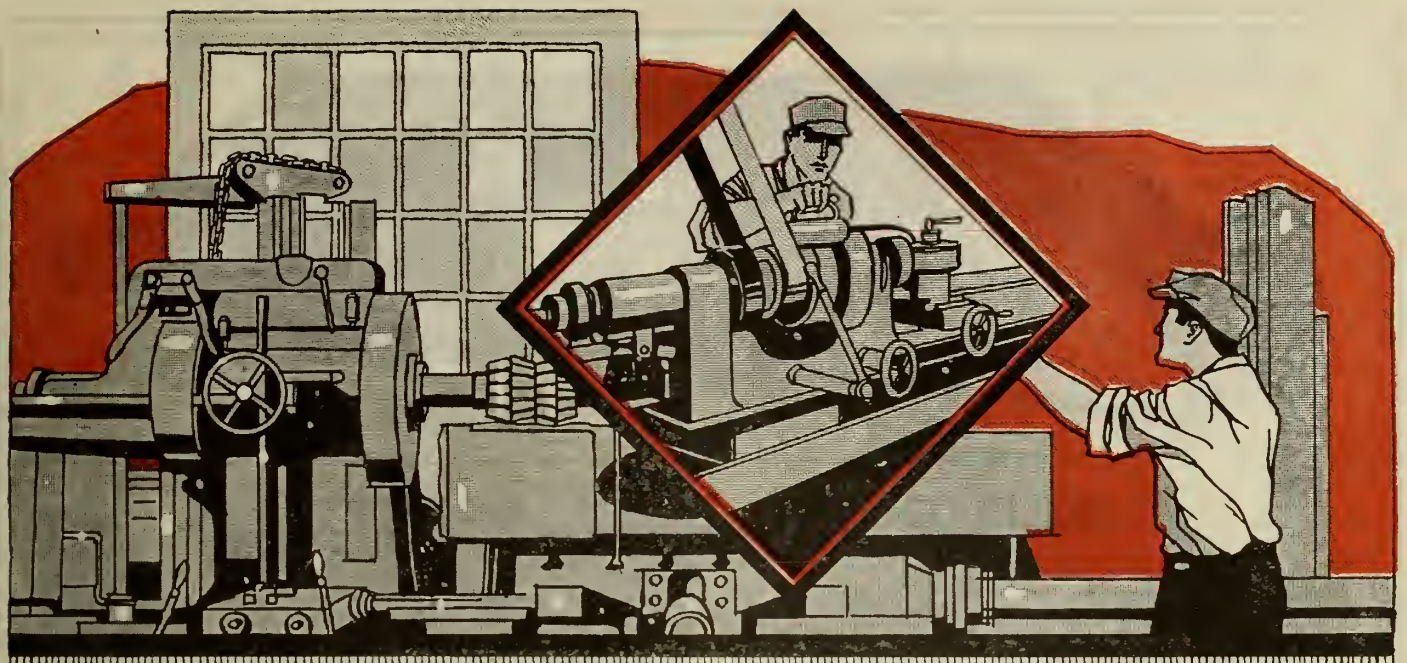
Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

TIP-IT Patent Welding Process

gives you tools whose shanks are carbon and whose cutting tips are high-speed steel.

Shell-Bar Boico Supply, Ltd. 376 Dufferin Street Toronto

Eastern Sales Agents: Mill Supply Department, Beverage Paper Co., Ltd., Montreal, Adolphe Huot & Sons, Quebec.



SPEED UP YOUR PLANT

CORRECT lubrication will do much to increase and maintain the efficiency of your plant. The right use of the proper lubricant means smooth-running and longer life for your power units, no matter whether you are producing ocean liners or baby carriages, electric power or metal ores.

Lubrication always has a direct and important relation to production costs. Correct lubrication means—

(a) Increased plant production.
(b) Lower operating costs.
(c) Minimum fuel consumption.
(d) Smaller repair bills.
(e) Longer life for your power equipment.

Correct lubrication requires not only high quality lubricants, but carefully selected lubricants. To correctly lubricate your plant, you must use the right lubricant for each specific purpose. Do not let poor lubricants or incorrect lubricants prematurely wear out expensive equipment.

Imperial Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial Cylinder Oil
Imperial Shield Cylinder Oil
Imperial Ebony Cylinder Oil
Imperial Acme Cylinder Oil
Imperial Disc Cylinder Oil
Imperial Dominion Cylinder Oil

ENGINE OILS

Imperial Atlantic Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Standard Gas Engine Oil
Imperial Kearsarge Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Solar Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Eldorado Engine Oil

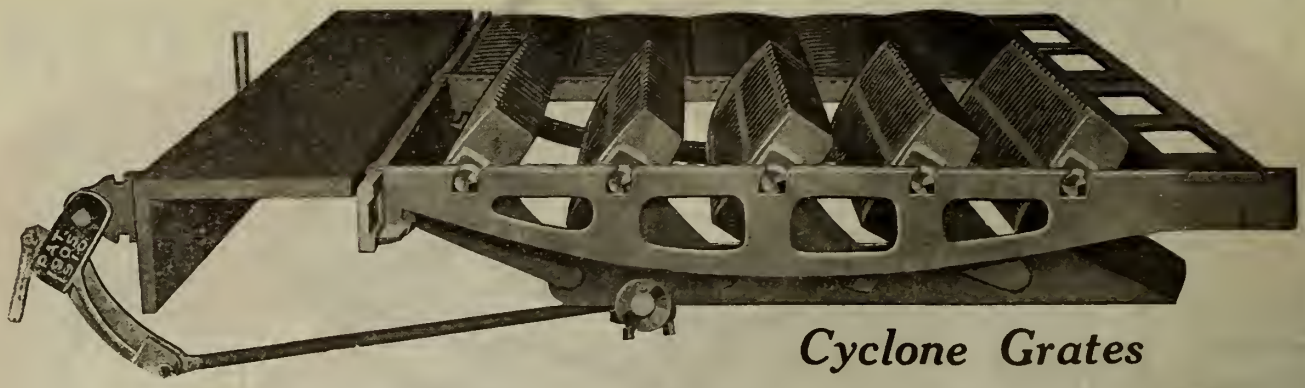
Our Lubrication Engineers will gladly advise you on anything relating to Lubrication. Write us at 56 Church Street, Toronto. All enquiries will receive prompt attention.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

If any advertisement interests you, tear it out now and place with letters to be answered.

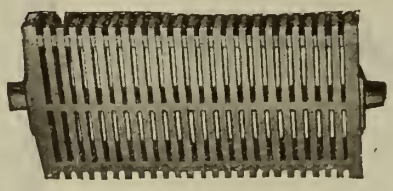


Cyclone Grates

ELIMINATE FUEL WASTE

With coal so high in price Cyclone Grates quickly pay for themselves in saved fuel. You should install them without delay. They burn any grade of fuel, even screenings, and give the necessary results. Their 60% air space and 90% underdraught insures perfect combustion.

There's no clinker formation, no good fuel lost in the ash pit, no waste whatever where Cyclone Improved Shaking and Dumping Grates are used. Cyclone Grates can be installed without delay or trouble. Our 30-day trial offer should interest you. Write to-day.



The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G. 3660 Toronto, Ontario

AGENTS:
ST. JOHN, N.B.—F. W. Blizzard, 329 Charlotte St. MONTREAL—Mason Regulator Co., Ltd., St. James St. HAMILTON—Robt. Fitzsimmons, 8 Grove St. WINNIPEG—Vulcan Iron Works.

HOYT'S FROST KING

HOYT'S Nickel Genuine

Used in gas engines, gasoline engines and all classes of marine engines. This specific purpose Babbitt will give service unsurpassed by any other babbitt made. If your dealer is sold out, have us ship you a trial supply direct.

The Best All-round Babbitt Metal You Can Use

FROST KING is used with efficient and economical results for stationary engines of every class; for rolling mills, planing mills, saw mills and pulp machinery, etc.

It is the best babbitt for high speed and heavy duty, and has lasting qualities.

Try a box of HOYT'S FROST KING and watch the results!

HOYT METAL CO., TORONTO

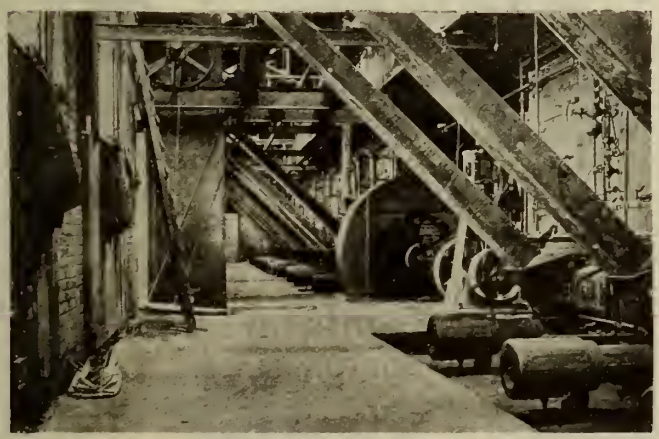
New York, N.Y. London, Eng. St. Louis, Mo.

15 Tons of Coal FREE

Mr. Engineer, does a saving of 15 tons of coal in every 100 tons interest you? This is an immediate and permanent result that comes from the installation of the

JONES UNDERFEED STOKER

It also effects a big saving of labor, automatically maintains a uniform pressure, and responds instantly to load fluctuations. Everything that should be burned to generate steam is consumed—this means no fuel waste.
And there are many other advantages in using the Jones Automatic Stoker.



Serves day in and day out with very little attention.

Ask the user. We'll gladly put you in touch with some in your locality.

Jones Underfeed Stoker Co.
Limited
37-41 Britain St. Toronto, Ont.

With the
Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

Fits any valve

—you always have immediate control of the valve from the floor by simply pulling the chain.

No rods, nor handles; no treacherous stepladders; no lost time.

Your valves should be equipped with Babbitts.

Write for our Catalog, and learn why you can't afford to be without them.

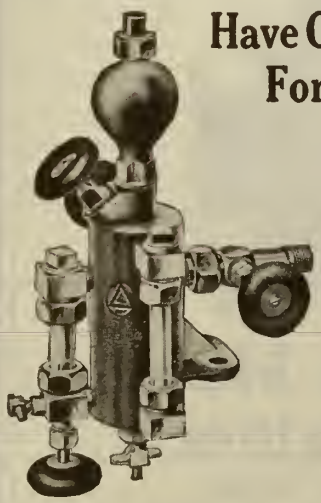
Babbitt Steam Specialty Company
NEW BEDFORD, MASS.

Manufactured in Canada, under Canadian Patents exclusively by the
ENGINEERING SPECIALTIES COMPANY LTD
TORONTO, ONT.
JENKINS BROS., 300 W. Lake St., CHICAGO
Western Distributors

93-26

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

If any advertisement interests you, tear it out now and place with letters to be answered.

SCHAEFFER & BUDENBERG
NEW YORK
It's All Over
And we've won the war. Great, isn't it? Now for good old peace times
But don't forget, boys. The scarcity of coal is serious. We must still economize to keep our plants running — to keep our homes warn.
Don't let's spoil it all by another coal shortage this winter.
Do your bit.
The Schaeffer & Budenberg Mfg. Co.
Makers of Power Plant Efficiency Instruments
BROOKLYN N.Y.
Chicago Philadelphia Pittsburgh
Los Angeles St. Louis
San Francisco
1850
EXPERIENCE
SERVICE
QUALITY
CAPABILITY

MASON

Reducing Valves

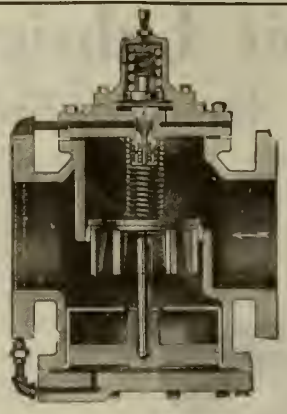
Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.



Kieley & Mueller Specialties

Regulating Valves
Back Pressure Valves
Pump Governors
Separators
Traps

FOR EVERY SERVICE
SALES ENGINEERS
THE ARTHUR S. LEITCH CO.
TORONTO

Having Commutator Troubles?

The Jordan Commutator Truing Device will true your commutators without a shut-down.

Jordan Bros., Inc.
82 Beekman St. New York City, N.Y.

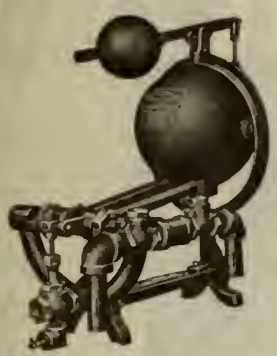
Canadian Representative :
CANADA SALES CO., 183 Church Street, Toronto, Canada

Efficiency and Sufficiency

are both Assured by

"MASON"

Quality and Service



New Bundy Return Trap

Power House Specialties

MASON Reducing Valves (Genuine).
MASON Pump-Governors.
MASON Pressure Controllers.
BUNDY Steam Traps for Every Service.
COPPUS Turbine-driven Blowers.
SIMS Hot Water Generators.
SIMS Open Feed Water Heaters.
BUNDY Oil Separators.
ASHTON Gauges and Safety Valves.
FEDERAL Metallic Packing.
EVERLASTING Blow-off Valves.
STRATTON Steam Separators.
REILLY Multicoil Water Heaters.
REILLY Evaporators and Distillers.
REILLY Multiscreen Feed Water Filters.

Mason No. 55 Style Pump Pressure Regulator

Exceptional industrial conditions demand that your Power Plant be supplied with reliable equipment. "MASON" sales engineers know the practical application of "MASON" specialties to actual conditions—they sell from knowledge and experience, not from catalog. When you adopt "MASON" equipment you GET results.

Full Information Quickly and Gladly Furnished.

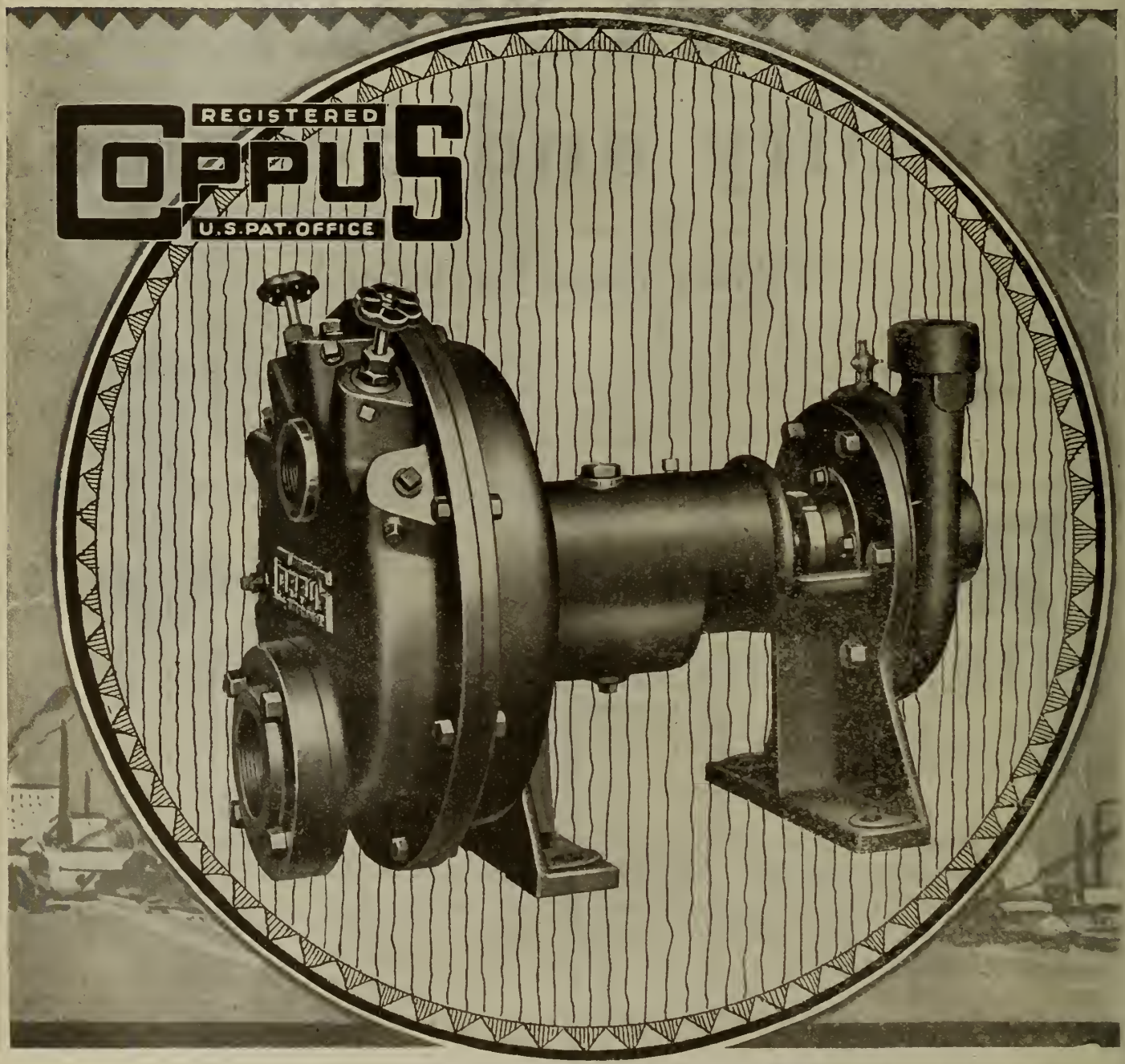
The MASON REGULATOR & ENGINEERING CO., Ltd.

Successors to H. L. PEILER & CO.

Montreal Office and Factory: 135-153 Dagenais St.

Toronto Representative: The Arthur S. Leitch Co., 506 Kent Building

The NEW COPPUS
Centrifugal Turbo Feed Pump

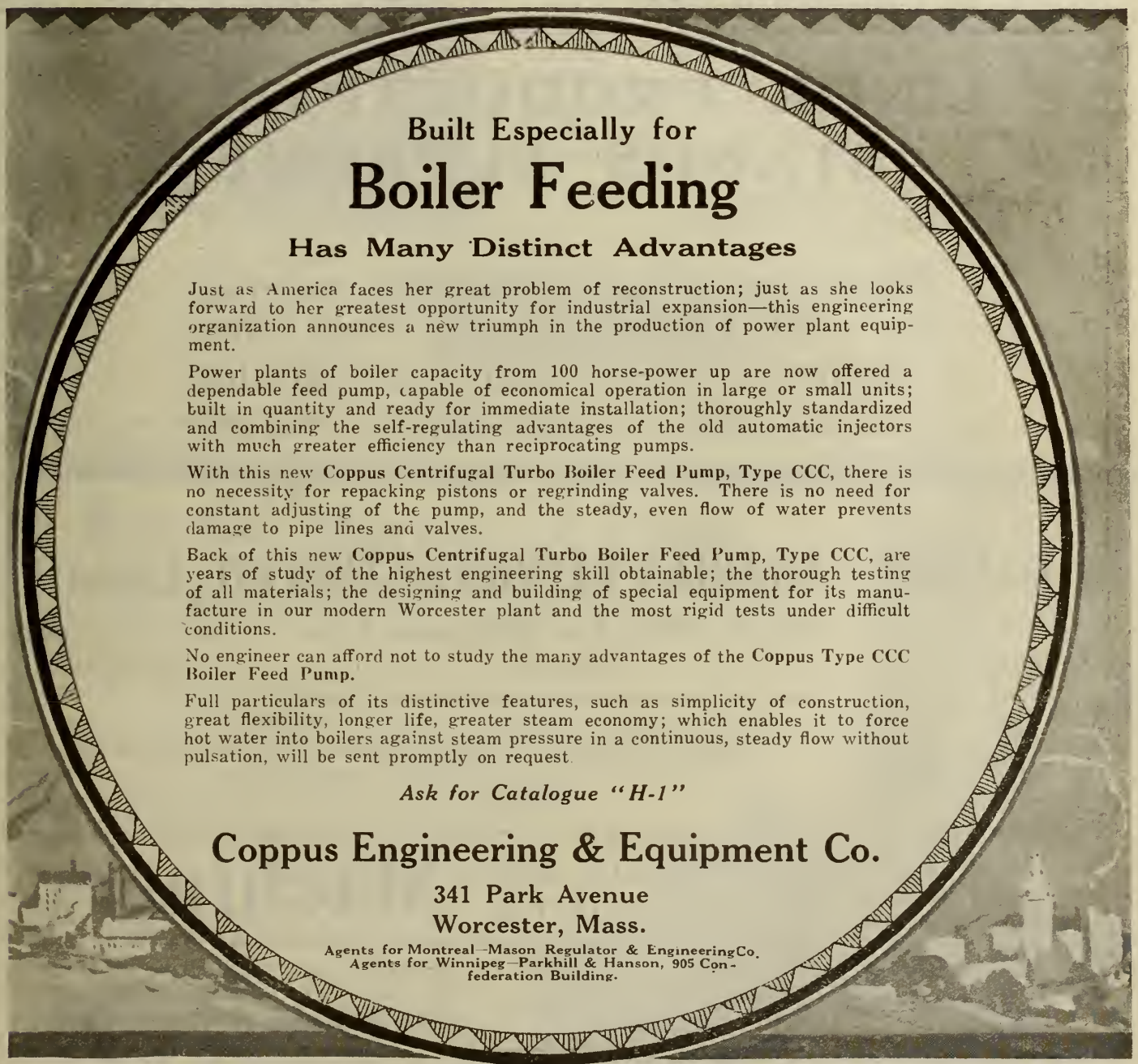


COPPUS ENGINEERING & EQUIPMENT CO.
341 PARK AVENUE
WORCESTER, MASS., U.S.A.

A New Triumph

In the Production of

Power Equipment



Built Especially for

Boiler Feeding

Has Many Distinct Advantages

Just as America faces her great problem of reconstruction; just as she looks forward to her greatest opportunity for industrial expansion—this engineering organization announces a new triumph in the production of power plant equipment.

Power plants of boiler capacity from 100 horse-power up are now offered a dependable feed pump, capable of economical operation in large or small units; built in quantity and ready for immediate installation; thoroughly standardized and combining the self-regulating advantages of the old automatic injectors with much greater efficiency than reciprocating pumps.

With this new **Coppus Centrifugal Turbo Boiler Feed Pump, Type CCC**, there is no necessity for repacking pistons or regrinding valves. There is no need for constant adjusting of the pump, and the steady, even flow of water prevents damage to pipe lines and valves.

Back of this new **Coppus Centrifugal Turbo Boiler Feed Pump, Type CCC**, are years of study of the highest engineering skill obtainable; the thorough testing of all materials; the designing and building of special equipment for its manufacture in our modern Worcester plant and the most rigid tests under difficult conditions.

No engineer can afford not to study the many advantages of the **Coppus Type CCC Boiler Feed Pump.**

Full particulars of its distinctive features, such as simplicity of construction, great flexibility, longer life, greater steam economy; which enables it to force hot water into boilers against steam pressure in a continuous, steady flow without pulsation, will be sent promptly on request.

Ask for Catalogue "H-1"

Coppus Engineering & Equipment Co.

341 Park Avenue
Worcester, Mass.

Agents for Montreal—Mason Regulator & Engineering Co.
Agents for Winnipeg—Parkhill & Hanson, 905 Confederation Building.

Write for Catalog

LINDE PRODUCTION STANDS SUPREME

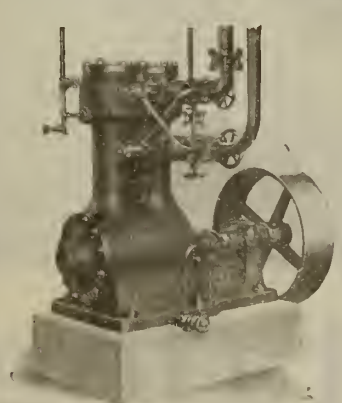
Because at all times really fine materials are used; and because each and every machine receives a degree of individual attention that is impossible in mass production.

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

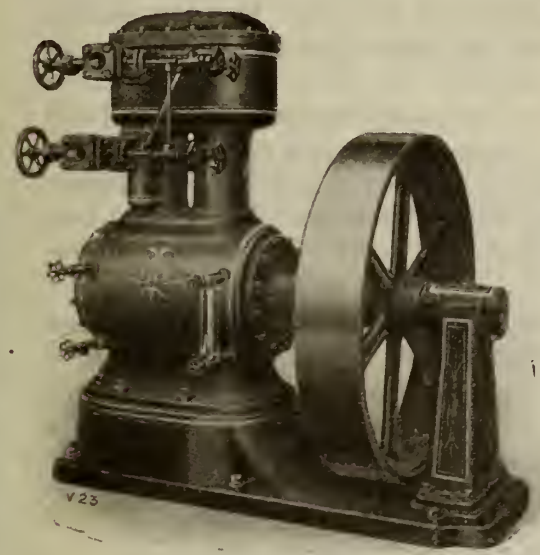
Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

FRICK Machines "Carry On"



It is a fact that FRICK Machines have been "Carrying On" for more than thirty years, meeting all attacks and conditions encountered in every day operation, especially during the busy season, when overloads and extra duty are of common occurrence.

"We are practically running our cold storage plant just as you installed it eighteen years ago; we added a twelve ton fish sharp freezer some dozen years ago, and added four rooms for fruit from time to time, and the machinery installed keeps all running in good shape. Our cost for maintenance and repairs during all these years has been very small, and the machinery looks good for another eighteen years."

(Name on request)

36 YEARS OF SUCCESSFUL REFRIGERATING ENGINEERING EXPERIENCE

Ask for a copy of our list of users covering 48 pages of satisfied customers — also your copy of "Ice and Frost."

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1862

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical — Horizontal — Absorption.

For the Storage of Food

Nowadays, when we have to feed our allies as well as ourselves, it is doubly essential that all food in storage be kept as nearly perfect as possible. Any spoilage means a reduction in the available supply.

That's just one more good reason for using

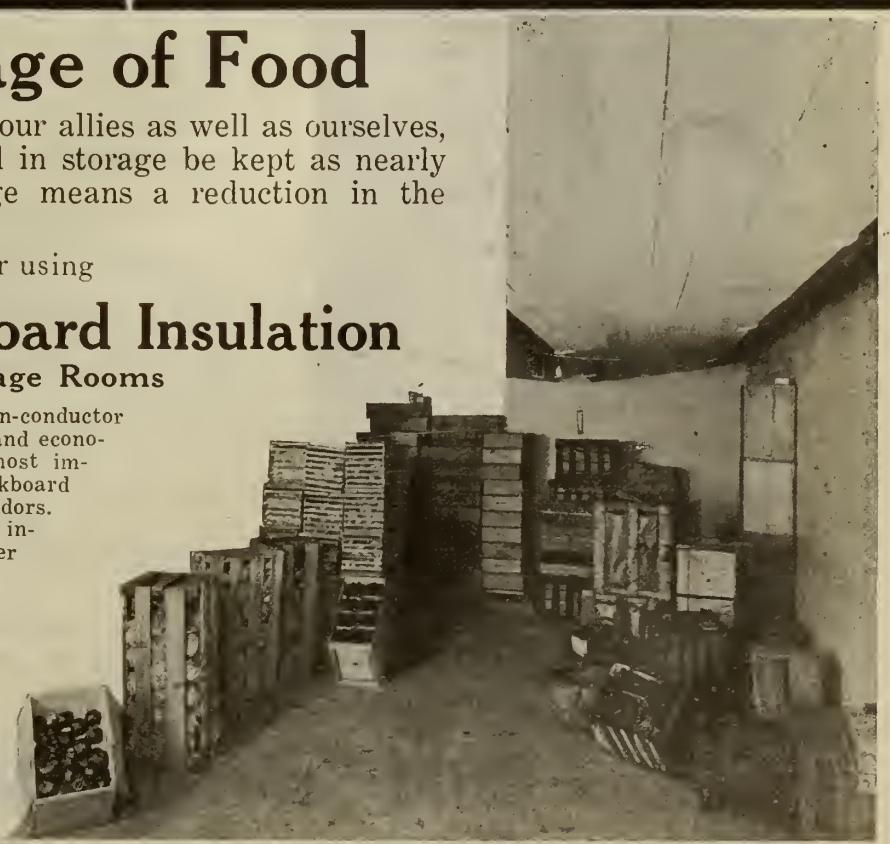
Nonpareil Corkboard Insulation

For Cold Storage Rooms

Because Nonpareil Corkboard is such a good non-conductor of heat, rooms insulated with it can be easily and economically held at the proper temperature—a most important point. Furthermore, Nonpareil Corkboard will not rot, mold or give off offensive odors. Properly erected, it is vermin-proof. Cork insulated rooms, with Portland cement plaster finish, are easily kept in sanitary and hygienic condition, reducing to a minimum the danger of contaminating the goods in storage.

If you are interested in the proper insulation of food storage rooms, write for a copy of the 152-page illustrated book. "Nonpareil Corkboard Insulation." It and a sample of Nonpareil Corkboard will be sent on request, without charge or obligation.

Armstrong Cork & Insulation Co.
504 McGill Building
Montreal, Quebec, Canada



A food storage room in the famous Battle Creek Sanitarium, Battle Creek, Mich., insulated with Nonpareil Corkboard.

A FAIR BARGAIN

It is unjust to charge too much for Refrigerating Machinery and poor business policy to charge too little. There is a point between where the buyer and seller must meet to conclude a fair bargain.

No transaction is ever entirely satisfactory that is not mutually beneficial. Goodwill never becomes an asset of any Manufacturer who charges too much for his product, and no Manufacturer can be successful who sells at less than a fair profit. Either the customer suffers or the firm sooner or later goes out of business. When you buy on the basis of price alone you generally pay for it and then some. Quality is remembered long after the price is forgotten.

If you are interested in Mechanical Refrigeration, we can furnish a plant to meet your local conditions at a fair price, all things considered.

The Quality and Service Guarantees back of all York Products should lead you to give us a chance at your business. Our interest in every plant after it is erected is a further protection to you and an assurance of our good intentions.

An inquiry from you will have our careful attention.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Ice Machine Company

WINNIPEG	TORONTO	MONTREAL	CALGARY
85 Lombard St.	82 Chestnut St.	626 Coristine Bldg.	605 Second St.

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

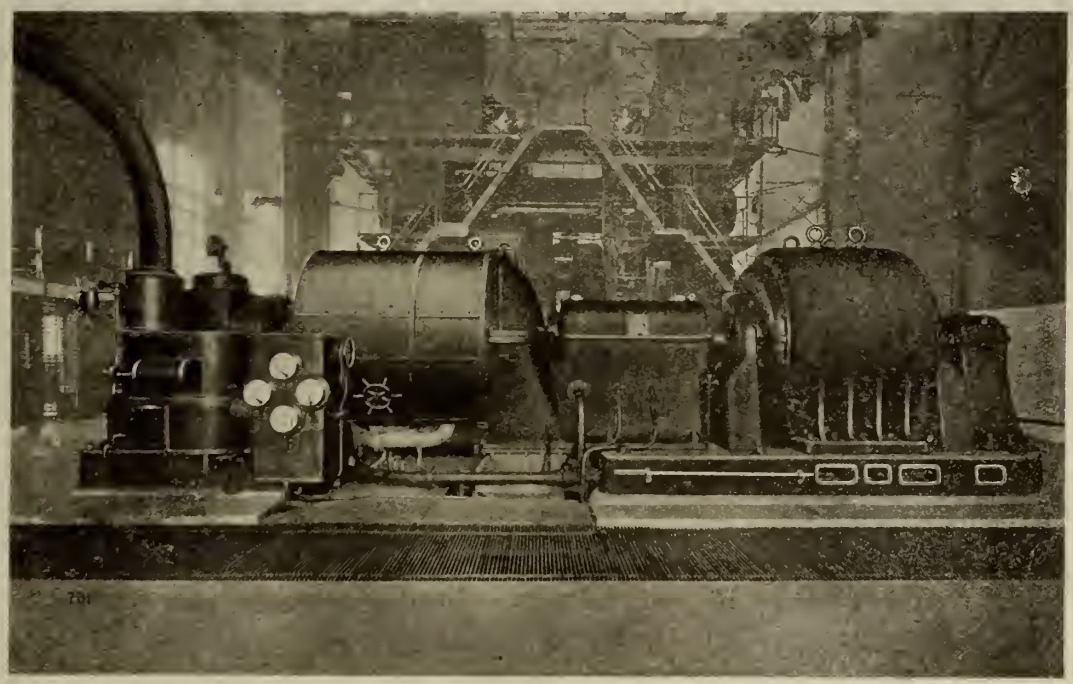
"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. HAGERSTOWN, M.D., U.S.A.

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom 2000 K.W. Steam Turbine at Montreal Tramways Power Plant

Belliss Steam Engines, Steam Turbines, Diesel Engines, Air Compressors, Condensing Plants

Heenan Refuse Destructors, Air Coolers, Water Coolers, Oil Coolers, Dynamometers

Paterson Water Softening Plants and Filters

Centrifugal Pumps

LAURIE & LAMB

Engineers

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The Customer's Viewpoint

PRESENT and future customers can look upon the sales combination of the SANFORD RILEY STOKER COMPANY and the MURPHY IRON WORKS from the viewpoint of service.

While in a sense it is true that each Company will act independently, nevertheless, their *service* efforts will be *united into one constructive force* available from a greater number of strategic points.

This combined service is quite unlike all others. It is designed from the customer's point of view rather than from the builder's. This new service begins with the customer's needs—takes his conditions into consideration —and sees him through.

When in the market for stokers or when you wish advice on the operation of your present equipment, don't overlook the advantages of this new and enlarged service.

Since no two plant conditions are alike you will find it to your advantage to profit by the experience of our engineers. They will gladly analyze your plant conditions and prescribe the remedy. If you will drop a line to our nearest office they will help you to get the most out of your present equipment or suggest new equipment which will save you money, men, and fuel.

Sanford Riley Stoker Co. and Murphy Iron Works

Worcester Boston
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Two Mines with but a single thought

The coal mine and the asbestos mine have a big job in common—maximum production of power.

With the burning of coal in these times goes the obligation to use its heat efficiently. So every ton of fuel mined summons more asbestos from another mine, automatically, to guard jealously the heat from that fuel.

The two mines are racing together toward a common goal.

As the largest factor in the mining and fabrication of asbestos, Johns-Manville bears a burden of heavy responsibility. Asbestos is the fibrous mineral base of the most efficient heat insulations. It is the necessary other 15% in 85% Magnesia.

It is, as well, the basic material for many economical packings which reduce friction, prevent leakage, resist wear, and save power. In almost every plant improvement or extension, asbestos in one form or another is practically indispensable.

This development of asbestos from the status of a little known curiosity to its present rating as an industrial necessity, is due in no small part to Johns-Manville. So we can be doubly proud that when the nation needed Asbestos, our mines and factories, our laboratories and mills, our engineers and chemists, all were ready to play their part in the nation's service.

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Montreal Toronto Vancouver Winnipeg
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To save steam and power, and hence to save coal, specify these Johns-Manville Materials:

Asbesto-Sponge Felted Heat Insolation; 85% Magnesia Sectional Insulatioo; Asbestocel and Air-Cell Sectioal Insulatioos.

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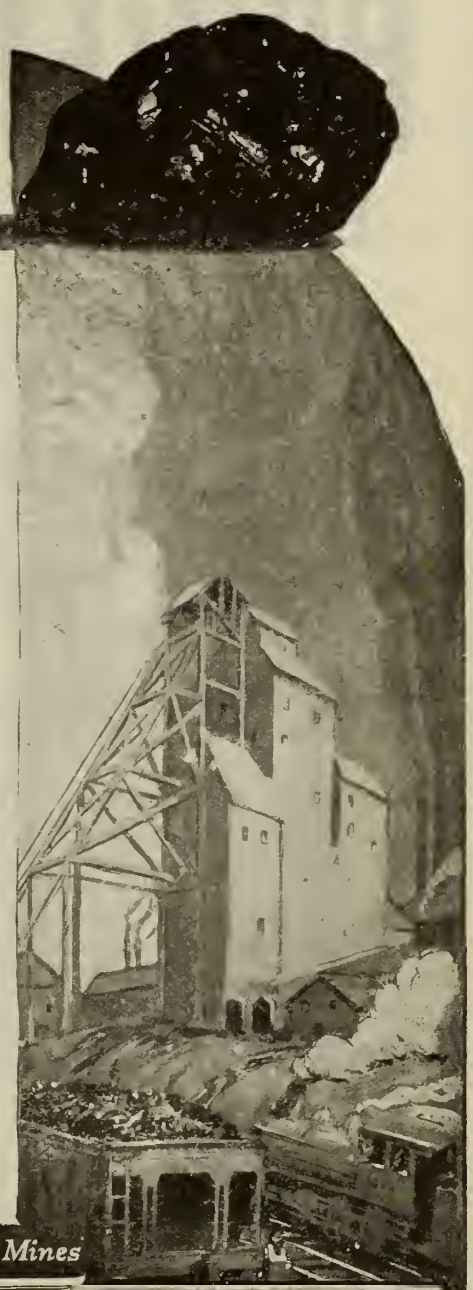

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ROOFINGS *that cut down fire risk*
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PACKINGS *that save power waste*
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If any advertisement interests you, tear it out now and place with letters to be answered.

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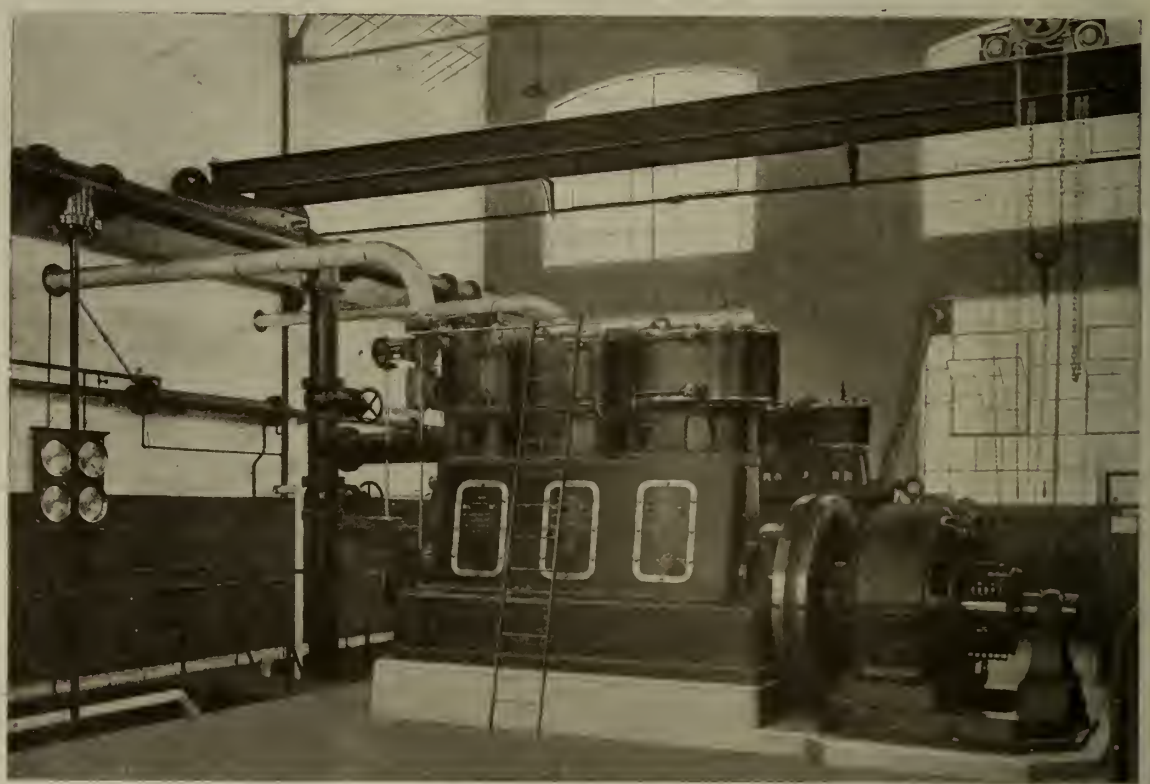
Built to Meet Your Own Requirements



A corner in the Engine Room of our New Power Plant recently erected at our Main South Works. Equipped with G. & McC. Co. Three-Cylinder Compound and Two-Cylinder Compound Vertical Forced Lubrication Steam Engines.

G. & McC. CO. ENGINES and BOILERS

will provide your plant with

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Horizontal and Vertical Steam Engines; Steam Turbines; Return Tubular and Water Tube Boilers; Heaters; Tanks; Pumps and Condensers; Transmission Machinery; Safes, Vaults and Vault Doors.

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POWER HOUSE

Historical Development of the Steam Turbine-- III

The Third Installment of a Series Dealing With Development of the Turbine—Growth in Size of Turbo-Generator Units in Recent Years—Compounding Adopted With Marked Success

THERE has been a lot of misapprehension about turbine blading. With all types of turbines, the design and material of turbine blading have undergone some evolution. Of necessity, blading is subjected to very arduous conditions. It works in a steam current of considerable velocity, the steam often being laden with moisture and sometimes with chemicals, and solid foreign particles as the result of priming boilers. Centrifugal stresses must of course be properly considered, but far more important is the fact that any blading must be able to withstand the tendency to vibrate in the steam current.

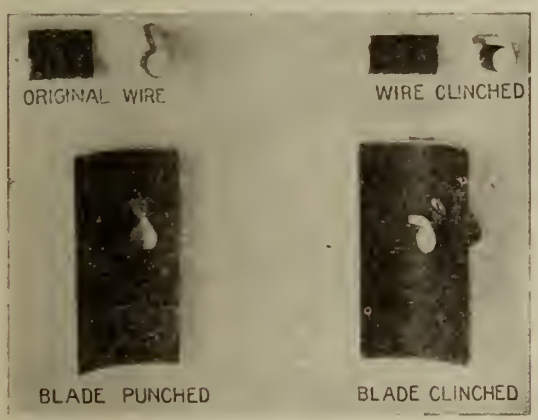


FIG. 27—COMMA WIRE TYPE OF BLADE LASHING.

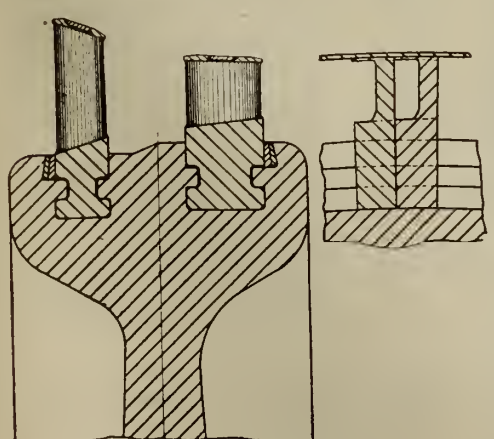


FIG. 28—TWO ROW BLADING.

The characters of the two salient types of turbine elements, impulse and re-action, require quite different blading; the one, massive blade sections, and the other, relatively light sections. However, the strain on the blades due to centrifugal force is the same in either case, and in the event of collision between blades the one is as subject to injury as the other, with the difference, however, that the results may be more far-reaching in the case of the more massive blades. In some early designs, breakages were due to contact between the stationary and revolving elements, resulting from distortion of theh cylinder structures. This has been eliminated by better design of these structures, the elimination of ribs and all unnecessary excrescences which might lead to internal strains in the castings or distortions due to uneven heating and cooling.

The principal cause of the breakage of turbine blades is vibration in the steam current. There are scarcely any records of blades having broken because of centrifugal force per se. Shrouding and other means of bracing the outer ends of turbine blades to each other have been employed to reduce the tendency to vibrate. Such devices increase the natural periodicity, and hence reduce the amplitude of vibration. Later designs of blading have their sections tapered, there being some 40 per cent. more cross-section at the foot than at the tip. With this construction, the deflection due to vibration will be distributed over a considerable length instead of being concentrated at the point of attachment. The later method of attaching re-action blades is shown in Fig. 26, the blades having a foot forged on the end which fits in a groove in the floor of the main groove of the blade-carrying element. The spacers between the blades are dovetailed to correspond with the dovetailing of the main groove, thus completely interlocking the blading and rendering the attachment at strong as the blades themselves. Large blades, like those shown, have their grooves provided with compound wedges which help to fill the grooves more completely. This type of blading was first employed in all commercial turbines in 1911, since which time little trouble has been experienced due to vibration of blades. This construction replaced the re-action blade system devised by Parsons in 1896 which comprised alternate blade and spacing pieces, each drawn to shape and cut to length, and calked in grooves very slightly dovetailed; the root portion of the blades being slightly serrated but friction, the result of calking, was wholly depended upon for securing the blades.

Ingenuity on the part of the builders of re-action turbines has not been lacking in suggesting improvements, but the apparently crude construction of Parsons was not easily to be improved upon, for it is still employed by builders of re-action turbines in Europe. The Fullager system was introduced in 1904, and was employed by the Allis-Chalmers Company in the United States and by William & Robinson in England. The Allis-Chalmers Company were compelled to abandon the riveted shroud portion of the Fullager system on account of a patent covering this, controlled by the General Electric Company. They

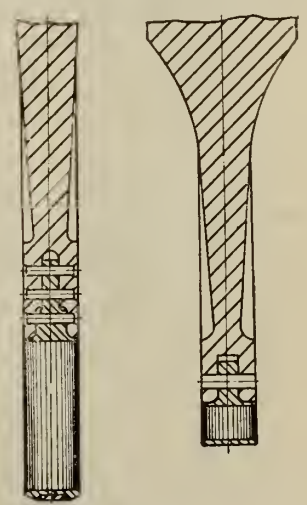


FIG. 29—SINGLE ROW BLADE CONSTRUCTION.

have since made further improvements to their construction.

BLADE LASHINGS

In the earlier machines, the blades were short and steam velocities low, so no blade lashings were required. Earliest blade lashings comprised a metal strip laid in a notch in the side of the blade, laced to the blades with fine wire and silver soldered. This method is still employed in Europe, except the lacing is discontinued and silver soldering relied upon entirely. The Westinghouse Company early abandoned this method and adopted in 1905 what is known as a "comma" wire construction,

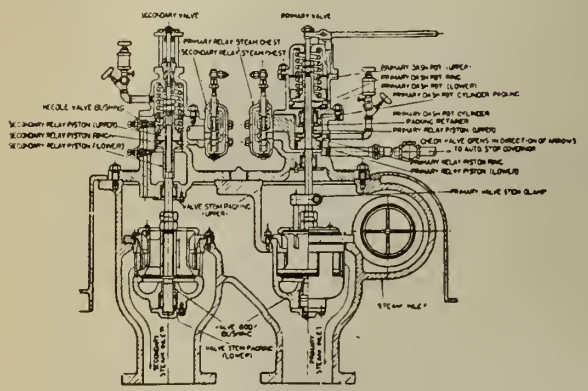


FIG. 30—CONTROL VALVE GEAR.

shown in Fig. 27; the tail of the comma being sheared at the walls of the blade and turned over between the blades, thus forming an abutment against the blades. This construction, while simple, was found after some years of use to be objectionable because of the close inspection required to insure a solid abutment, without which the blade may commence vibrating slightly between the abutments, the vibration increasing its amplitude on account of wear, until rupture is reached.

In the last few years silver soldering of the comma wire has been employed as an insurance and to avoid difficult inspection, the construction otherwise remaining the same. The clinching of the comma wire serves as a ready means of spacing the ends of the blade properly, after which the soldering may be performed. Brazing spelter was for a time employed in order to avoid the high cost of silver. It was found objectionable because the higher heat involved necessitated the blade cooling under some shrinkage stresses, through what appeared to be a critical temperature, sometimes causing rupture.

With later designs, involving large steam volumes at high velocities, the blade lashing is of paramount importance in order to reduce vibration in the steam current, and judgment must be employed in determining the length of segments to obtain the maximum rigidity on the one hand, and to provide the necessary flexibility for expansion on the other; it being remembered that the blading heats and cools at a different rate from the supporting drum or disc.

IMPULSE BLADING

As previously stated, impulse blades partake of a construction different from re-action blading. Generally they are more massive and the fourth wall to the blade passage, formed by a shroud, is always employed. Impulse elements were not employed commercially by the Westinghouse Company until the advent of their single-double-flow combination turbine in 1909. A number of different forms of impulse blade construction have been employed, not all of which are instructive. A modern standard construction of blading for two-row impulse elements is shown in Fig. 28. Two constructions of single row impulse element (Rateau turbine) are shown in Fig. 29. In each case the shroud is integral with the blade. A groove is cut in the shroud into which is inserted a strip of suitable length, which is brazed to the blade. The blade is drawn to the shape corresponding to the shrouded portion, the blade portion between the shroud and base parts being formed by a profiling milling operation.

BLADE MATERIALS

A brass alloy, known as Delta metal, was employed for re-action blades for the earliest machines in this country. Some blade breakages, which no doubt were due to vibration of the blades themselves, were attributed to defects of the material; such as crystallization, due to heating and cooling. Careful trial in a few machines showed us that blading made of ordinary steel would not corrode, so between 1904 and 1907, steel was adopted, and many of these machines are in operation to-day without showing any particular corrosion. However, enough cases of severe corrosion appeared to render the use of ordinary steel blading untenable.

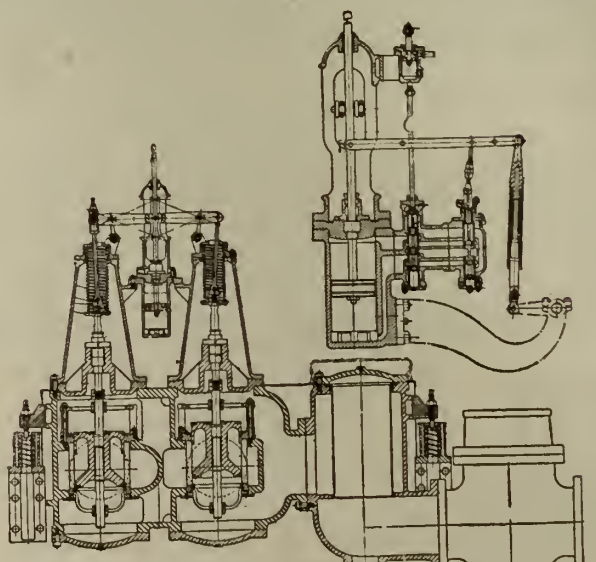


FIG. 31—A MODERN CONTROL VALVE AND ITS RELAY.

The effects were obviously caused by corrosion (not to be confused with erosion) and occurred mostly at the dew point, that is, at the zone of the turbine where, on account of latent heat being given up, superheat is lost and moisture commences to be precipitated. The cause of corrosion in power house apparatus seems obscure; it exists in one plant, and is absent in another, and the analytical chemist has not been of material assistance in determining specific causes. No doubt injudicious use of boiler compounds and the presence of unsatisfied oxygen with pure water were among the reasons.

In 1907 blades were made from Monnel metal, the original steel ingot having 25 per cent. of copper welded to the outside by a proprietary process, subsequent rolling and drawing still maintaining the proportion of copper in the final blade shape. While more resistant to corrosion they are by no means immune. So a bronze alloy was again adopted; this time using an alloy containing copper 97 to 98 per cent., tin 2 to 3 per cent., phosphor 0.03 to 0.07 per cent., which for moderate stresses is still employed. For higher stresses and impulse blading a low carbon steel is employed, having a carbon content not to exceed 0.08 per cent., combined with 5 per cent. nickel. This is practically a nickel iron, manufactured in an electric furnace.

The quality of material has always been considered as being a considerable factor in the ability of a blade to resist fracture under vibrating stresses. No doubt homogeneity is important, and some low carbon steel made by ordinary processes has failed for lack of it. It would appear that while the strength of a section under tension depends upon he taverage strength of the fibres, the ability to resist vibration is perhaps only dependent upon the strength of the weakest fibre.

A variety of materials have been suggested for blading, and employed at one time or other by various manufacturers; a few may be commented upon as follows:

NICKEL-STEEL, higher in both nickel and carbon than that mentioned above, is used in Europe, but alleged to be by no means immune from corrosion.

NICKEL-BRONZE (80-82) has been successfully employed by some manufacturers. It is alleged to become brittle by absorbing carbon monoxide should it be present in the steam.

MONEL METAL has satisfactory characteristics but it is difficult to work and varies in composition.

NICKEL, if pure, has satisfactory physical characteristics and is immune from corrosion.

GLANDS

In their early turbine work, the Westinghouse Company employed a steam labyrinth similar to that employed by

Parsons. It had the objection that to provide enough sealing steam to preclude air leakage invariably meant an objectionable leakage to the engine-room. In 1903 was developed the well known water gland which has been employed without material change until this time. It comprises simply a double centrifugal pump operating in a chamber. It is provided at its periphery with water, say of five pounds greater pressure than the pressure against which it is designed to pack; the pump thus maintains an annulus of water at the outer edge which forms a very complete seal.

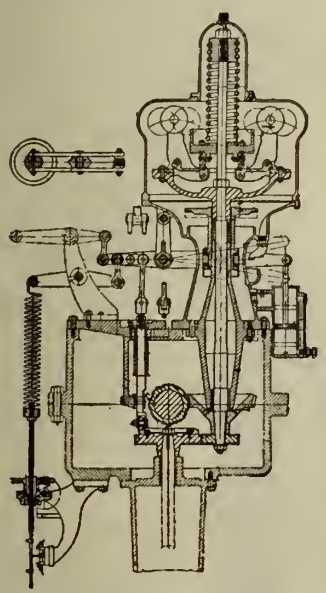


FIG. 32—GOVERNOR DETAIL.

The advent of water glands reduced a troublesome and difficult detail to one causing no concern to either the designer or the manufacturer. It is extremely simple in operation, requiring only a supply of water of the requisite pressure. This is best supplied by a float valve and tank located at the proper elevation. Inasmuch as there is some evaporation taking place in the gland, in part due to transfer of heat along the cylinder wall and to fluid friction of the fluid itself, water containing scale forming matter should not be used, so the gland is preferably supplied with condensate.

This type of gland has been extended to use with marine propelling machinery, in which case the gland must pack at any rotational speed in either direction, so a labyrinth pack is provided in combination with the water seal. Further the turbine governor is arranged to turn off the water supply and admit steam through a reducing valve to the labyrinth automatically, whenever the speed of the turbine is reduced below that at which the water gland can seal, usually about half speed. This is accomplished by providing the governor with two springs, one heavier than the other. The first half of the governor travel compresses the lighter spring at only about half full speed. The governor on reaching this position, operates a relay, turning steam on and water off, or vice-versa, according to whether the turbine is being accelerated or retarded. On the turbine reaching full speed, the governor will go to the outer half of its travel, compressing the heavier spring and controlling the main steam admission.

BEARINGS

The bearings devised by Parsons in 1890, comprising a shell surrounded by three concentric sleeves, are still employed for turbines that operate above their critical speed. Such turbines, however, are few in number, for so far as practicable, all modern machines operate below their critical speeds. For these, ordinary cast-iron bearing shells are employed, lined with babbit. The progress represented in them is that pressures per square inch of projected area have gone from 50 to 120 pounds and surface speeds from 50 to 80 or 90 feet per second, and it is believed that the duty to which such a bearing can be subjected is considerably beyond these limits.

An innovation introduced by the Westinghouse Company at the inception of their turbine work, was to provide the turbine bearing shells with four keys fitted in recesses on the outside. These keys have sheet metal liners beneath them, and are turned spherically to suit the housing which supports the bearing, the bearing being supported by the keys in the pedestal. Removal of liners from one side to the other provides a very definite adjustment of the rotor in the turbine cylinder. By these means the position of the rotor may be easily determined as well as definite knowledge of the least radial clearance obtained. The rotor may be displaced by definite amounts, and the rotor meantime revolved, permitting an adjustment of position to be made that beyond peradventure is what is required.

THRUST BEARING

The thrust bearing, comprising a number of collars, has been replaced by the Kingsbury thrust bearing which is capable of supporting an enormous thrust, enabling turbines to be constructed to have a considerable normal end thrust, and permitting the reduction of diameters of balancing pistons and the like. Furthermore, with such bearings an accurate balancing of the turbine, so that there shall be no end thrust, is no longer necessary. These thrust bearings operate satisfactorily with pressures as high as 500 pounds per square inch of actual bearing surface. They have been operated experimentally with pressures as high as 5,000 pounds per square inch without heating. Dr. Kingsbury has secured a variety of applications for his bearing for the main propeller thrust bearing; required, including heavy vertical generators. Most modern geared turbine steamers are being equipped with them for the main propeller thrust bearing; the multicollar type of marine thrust bearing, seven or eight feet long, being replaced by a single disc occupying an axial dimension of less than two feet.

GOVERNOR AND GOVERNOR VALVES

A speed-responsive centrifugal type of governor has always been employed in this country. A development of detail design has occurred which is of considerable interest, but would be of too great length to be described here. The result is the employment to-day of governors of large power and of such construction as to assure a perfectly constant rate of speed variation.

At the time the Westinghouse Company became a licensee of Parsons, it was Parsons' custom to control all machines by an electrical governor, comprising a solenoid actuating a steam relay. The solenoids were compounded and could be arranged to maintain substantially constant voltage, in which case the turbine operated at higher speed at full load than at friction load in accordance with the generator characteristics. Parsons was able to obtain excellent regulation from a solenoid, by introducing a constant oscillation to the lever system that connected the relay with the armature of the solenoid, effectively eliminating friction of rest. This also oscillated the relay, causing a quite violent opening and closing of the main valve and admitting the steam to the turbine in puffs. At that time

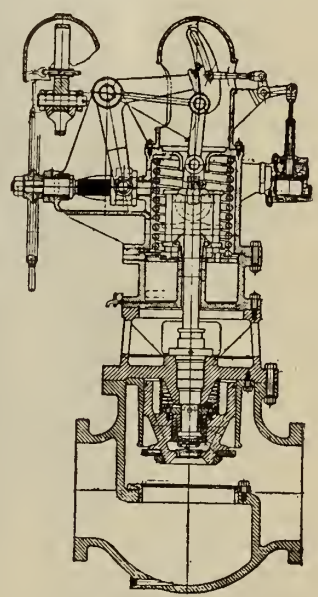


FIG. 33—TURBINE THROTTLE VALVE.

there were few cases in Europe where alternating-current generators operated in parallel, so the electrical governor was satisfactory.

The governor control employed by the Westinghouse Company in their earliest machines employed a similar steam relay, substituting a speed responsive fly-ball governor for the Parsons solenoid. The steam relay went through a process of elaboration and improvement. Arrangements were developed for the automatic operation of by-pass valves by the same system to enable the turbine to carry heavy overloads. An example of this valve gear is shown in Fig. 30.

The character and the quickness of

governing to be obtained with such mechanism left nothing to be desired. An objection to it was that its method of operation was not obvious to the observer, and the cause of any little derangement was not easily diagnosed. Later with the advent of larger machines, the puff system of admitting steam was found to cause at times objectionable re-action and vibration in the main steam lines of the power house, so that by 1909 the steam relay began to be abandoned for the well-known hydraulic relay and floating lever that is employed to-day, using oil at 50 pounds pressure provided by the regular turbine oiling system. At this time it was arranged that in cases of smaller turbines, where the steam flow was 20,000 pounds or less per hour, no steam relay would be employed, the regular governor being sufficiently powerful to operate the valves direct.

In the earlier machines, cast iron or ordinary bronze, double-heat, poppet valves were thought good enough. The higher superheats and larger capacities of to-day have brought about considerable changes in these parts. A high grade nickel bronze is employed for quite small sizes. Generally steel is employed for all parts, the seats in both the valve and cage being formed by monel metal rings suitably secured in place, the life of which appears indefinite. A modern control valve with its relay for a large turbine is shown in Fig. 31, and the design of the governor controlling it, Fig. 32.

Automatic Stop Governors

All machines except the earliest have been provided with automatic stops. There has been no particular change in these during the last ten years. In earlier machines it was thought preferable that the automatic stop governor that the automatic stop governor should operate a separate and distinct valve in the main steam line. This was found objectionable in some cases as the separate automatic valve would never be operated except in the emergency when, on account of long disuse, it may be found to be inoperative. It was therefore abandoned and the main throttle valve itself arranged to be operated automatically by the stop governor. The advantage of such an arrangement is: first, the valve must necessarily be maintained tight; second, of necessity it must be operated every time the turbine is started or stopped; and third, the valve may be partially closed even while the turbine is operating, so there may be assurance of no sticking in the pistons, etc. Fig. 33 represents a modern throttle valve of this type. The seats are of monel metal which appears to be the metal most capable of resisting the erosive action of steam.

13,200 2,300 575-VOLT MOLONEY TRANSFORMER, SINGLE PHASE, 1,500 KV-A. CAPACITY.

NEW DEVELOPMENT IN TRANSFORMER CASES

The accompanying illustration shows a new departure in the making of oil-tight transformer cases. As is well known to operating engineers, the usual type of case with the corrugations cast into the base is a constant source of trouble. In the case illustrated the Canadian Moloney Electric Co., Bank of Hamilton Building, Toronto, have produced an all steel arrangement which is absolutely oil tight. The bottom of sheet steel is cut to fit the corrugations of the case by the oxy-acetylene cutting torch and is then solidly welded to it by the same means. This ensures an absolutely oil-tight joint and no trouble is experienced through expansion troubles as the bottom and sides are of the same material and have the same co-efficient of expansion.

It will be noticed that a solid sub-base is provided. equipped with eyebolt for block and tackle wide wheels. By the use of wheels it is found possible to move the transformer, weighing fifteen tons, with the use of six men, no jacking or other work of like nature being required.

A quick opening gate valve, on the oil connection is provided, and a special oil-tight connection enables self-draining connections to be made on the transformer water cooling coils.

The transformer illustrated is being erected in the shop and is of 1,500 kva. capacity, three-phase, oil insulated, water cooled. The primary voltage is 13,200 and the secondary either 2,300 or 550. Three of these have been insulated at Leaside Munitions in Toronto.

The illustration gives an excellent idea of the coils method of bracing and the arrangement of the leads to the terminal board.

HOW TO SAVE COAL

Coal is the chief form of fuel used in the generation of steam, though wood is still available in some sections, particularly in connection with saw mills. Oil and natural gas are used where they can be had at a cost that is not prohibitive, and the gases from blast furnaces are used to a considerable extent in the iron regions. Waste and refuse of many kinds are likewise burned with success for steam generation, though special furnaces are usually required, adapted to each particular kind of fuel. Coal being by far the commonest fuel, it will be assumed to be used, throughout the following pages, except where the contrary is expressly indicated.

In general, it is more economical to burn soft coal than hard, though this will vary somewhat with the locality, and also with the nature of the output of the plant. In some cases freedom from smoke is the determining factor, etiher because of local ordinances against smoke, or because smoke or some of the other volatile substances that are given off by soft coal would be detrimental to the product that is manufactured. In this latter case "economy" has to be construed in its broadest sense, as including the operation of the plant as a whole.

The Power Plant of the Simpson Knitting Mills

A Power Plant Where Isolated Plant and Control Station Service Combine to Give Economy in Operation — Large Amount of Steam is Used For Industrial Plant Purposes

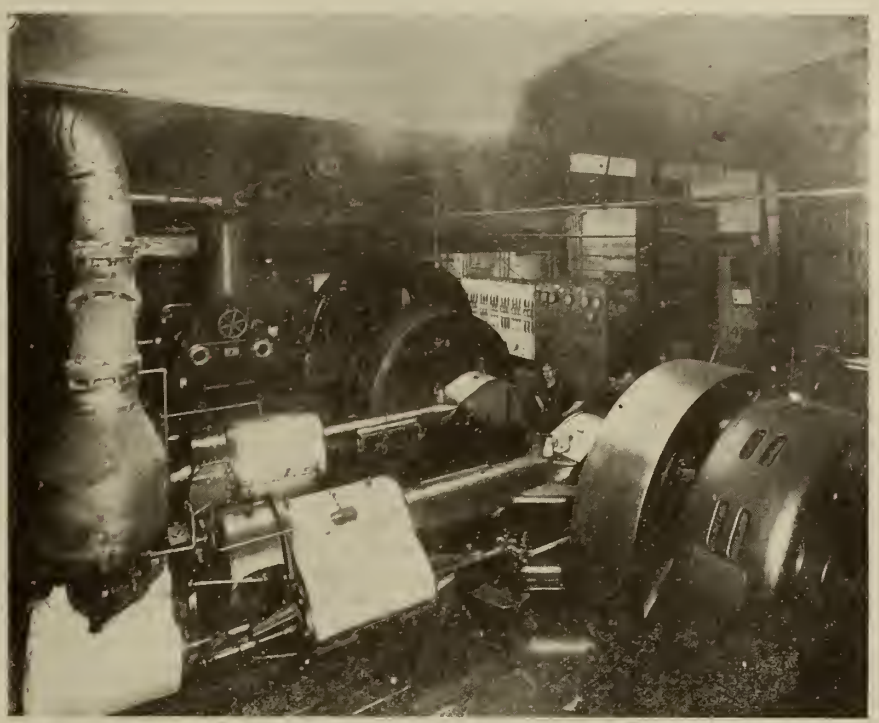
By HUGH CLARK, Chief Engineer

THE power plant of the Simpson Knitting Mills, Toronto, has been in continuous operation night and day for the past ten years, and since the commencement of the war, now happily past, the firm has supplied war material for every one of the Allied Governments and has succeeded in maintaining its domestic trade as well as filling with promptness the requirements of the Allies.

Boiler Room

Five horizontal return tubular boilers are installed. These boilers are 72 in. by 18 ft. and are fitted with 72 four-inch tubes. Three of these are of Goldie and McCulloch make and the remaining two are of John Inglis make. In addition to these boilers there is also installed one 400 hp. Robb Brady Scotch boiler.

The boilers are fed from an open Webster feed-water heater by a 10x7x12 outside packed Martin duplex pump, with a similar pump in reserve. The feed-water is heated to 200° Fah. with the exhaust from the engines, and the heater also receives the returns from the heating system. These latter are brought back through a Martin 6 x 10 x 12 Martin vacuum pump.



VIEW OF ENGINE ROOM

The plant requires a considerable amount of hot water for dying, washing and scouring the wool used. This water is heated in two closed heaters, also heated by exhaust steam and the process water is delivered at a high temperature, making for greater efficiency and economy in manufacturing.

Exhaust steam is also used for drying the raw stock after washing, and also for drying the finished fabric.

A hydraulic power pump is also used for humidifying the atmosphere, a very essential factor in the carding and spinning of cotton yarns.

Engine Room

The main engine room is set entirely apart from the boiler room and the units consist of three distinct sets. The largest unit is a Robb Armstrong 28x39x30 cross compound non-condensing engine running at 120 revs. per min. This engine is direct connected to a Swedish General Electric three phase, sixty cycle, 600 volt alternator. The other two sets consist of two 16x26x18 Goldie and McCulloch tandem compound non-condensing engines running at 200 revs. per min. and direct connected to 250 k.w. 8 sixty-cycle alternators; also generating current at 600 volts, three phase. These generators are of Canadian General Electric make.

The generators are excited from a 20 k.w. 125 volt d.c. Swedish General Electric generator, driven by an eight by eight Robb Armstrong vertical engine, running at 400 revs. per min., direct connected to the generator.

A motor generator set is used as an auxiliary source of excitation. This unit is of Swedish General Electric make and consists of a 25 k.w. 125 volt d.c. generator driven by a 600 volt, 1,150 rev. per min., 40 h.p. induction motor.

The main generators are run in parallel, synchronizing being done by means of lamps.

Central Station Energy Used

At present 75 per cent. of the power is taken from the Toronto Electric Light Co. From four to 7 p.m. the large unit is used and carries the load during the Central Station peak. A transformer house also forms part of the equipment, six 100 k.w. transformers stepping the primary voltage of 4,000 down to 600.

Switchboard

The main switchboard consists of five white marble panels, three ft. by seven in size. The switching equipment consists of eight 200 amp., double pole, three pole switches, and two 400 amp. switches of similar type. Each circuit is also fitted with a three-pole Swedish General Electric oil switch. All circuits are metered by Terranti ammeters.

The Central Station busbars are on top and the company's own on the bottom, and ease and flexibility in operation are obtained by the excellent design of the board. There are five machine panels, all fitted with the latest operating devices, such as inverse time element relays, circuit breakers, ammeters, voltmeters, and a recording voltmeter.

BUYING COAL IS A SCIENCE

The best method of buying coal will vary with the quantity that is used. In small plants the cost of making frequent analyses and tests is usually prohibitive, and in such cases the buyer must be guided by general considerations, rather than by an accurate knowledge of the heating value of the fuel. He should see that the coal has been freshly mined, and that it comes from mines which yield a uniform and satisfactory product, as judged by his own experience or by that of others. It is better, in general, to be content with a supply of known and proved worth, rather than to experiment on any large scale with untried mines or sources. Experimenting in a small way may be encouraged, however, if the results are checked up by actual steaming tests, so that positive and reliable information is obtained, for future guidance. It is safest for the small buyer to deal with a merchant who has a good reputation to maintain, even though the first cost of the fuel is a little higher.

Systems of Hot Water Heating Explained

Gravity System Principles of Action and Causes of Failure—Proportioning and Layout of Installation—Honeywell System—Forced Circulation System—Advantages of Hot Water Heating Over Steam

By S. BALMFIRTH

WATER in motion is the best medium for absorbing heat, transmitting same to required points and there delivering. Still water is a poor absorbent, but in circulation absorbs heat rapidly. Having high specific heat or absorbing capacity, it lends itself readily to man's use for heating, so that in most buildings of any considerable size hot water is becoming the favorite method of heating.

Systems

Gravity open
Gravity closed
these are not controlled. Honeywell or circulation booster, forced circulation systems.

The first system consists of one boiler, piping, radiators and expansion tank. In this system the water is heated in the boiler, which is placed in the basement of the building and circulates through the piping to the radiators where it delivers up its heat and flows back to the boiler again. This sounds quite simple and so it is, but it might pay us to investigate a little and find out why and how this is done.

Gravity System

We will assume a gravity system of open type, in a house of, say, two storeys and basement, giving a total height of about twenty-five feet. Water weighs approximately 62.5 lbs. per cubic foot, so that for every foot in height we have a pressure of 62.5÷144=.434 lbs. per sq. in., so that at the lowest point in our system, we have a pressure of .434× 25=10.85 lbs. per sq. in. with water at its greatest density, that is, 39 deg. F. However, for conveniences, we will assume the water to be at ordinary temperature, say 50 deg. F. We will further assume that the system is filled, air all out of the radiators, and all ready for starting up. Now, if the fire be lighted, a change of conditions takes place. The water in the boiler is heated and at once expands, taking up more space, therefore becoming lighter in weight, volume for volume. At 150 deg. F. water weighs 61.18 lbs. per cubic foot, a reduction in weight of 1.23 lbs. from its original weight, at 50 deg. F. This gives a pressure per square inch of .425 lbs., very nearly, per foot in height. Now, if we could imagine that no water from the return side of the heating system were admitted to the boiler. and also that the water in the boiler and flow risers was heated, right up to the top to temperature already given, 150 deg., we should have a difference in pressure of (.434—.425) x 25 = .225 lbs. per sq. in.

Assume now that the water from the return side be admitted to the boiler, then we should have two columns of water of different weights with a common base. Naturally this cannot be, as we know. Water will flow in from the return side of the system because that side is the heavier, and the heated water will flow into the radiators, giving up its heat, down the return side to the boiler, where it is reheated and starts on the same cycle again.

Causes of Faulty Action

This illustration will give us not only the why of hot water heating, but also the why not, for it also discloses the reason that so many hot water installations are not the successes that they deserve to be. The figures given show that for a height of 25 ft. and a difference in temperature of 100 deg., we have a difference in pressure of only .225 lb. per sq. in., less than ¼ of 1-lb., and when we consider that 20 deg. to 25 deg. difference is all that is allowed between flow and return temperature in hot water heating systems, which gives a pressure of only .065 lbs. per sq. in., we can see that it is necessary to be very careful in the lay-out of a hot water system if it is to work efficiently and economically.

Proportioning

I do not intend or expect to show anything new or startling, or even original, but propose just to see what it is necessary to consider in the lay-out of a good hot water job. First, a properly prepared plan.

By a properly prepared plan, I mean one in which everything appertaining to the job has been figured out. The ground floor plan should be drawn to scale, and the risers marked in on it with the footage they are to supply, and the style of connection between main and branch. Also the amount of radiation should be calculated, not put in by guess, or cubical contents method, or any old rule of thumb, but scientifically (that much abused word) by the heat loss method. This rule takes into consideration the amount of fresh air required in each room, as well as the exposed area of wall and glass. This is the rule:

Add results obtained and divided by 160 for sq. ft. of direct hot water radiation required. Add results and divide by 250 for steam. Secondly, a properly proportioned boiler, well set up and having ample draft. When I say properly proportioned, I mean a boiler which has sufficient heating surface for the work it has to do, yet at the same time not so large that the circulation through it will be sluggish, or that the fire will require to be checked down all the time, nor yet so small that it is necessary to keep all drafts wide open in order to get the work out of it.

When we consider that out of the 12,000 or so B.t.u. in every pound of anthracite coal, only 8,000 are available for useful work, the rest being lost in radiation, leakages, producing draft and other boiler losses, it becomes obvious that too much care cannot be bestowed upon the selection and installation of the boiler. There are any number of good makes of boilers for this purpose. so that the matter of selection is fairly easy, but here are some of the requirements for a good boiler:

1st. It should be built of few parts.

2nd. It should permit of easy cleaning.

3rd. The sections should be fairly thin, so that the boiler does not hold too much water.

4th. The fire pot should be not less than eight inches deep.

5th. The grates should be, of course. shaking grates, but should be in two or more sections, if at all possible in the size of boiler.

6th. The boiler should be installed where there is sufficient room for a man to get around it, not down in a pit where the attendant has to jump down two or three feet every time he has to clean fires. Further, as far as possible. the boiler should be installed as nearly equi-distant from the risers as possible. and as close to the chimney as possible to avoid a long fule.

These requirements may or may not be obtainable in one boiler or installation, but they are the main points. Having obtained the boiler and seen to its proper installation, the next thing to do

For ½ air change per hour multiply.....	20	10	½	—10	—20	Outside temperatures	
cubic contents by	.5	.6	.7	.8	.9	"	"
" 1 air change per hour	1.0	1.2	1.4	1.6	1.8	"	"
" 1½ air change per hour	1.5	1.8	2.1	2.4	2.7	"	"
" 2 air changes per hour	2.0	2.4	2.8	3.2	3.6	"	"
Multiply exposed glass by	50.	65.	75.	85.	95.	"	"
Multiply exposed wall by	17.	20.	25.	27.	30.	"	"

Use co-efficient for ½ air change for rooms only requiring tempering.
Use co-efficient for 1 air change for bedrooms.
Use co-efficient for 1½ air changes for living rooms.
Use co-efficient for 2 air changes for halls, bath and exposed rooms.

is to lay in the mains. Right here is a splendid chance to make or mar the whole system. I have one building in my care which it is impossible to heat, through wrong design, although the boiler is amply large. The sizes of the mains are, of course, decided by the amount of radiation they are to serve. The following sizes of mains are taken from Kent's Handbook:

CAPACITY OF MAINS 100 FEET LONG

Inches.	Two Pipes Feet.	One Pipe Feet.
1¼	75	45
1½	107	65
2	200	121
2½	314	190
3	540	328
3½	780	474
4	1,060	645
5	1,860	1,135
6	2,960	1,800
7	4,280	2,700
8	5,850	3,500

Capacity of mains 100 ft. long expressed in the number of square feet of hot water radiating surface they will supply, the radiators being placed in rooms at 70° and 20° drop assumed. There is a danger of making the mains and risers too large and thereby checking the circulation. It must be remembered that the larger the mains, the greater will be the amount of water contained, and as this water is to be heated, it naturally follows that the circulation will be sluggish, and as the success of a hot water system depends upon the rapidity of its circulation, it will be seen that this is a most important point.

One small detail I might mention here is, to have all pipe ends reamed out clean, as a burr on a pipe reduces the area of cross section by fully 25 per cent. in the smaller sizes and also gives rise to small eddies, all of which tend to impede the circulation. All mains, both flow and return, should have a rise from the boiler of not less than 1 in. in 10 ft. The next point to watch is the way the branches are connected to the mains. Anyone who has watched a gravity hot water system at work from the time of its lighting up, will remember that the hot water flows along the the top of the pipe, that is, the top of pipe always gets hot first. So a little reasoning will show that if the first branch off the main be connected at the top, it will get the hottest water, and the other branches will naturally have a poorer circulation.

To avoid short-circuiting of the nearest radiators, therefore, with the natural result of robbing the further ones, it will be necessary to arrange to introduce friction into the circuits of the nearest, or rather to equalize all the circuits so that short-circuiting shall not take place. The ideal system is one in which the circulation to all radiators is equal, thereby ensuring water equally hot, and as it is obviously impossible to have the boiler equi-distant from all radiators or even to have all the mains and branches carry the same amount of radiation, some means of balancing the friction on the different mains and branches must be considered.

Assuming 4 branches on 2 mains; the first branch from the boiler should be made, generally speaking, with a tee turned down at an angle of 45 deg. and nipple and tee at the bottom plugged for cleaning, and then with a nipple in the tee and a 45 deg. ell, we have the first branch. The second branch should be taken off horizontally, the third with a tee turned up at an angle of 45 deg. and the last turned directly up from the main. If the amount of radiation does not call for a main of over 2 in. at the boiler, it should not be reduced below 1¼ in. at the end of the main. It may be necessary to vent the mains at different points.

To avoid short-circuiting of the system, the ground floor radiators should have a separate return main, which should enter the return header close to the boiler. If this is not done, the radiators on the ground floor will not heat properly, because the circulation will be held up by the cooler water from the other radiators. When making connections for the ground floor radiators off the risers, it is better to use O. S. tees or to use a connection like sketch. This will prevent the radiators on the upper floors from robbing those on the ground floor.

Expansion Tank

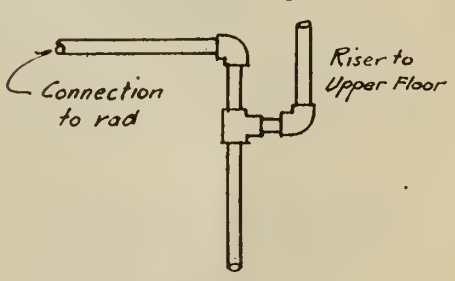
The expansion tank is, as its name implies, installed to take care of the expansion of the water. As water expands about 1-23 of its volume, from 50 deg. F. to 185 deg. F., it will be seen that a tank whose volume is 1-20 of that of the water in the system will be about right. This will take care of all expansion, and having ample room, will avoid the necessity of adding fresh water to the system due to boiling over. Most expansion tanks are too small, thereby causing an unnecessary expense in the operation of the system. For if the tank be too small, the system filled with cold water with the water showing in the gauge glass, then as the water is heated, the tank will overflow, carrying away heat. Now, as the outside temperature varies considerably, so must the temperature of the water vary. If the water has overflowed to any extent while the system was very hot, then cold water must be added to make up the loss, as the system cools off and as this fresh water must be heated it will readily be seen that with our varying temperature, that quite an appreciable heat loss will take place.

Radiators, in order to give off the maximum amount of heat, should be placed either under the windows if it be at all possible, but at any rate, next the outside wall. There is a difference of fully 25 per cent. in the efficiency of a radiator due to its position.

The Closed Gravity system differs only in that it has no expansion tank, but is supplied with a relief valve instead. The relief valve may be an ordinary lever and weight, or spring loaded valve, or the whole system may be connected to the city water system, in which case the pressure in the city mains acts as a relief valve. There is one advantage of a system of this kind over the open type, which I will take up later.

Honeywell System

The Honeywell system of hot water heating differs from both the open and closed gravity systems. In this system there is employed a so-called generator. This is entirely a misnomer, as the apparatus does not generate anything, but applies a varying pressure up to 10 lbs. on the flow side of the system. This results in a higher temperature being obtainable and also a more rapid circulation. Perhaps at first sight this may not seem feasible, but if the action be traced, it will be found that it is so. The usual maximum temperature for a



RADIATOR CONNECTION.

hot water system to work at is 180 deg. F., but generally the temperature is around 160° F. If the water in the boiler is not allowed to expand and rise in the expansion tank in the usual manner, the energy imparted to it by the burning coal must find an outlet somewhere, and this outlet can only be through the system of piping and radiators provided. With the Honeywell system a temperature equal to a steam pressure of 10 lbs. is possible, so that a higher temperature is possible at the radiators, and as none of the motive force is lost in the expansion tank, there is a very rapid circulation produced. Further, a greater drop in temperature between flow and return sides of the system may be allowed, which in turn increases the circulation. Where the gravity system has an effective range of temperature of only about 40 to 60 deg. F. that is from 120 to 180 deg. F., the Honeywell system has a range of from 90 to 240 deg. F This tends towards the use of smaller mains and radiators; 20 per cent. smaller than for gravity systems.

I applied one of the generators to the heating system that I mentioned before with the result that now the radiators can be heated, where as previously they could only be warmed, and this without any alteration to the system, or without using any more coal. But I would recommend all present to get the Honeywell book; it will repay any engineer for the time spent in its study.

Forced Circulation System

The last system I wish to deal with is the forced circulation system. To my mind this is the best system of heating, not excepting steam. In this system the circulation does not depend on the temperature of the water. The water is circulated through the radiators by means of a pump. The radiators are proportioned at the same rating as for steam, whilst the sizes of the mains and risers are calculated wholly upon the friction load on the pipe. In this system it is quite easy to make a one-pipe job, which works very well indeed. By running the mains to the top of the building and there branching off to the different drop risers and using O. S. fittings, it is possible to do with only one riser. By using this system there is no trouble with ground floor radiation or short-circuiting of any section. Further, the initial cost is lower than that of a steam system and the maintenance cost is much lower. I am operating one forced circulation system that I connected myself. I replaced three No. 9 Spencer boilers, using a No. 13 Sims heater and a three inch Mather & Platt centrifugal pump. There are 8,000 feet of radiation on that system. It takes about 100 Imperial gallons per minute at a temperature of from 110 deg. Fahr. for an outside temperature of 50 deg. Fahr. to 210 deg. Fahr. for an outside temperature of 20 deg. Fahr. This system does not give one day's work in the season. There are no valves to pack—I mean they never need packing because they are never used. There is no question of overheating or underheating, no radiators not heating because the trap has stuck. The friction head at the pump is 10 pounds, and the horse-power of the motor is 3 h.p. The temperatures are read hourly, and any corrections in the flow temperatures are made.

To sum up, in my opinion a hot water heating system is much to be preferred to a steam system for the following reasons:

There is a greater flexibility, or rather a longer range of temperatures through which the temperature of heating fluid may vary.

With a low pressure steam the range is extremely small, from 212 to 230 deg.

With a vacuum system the range is 140 deg. to 212 deg.

With a gravity system the range is from 120 deg. to 160 deg. Fahr.

With a closed system the range is from about 120 deg. to 230 deg. or even higher, depending on the pressure at which the relief valve is set.

With a forced circulation system the range is from anything desired to a temperature corresponding to the steam pressure with which the heater is supplied. I have frequently supplied water at 230 degrees.

With a Honeywell system the range is from 90 deg. Fahr. to 230 deg. Fahr.

Owing to the greater flexibility of hot water systems, they tend to the more economical use of fuel; as to the case of temperature regulation there is less probability of heating so much of the wide, wide, world, which often happens with a steam system on account of the usual perverseness of the average human, who would rather fling a window wide open in zero weather than attempt to regulate the temperature of the room he is in by using the radiator supply valve in conjunction with a little gray matter.

Further, there being no radiator traps there is less work for the man in charge, and no sticking of traps to stop radiators from working.

Refrigeration Troubles and Their Remedies

Corrosion, One of the Most Active Sources of Trouble—Tests for Acidity—For Ammonia Leaks and for Purity of Ammonia—Common Causes of Ammonia Leakage and Its Remedy

By JAMES F. PATTON

IN ALL refrigerating plants, corrosion of pipes, coils, and condenser tubes must be guarded against as it causes many troublesome problems and may seriously reduce the efficiency of the entire system. Oxygen, the active agent in the air, may soon become entrained in the water and cause considerable corrosion through its oxydizing power gradually attacking the iron with which it comes in contact. Water at 68 deg. Fahr. will absorb about 3 per cent. of its bulk of oxygen, while at 32 deg. Fahr. it will absorb 4.9 per cent. Oxygen is an extremely active element and serious trouble may result if proper precautions are not taken. Free acids may get into the boiler and decomposition of mineral salts may cause acidity of the boiler water. In general, corrosion is caused by impure or contaminated water or faults in the individual system. To prevent corrosion from air, the pumps and other parts of the system, especially these which have stuffing boxes, should be very carefully examined at frequent intervals, and in designing the piping system care must be taken to obviate all high spots, as air will accumulate at such points and cause trouble. The system must be kept full of water or brine, or the spaces above the liquid will surely fill with air. When the boiler feed water is heated to a high temperature the air will be liberated, and to reduce corrosion from this source an open type heater is to be recommended.

If a purge valve is located on the system it should be opened whenever air or foreign gases are suspected. When the condenser is stopped and fully cooled, open the valve and carry a small rubber hose to a pail of water, as shown in Figure 1. The bubbles which result show air or gas, but not ammonia, which will be absorbed by the water. If ammonia is discharged the temperature of the water will increase owing to chemical action. The evaporating pressure should never be brought below atmospheric pressure, which is zero on the gauge, because at such times if there is the least leakage air is sure to enter. If it becomes necessary to reduce the pressure below this point tighten the compressor stuffing boxes and permit the pressure to be low for the shortest possible time.

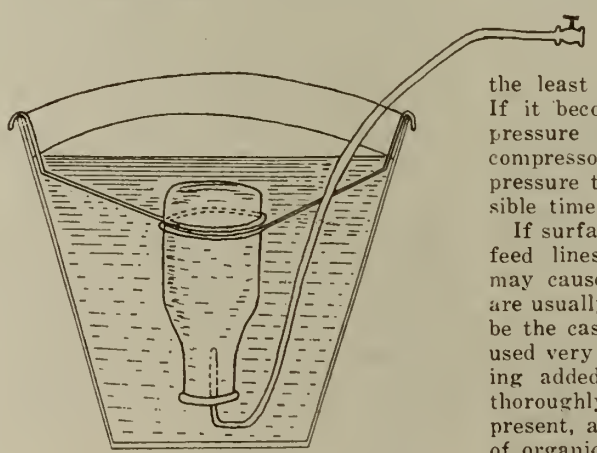


FIG. 1

If surface water is used in boilers and feed lines, sulphuric or carbonic acid may cause trouble, as these free acids are usually found in such water. If such be the case, sodium carbonate should be used very freely, a sufficient amount being added to the water to make it thoroughly alkaline. When sewage is present, acids due to the decomposition of organic matter may be expected, and when subjected to heat these are especially troublesome. The practical method of eliminating them is by agitation of the water in an open heater before it enters the system. This method, with the use of sodium carbonate, will usually produce good results. When high boiler pressures and temperatures are carried

there may be decomposition of the mineral salts in the water which may form hydrochloric and sulphuric acids. Magnesium chloride, if heated sufficiently, will liberate hydrochloric acid, but if the water is sufficiently alkaline to counteract this no trouble will result; if not, the remedy is in the use of sodium carbonate. Frequent water tests should be made to determine the presence of acids as water from a presumably reliable source may change without notice, due to the supply becoming contaminated. An approximate method of testing is to observe the color of the water in the gauge glass. Water which is transparent, or which is of a gray or straw color is usable, but a red discoloration denotes corrosion, which may be neutralized by lime or soda. A bright nail hung in the water will not rust if the water is sufficiently alkaline. These tests should not be accepted as final, but in every case where the water is suspected exact chemical tests should be made. A good test is to put a few drops of methyl-orange in a sample of water. This will give it a yellow color so long as the water is alkaline, but if the water turns pink it shows that acid is present. If red litmus paper is put in the water and does not turn blue, the water is not alkaline. If blue paper is tried and fails to turn red it shows the water is not acid. An accurate test for carbonic acid is the use of lime water, and if this acid is present the mixture will turn milky, while hydrochloric acid will turn it clear again. In some cases poor work in the manufacture of tubes causes corrosion. When a condenser tube is made of copper and zinc it frequently happens that these metals are not thoroughly mixed, and it is well known that these, if properly brought together with an electrolyte, galvanic action will be set up. An eating away of the metal in many systems has been traced to this action. the strong brine acting as an electrolyte. Trouble will also occur if water gets into the ammonia charge. Capacity will fall off, stuffing boxes will leak or run hot, and the only remedy is to eliminate the ammonia, then recharge.

Ammonia Leakage

Ammonia leakage is a frequent cause of trouble in every absorption machine. The efficient engineer is constantly on the lookout for these leaks, for while one leak may not be serious, several, if left uncared for indefinitely may seriously impair the efficiency of the system. The small ones should be located and repaired, and better still, the joints which might develop a leak should be watched. Naturally the oftener a machine is started and stopped the more likely it will be to develop leaky joints; also, a joint which may be tight when the machine is in operation and hot, may leak when it is cold. For this reason intermittent operation should be avoided if possible. Particular attention should be paid to the stuffing boxes in generator and exchanger as these are subject to great variation in temperature. When tightening, care should be exercised not to put on any undue pressure as extreme pressure on packing shortens its life. A worn rod in the piston stuffing box on the ammonia pump may also cause much trouble. This is easily located, but the trouble comes gradually, and the engineer may be deceived as to its condition till serious developments occur. A worn rod should not be tolerated, for in addition to loss of ammonia it also

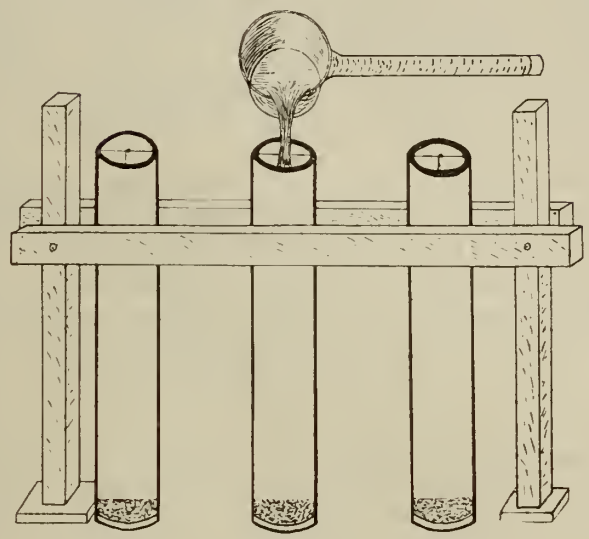


FIG. 2

results in a loss of packing. The header joints on the ends of the generator may also spring leaks. If this occurs take up the bolts, but if this fails to eliminate the trouble renew the gasket, being sure to renew both at the same time. When the leak is in the air the experienced operator has little trouble in locating it, but when it is into water, chemical tests are necessary. Various agents are used, the most common being red litmus paper. When dipped in water or brine containing ammonia this will turn blue. Nessler's solution causes the affected water to turn yellow and brown, while phenolphtalen causes a bright pink color when the slightest amount of ammonia is present.

Leaks in air can always be detected by the use of sulphur. Melt common sulphur and dip wicking into it, making a sort of candle, or the candles may be formed as shown in Fig. 2. The tubes should be made of sheet asbestos and the bottom plugged with fireclay, then pour the sulphur into the tube. Care must be taken not to set the sulphur on fire or to permit it to come in contact with the body as it cools instantly and produces painful burns. To test for leaks, light one of the sticks and hold it under the suspected joint. The sulphur fumes mingled with ammonia produce a dense grey-white cloud. Nessler's solution should be used instead of litmus paper if the leak is into brine. A precipitate will be formed almost white if no ammonia is present, and reddish brown if the brine contains considerable ammonia. Lead should not be used for gaskets on the high pressure side, for every time the line gets hot and expands, the lead squeezes together, and when the line contracts the joint is sure to leak, consequently such joints require constant tightening. Asbestos should be used, the gasket first being covered with cylinder oil, then brushed with graphite. Such a gasket will last indefinitely.

If there is reason to suspect the ammonia charge is contaminated draw off a sample and let it evaporate. If it all evaporates everything is satisfactory, but if a sediment and liquid remains the charge should be renewed or purified. This of course applies only to those systems in which a purifier is not installed. Another point to be considered is the scale and other matter which may accumulate on the outside of an atmospheric condenser. If this is not removed regularly the fuel and water consumption of the plant will be enormously increased. The practice of removing this by tapping with a hammer should be avoided as this may result in leaky joints. It is better to use a scraper, although the condenser may be kept reasonably clean by letting it be inactive for a short time, possibly a few weeks, which will cause a large part of the scale to loosen and fall off. In every case the engineer should keep a record of all temporary repairs which have been made during the running season so that these may be rectified when the plant is given the periodical general overhauling.

COKE FIRING

This is one of the best methods of firing soft coal by hand. It is known also as "bank firing," and consists in banking up a windrow of fresh coal across the front edge of the fire near the furnace doors, while leaving the coal on the rest of the fuel-bed at a white heat. The volatile parts of the fresh coal are distilled off by the heat, and in passing over the white-hot fuel bed they will usually be completely burned, if there is a sufficient amount of air present in the furnace to combine with them. After the volatile parts of the fresh coal have been distilled off, so that what remains is coked and thus transformed into practically pure carbon, the windrow is pushed back over the grates so as to cover them with a uniform layer. This is a very ancient method of firing.

The Buckeye Machine Co., Lima, Ohio, have issued a catalogue on the Buckeye Barrett oil engine. This publication describes the sturdy design of these engines which have been developed for operating on low grade fuel oil. In the design of the engine the makers have drawn largely on past experience and have adopted those principles which have proven themselves most efficient on continuous use. To these they have added the many special features required for the successful use of the fuel on which these engines are adapted to run.

Some Notes on Economizer Operation

Saving Effected — Importance of Removing Soot — Size of Economizer Necessary — Boiler Scale Elimination — Entrained Air and Its Effect in Increasing Corrosion—Scraping Mechanism

By E. CONN

THE economizer consists of a number of cast iron tubes and headers through which the feed-water passes on its way to the boiler and around which the waste gases of combustion pass on their way to the stack.

The purpose of the economizer is to heat the feed-water to a high temperature before it enters the boiler by means of the heat contained in the flue gases when they leave the boiler.

The rise in feed water temperature thus gained from heat, which would otherwise be wasted results in a greater evaporation in the boiler per pound of fuel burned and a corresponding fuel saving, or if desired, the same amount of fuel may be used with a proportional increase in the steaming capacity.

The average saving or increased capacity obtained by installing an economizer varies from 10 per cent. to 15 per cent., depending upon plant conditions, although in some cases greater savings have been made. Economizers show an unusually high return on the investment due to the large saving in proportion to the small cost of installation and they should be used in almost every boiler plant, especially as the conservation of fuel is a matter of national importance.

The standard boiler rating is 10 square feet of heating surface per horsepower and is based on the evaporation of 34.5 lb. of water per hour from and at 212° F. by the heat transmitted through that amount of heating surface or, in other words, the transmission of 33,480 B.t.u. per hour. Actual operating conditions, however, vary greatly from this, as the boiler may be operated at some point below this rating or perhaps at 400 per cent. of rating.

A percentage of the heat in the fuel always leaves the boiler in the flue gases. Table No. 1 shows the percentage of the heat of combustion present in the flue gases under various conditions.

HEAT OF FUEL PRESENT IN FLUE GASES

Flue Gas Temperature.	A	B	C
300° F.	.....	.....	12.4%
350° F.	.....	12.0%	14.9%
400° F.	.....	14.0%	17.4%
450° F.	12.2%	16.1%	20.0%
500° F.	13.8%	18.2%	22.6%
550° F.	15.4%	20.3%	25.2%
600° F.	17.0%	22.4%	27.8%
650° F.	18.5%	24.4%	30.4%
700° F.	20.1%	26.5%	.....
750° F.	21.7%	.....	.....
800° F.	23.2%	.....	.....

A. is based on using 18 pounds of air per pound of combustible in the fuel and represents average underfeed stoker operation with forced draft.

B. is based on using 24 pounds of air per pound of combustible in the fuel and represents average overfeed or natural draft stoker operation.

C. is based on using 30 pounds of air per pound of combustible in the fuel and represents average operation with hand-firing and natural draft.

Without the use of an economizer this heat would all be wasted, but by applying the "counter-current" principle and using the heat in the flue gases after they leave the boiler to heat the feed-water before it enters the boiler a large part of this heat may be saved.

By using an economizer the temperature of the feed-water may be raised from the water supply, hot well or exhaust steam feed water heater temperature to a temperature approaching that of the water in the boiler. The higher feed-water temperature thus obtained results in a proportionate saving in fuel as the transmission of less heat by the boiler surface combined with the heat recovered by the economizer will produce the same amount of steam as would be produced if an economizer were not used.

The actual saving that any economizer installation is making can be easily calculated from the following formula:

$$\text{Percentage saving} = \frac{100\,(T - t)}{(H + 32) - t}$$

where

T = temperature of feed-water after heating.

t = temperature of feed-water before heating.

H = total heat in steam above water at 32° F.

For example, assuming a feed-water temperature entering the economizer, of 180° F., a final temperature leaving the economizer at 310° F., and a boiler pressure of 150 lbs. per square inch above atmosphere—the actual saving would be:

$$\frac{100\,(316 - 180)}{1225.5 - 180} = 12.44 \text{ per cent. saving.}$$

Results under various conditions of feed-water temperature and boiler pressure may be approximated by estimating 1 per cent. saving of fuel for each 10° F. added to the temperature of feed-water.

Knowing the temperature of the gases leaving the boiler and desiring to find the saving that may be made by using an economizer to heat the feed-water by means of the heat which would otherwise be waste, take the temperature of the gases in the boiler uptake and assume a final gas temperature entering the stack of 300° F. in order to obtain the approximate drop in temperature through the economizer. Then as each 20° F. taken from the gases under average conditions will heat the feed-water 10° F., this will give the estimated saving.

The size of the economizer necessary to secure these results may be approximated by allowing 5 square feet of economizer heating surface per boiler horsepower developed under average conditions.

After the economizer is installed, great care must be taken to keep the external surface of the tubes, which are in contact with the hot gases, as clean as possible in order to prevent soot collecting on them, as this insulates them from the heat and materially reduces the rate of heat transmission, thus reducing the saving that might be obtained. In order to do this in the easiest and most convenient way, the manufacturers provide mechanically operated scrapers for this purpose. These scrapers consist of three parts, each part having a bevelled cutting edge at the top and bottom which encircles the tube. These cutting edges are both directed upwards and the parts are so supported that these edges are forced against the tube on the up stroke, thus dislodging the soot, which falls down between the bottom headers to the soot pit below the economizer and can then be removed at convenient intervals.

The mechanism for operating the scrapers and for reversing the direction in which they travel, is simple and effective. Power required for this purpose is small and is usually supplied by belt from a small motor, small steam engine for same convenient shafting.

Care should be taken to see that the scrapers do not stick, due to any unusual conditions, in which case the chains passing over the pulleys on the gearing frame simply slide over the surface of the pulley. As the scrapers are arranged in sets cleaning four sections of the economizer, the accumulation of soot due to this would render a large percentage of the heating surface inactive, as the ordinary economizer has from 6 to 12 such groups.

The feed-water should not be introduced into the tubes of the economizer at a temperature which combines the moisture in the flue gases, as this will combine with the sulphur in the gas to form sulphurous acid, which will attack the surfaces of the tubes causing external corrosion. Where the initial feed-water is below 90° F. and might cause this condition, the difficulty may be overcome by passing a small part of the heated feed-water from the discharge of

the economizer back to the feed-water line, where it enters the economizer and thus tempering the cold water.

Many waters used for boiler feeding purposes contain impurities which are precipitated when the water is heated in the economizer. Because of the slow motion of the water in the tubes these precipitates fall to the bottom and the economizer should be blown down at frequent intervals in order to remove them. In some cases the economizer should be washed out two or three times a year in order to remove all of the sludge which might accumulate. This is much easier and better than allowing these scale-forming substance to get in the boiler, where they would become baked on the tubes as hard scale, which is dangerous and also which is difficult to remove. The most common scale-forming substances are the bicarbonates of lime and magnesia. These are precipitated in the economizer when the water is heated to about 200° to 210° F. because the bicarbonate is reduced to the monocarbonate, part of the carbon dioxide being set free and the monocarbonate is insoluble. The sulphates of lime, which form the harder scale, are not thrown down in this matter, but become insoluble in part above 270° F. so that if this temperature is reached in the economizer they will be precipitated. Some of the salts of magnesia are decomposed at high temperatures and will also be precipitated in the economizer.

Air entrained in the boiler feed-water or poor circulation, due to irregular feeding, will cause pitting of the internal surfaces of the economizer and inspections should be made annually to determine the possible presence of this trouble in order to prevent this condition rendering the economizer unsafe for operation.

In conclusion it may be well to state that it is advisable to take up with the makers of economizers such as Green's Economizer, Ltd., Toronto, any questions relating to design and installation.

Power Plant Management; Mechanical Stokers—II

Various Stokers Described and Their Operating Characteristics Outlined—The Underfeed Stoker—The Galt Sprinkler Stoker—Summary of Features of Interest in the Design of the Various Types of Stokers

AS we have seen, the advantages of the mechanical stoker over hand-firing are as follows:

1. Even and continuous firing of the automatic stoker, as compared to the intermittent action of hand-firing.

2. Practically constant and uniform supply of air, which can be controlled to some etxent to meet actual operating conditions, as contrasted with the wide variations in air supply occurring in hand-firing with constant opening of fire doors and varying depth of fuel bed.

3. Continuous and automatic cleaning of fires, leading to development of better over-all efficiency.

4. Large savings in labor, due to the fact that one man can take care of 2,000 H.P. of stoker-fired boilers, as compared to 250 to 500 H.P. of hand-fired.

5. Saving in fuel cost through ability to burn lower grade of coal than can be handled to good advantage with hand-firing.

6. Practical insurance of smokeless operation.

Overfeed Stokers

Overfeed stokers are of two types—front-feed and side-feed. To the first type belong the Roney, Wilkinson and Acme stokers; to the second, belong the Detroit, Murphy and Model.

With the front-feed stoker, the grate, which is arranged in a series of steps, slopes at a considerable downward angle front to rear. Coal received from the hopper is caked under a short suspended arch, and is then fed forward and downward by the rocking action of the movable grates, aided by gravity. The clinker, working forward, is emitted at the bottom, being crushed by rolls in some types of installations. For convenience in handling, the dumping grate is frequently divided into several sections.

Front-feed stokers possess the important advantage of permitting easy passage of air through the fire, so that complete and efficient combustion is readily secured. On the other hand, their construction is such that if boilers must be continuously driven at high ratings, the grates may become over-heated. In order to avoid this danger of burning, with possible necessary renewal of grates, engineers usually prefer other types of stokers, if it appears probable that boilers must be operated above 200 per cent. rating for considerable periods of time. Front-feed stokers are either natural or forced draft.

The side-feed, or "V" stoker, receives coal from two magazines located on each side of what is to all intents and purposes a Dutch oven. At the bottom of the magazines are coking plates, against which the grates, which are inclined at a steep slope toward the centre of the furnace, rest at their upper ends. As the coal leaves the magazines, from which it is fed alternately and intermittently, it rests for a short time upon the coking plates. At this point the volatile gases are largely driven off, being mixed with air, which has been pre-heated by admission through the arch over the fire.

As combustion proceeds, the fuel travels slowly down the inclined grates toward the clinker grinder, receiving the requisite amount of air through the grates to complete the process of combustion by the time the lower portion of the grate is reached when the ash and clinker are automatically removed.

The speed at which the stoker boxes push the coal into the grates is, of course, subject to easy regulation. The grates being pivoted at their upper ends and actuated at their lower ends, agitate the fuel bed to a constantly increasing extent as combustion proceeds, thus permitting free admission of air and assuring complete combustion. In stokers of this type the clinker grinders can be adjusted to operate with reference to the amount of ash and clinker in the coal, irrespective of the action of other parts of the mechanism.

For boilers of moderate size, operated at 200 per cent. rating or less, the side-feed stoker makes a desirable and economical installation. It has the advantage of possessing a decidedly larger coking area than other types of stokers, and as the combustion area is likewise very large, it is possible, with careful manipulation, to secure complete and practically smokeless operation. Natural draft is the rule with this stoker.

The Down-Draft Furnace

While the down-draft furnace is not to be strictly classed as a stoker, since its use involves hand-firing, it nevertheless deserves consideration, since it performs certain of the functions of the mechanical stoker; that is to say, as compared to ordinary hand-firing, it permits the use of lower grades of fuel, assures practically complete combustion, and what is extremely important in many installations, smokeless combustion.

The down-draft furnace consists of two separate grates, one above the other, the upper grate being formed of a series of tubes opening at their ends into steel drums or manifolds, through which the water of the boiler circulates, whereas the lower grate is formed of ordinary

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Editor's Note:—This is the seventh in a series of articles by Mr. June, on Power Plant Problems. Succeeding articles deal with principles of heat absorption, coal and ash-handling equipment, storage of coal, abuse of steam, etc. Later articles sum up the best current practice in the business management of the power plant. The series is of timely interest and should prove of value to our readers.

grate bars. The firing doors are near the top of the furnace, and the upper grate only is fired. This grate, it should be noted, slopes upward at a sufficiently steep angle to assure rapid circulation.

A division wall at the back of the furnace prevents the gases from going rearward, hence the draft is downward through the fuel bed, and the volatile matter, as it is evolved, passes directly between the grates into the combustion chamber. The lower grate is fired entirely by coked coal, falling through the tubes of the upper grate. As the flames from the lower grate arise they meet the down-coming gases, and the process of combustion is complete.

An objection sometimes raised to the down-draft furnace, is that it "cannot be forced above rating," but this is not strictly true, as it can be driven to nearly, if not fully, the same extent as a hand-fired furnace. When installed under conditions within its limitations it is more economical and satisfactory than hand-firing.

The Underfeed Stokers

Among the best known underfeed stokers, are the Taylor, Type "E," Jones, Riley, Westinghouse, and American.

The underfeed stoker is the stoker for large installations and excessively high ratings. Indeed, so completely has it pre-empted this field that it is unusual to go into a large central station or high-duty large boiler power plant of any sort, built within recent years, and find other types of stokers installed.

There are a number of reasons for this. First of all, the underfeed stoker is adapted to all grades and sizes of free-burning bituminous coal. Next, it is essentially a forced draft stoker, since it operates with restricted air openings and very deep fires. The forcing capacity is almost unlimited, instances being known where this stoker has been driven to over 400 per cent. rating.

Sufficient combustion chamber space is the principal consideration in making underfeed stoker installations, as with this stoker it is necessary to elevate the boiler a very considerable distance above the floor. Cooking arches or plates are dispensed with entirely. The principle of the underfeed stoker is that of a steam-driven ram, which forces the fresh coal into a large receiving retort, contained within the furnace, and from there up under the fuel bed.

The Jones stoker consists of nothing whatever except this retort, or a series of retorts, depending upon the size of the boiler. There are no grate bars and no ash-pit—just a blazing pile of coal, continually fed with new supplies pushed up from below. Air is admitted through hollow blast tiles at the upper edges of the retort. Ash and clinker form chiefly on the dead plate between the retorts, and are removed by hand at intervals of a few hours. Automatic control of air and fuel supply is secured, definite proportions of each being admitted as the steam pressure tends to rise or fall.

In the Type "E" stoker, the retort has a reciprocating sliding bottom, which carries the coal forward. It is delivered uniformly from front to rear, by auxiliary pushers, and as it rises in the retort, is distributed to the sides of the furnace by means of rocking-bars, so set as to slope both ways from the centre of the furnace toward the side walls. The progress of the burning coal and also of the ash and clinker is constantly toward the sides. By the up and down action of the rocking-bars the clinker is kept from forming in large pieces. Dump trays at the side permit cleaning by the act of throwing a single lever.

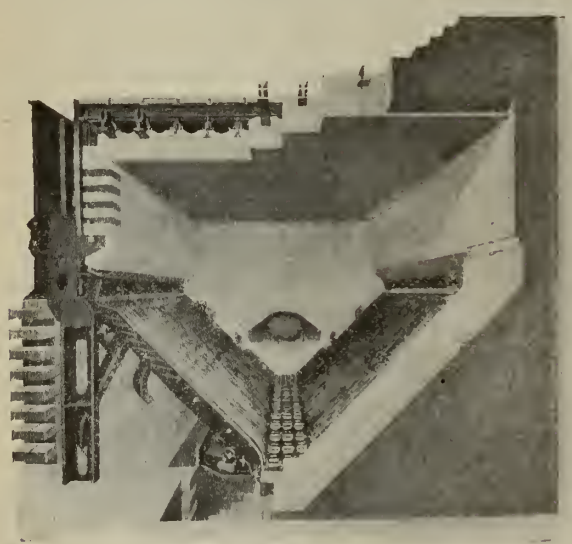
More elaborate than other underfeed stokers, the Taylor consists of a series of alternate retorts and tuyeres, sharply inclined toward the rear of the furnace. Each retort is filled with two rams—the upper for pushing the green coal inward and upward—the lower for forcing the fire toward the dump plates at the rear. The dump plates referred to are hung on the rear of the wind-box. They are controlled from the front of the furnace. This stoker may be operated efficiently and smokelessly at the heaviest known overloads, hence it is frequently found in the largest plants. Stoker and blower are operated by the same engine, and power required for this purpose is from 2.5 to 5 per cent. of steam generated, making it probably the highest steam user among the stokers.

The Riley is a multiple retort stoker, the distinctive feature of which is that the sides of the retort reciprocate relative to the bottom. This arrangement results in the fuel being moved at a uniform rate out of the retort and across the ash supporting plates until it is discharged through adjustable openings next to the bridge-wall.

Points to Remember Regarding Stoker Operation

Here are a few of the points to remember regarding stoker operation:

1. Draft must be under close control at all times.
2. Keep air vents open.
3. Look out for air leaks, particularly after making adjustment.
4. Make frequent flue gas analysis
5. Keep side walls clean of adhesions.
6. Do not stop stoker long with hopper full of coal.
7. In chain grates, make adjustment of gate and speed if fire tends to withdraw from gate or run over end.
8. Coking coal may require slice bar.
9. In washing out boiler, do not get water on arches or brickwork.
10. Do not pull dead plates entirely clear of ash.
11. Keep ash-pit cleared out.
12. Have all necessary maintenance work attended to promptly.



OVERFEED STOKER

UNDERFEED STOKER

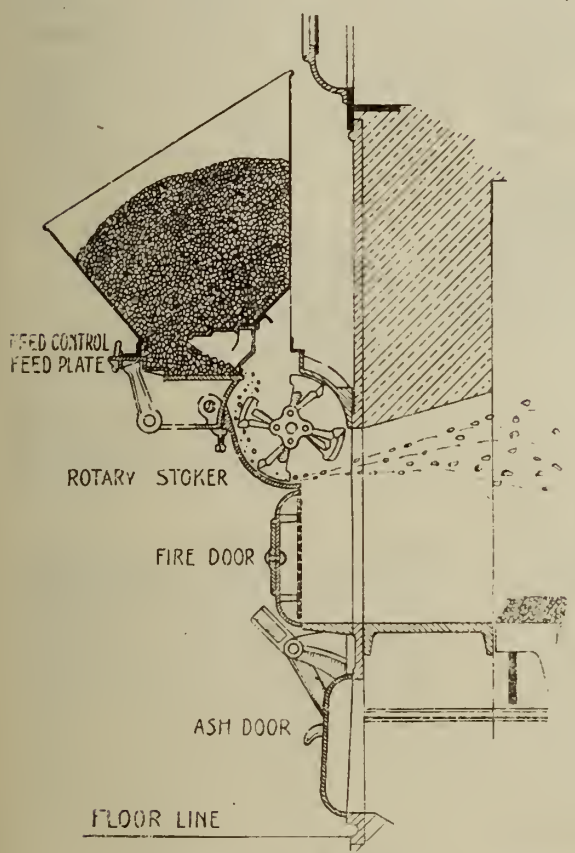
Summary

We have found that the chain grate is suitable for boilers of quite good size, up to 250 per cent. rating, and that its important characteristic is that grates must be designed for the fuel burned. We have shown the overfeed stoker is particularly suitable for medium sized

installations, up to 200 per cent. rating. The down-draft furnace, particularly for small boilers operated at non-excessive ratings, offers a comparatively inexpensive substitute for certain functions of the mechanical stoker. And finally, we have placed the underfeed stoker as the apparatus for large boilers, operated at extremely high ratings.

Sprinkler Stokers

The sprinkler stoker is one of the best known to Canadian power users—a circumstance attributable perhaps to the



GALT SPRINKLER STOKER

fact that the Canadian manufacturer of this type of stoker, the Galt Foundry Company, has developed it to a point of greater efficiency and capacity than it has attained elsewhere.

The principle of operation of the lustration. The apparatus is bolted to a frame casting in front of the setting. Coal of nut size or smaller is fed into a hopper, from which it gravitates onto a feed plate. From the latter the fuel is fed to a rapidly revolving crusher and spreader.

This apparatus consists of heavy pieces of cast steel, so designed as to throw the coal in various directions. Several of these spreaders are so arranged on the shaft that adjacent sections throw the coal, after it has been ground into small particles, over different sections, thus covering the entire surface of the bed.

Advantages of the arrangement are obvious. Powdered and fine coal is burned in suspension, and larger pieces, falling on the bed, burn with great rapidity. A thin, level, brilliant fire is maintained, and complete, smokeless combustion secured.

The stoker is, of course, not self-cleaning, that is, ashes must be removed by hand, or by suitable shaking grates. This does not alter the fact, however, that the stoker is greatly superior to hand-firing—both as regards results, and conservation of labor. It possesses the important advantage of low cost of maintenance, since there are no parts to burn out. The sprinkler stoker is particularly suited for small and medium-sized boilers, operated at normal high ratings.

FRICTION FABRICS

By H. A. L.

The material wherewith to line clutch and brake surfaces has always been a problem. In railway work the cast iron shoes wear out rapidly, and it is considered more economic to have the metallic wastage upon the easily-renewed and cheaply-produced brake shoe than on the xepensive tire. At the same time the metallic wastage irrecoverable as scrap must be very large. In the motor car the cone clutch largely used has most often a leather lining, while the brakes are steel bands over drums, which serve to give the braking effect when controlled from the dishboard.

Recent solutions of the problem have led to the marketing of textile fabrics of special type for which large claims are made. One of these materials seems to have disappeared, but the other is rather prominent.

Both claimed an asbestos foundation, and are supplied in a form resembling belting or braid of very coarse texture. As in the case of engine packing, the experienced engineer is always somewhat curious and sceptical, and while no doubt is cast upon the efficacy of the materials the result of a close examination is interesting. At first sight the resemblance to what is known as wire woven, high-pressure packing is considerable, the chief feature of the construction seems to be the combination of a single brass wire of fine gauge as the core of a rather coarse textile thread. High pressure packing is similar in construction, the asbestos fibre being rolled or carded on to a wire core. This reinforced or composite thread is then woven into the familiar forms.

In the case of the material discussed, the claim as to the inclusion of asbestos seems hardly warranted, for the thread seems to consist of a large proportion of fibre other than asbestos. It was claimed at one time that old sail canvas made the best canvas engine packing, universally known as Tuck's, the stretch having been taken out of the fabric by prior use. At the same time such material is initially cheaper, and the economic factor would probably be a greater incentive than the reason alleged. However this may be, in the friction lining similar material seems indicated, the fibre looks more like old rope, either hemp or manila. It has occurred to the writer that the inclusion of asbestos is to minimize overheating in the absorption of power by friction. The rope used in the Prony brake does occasionally smoke, but not usually, unless its proportions are inefficient and it is grease saturated, when its liability to overheat is similar to that of oily waste. The presentation of a wire mesh surface by wear in conjunction with a textile material of frictional qualities finds a precedent in the non-slip stair tread, where lead and steel or cast iron form a composite surface, the harder material, whether as straight lines or woven wire diminishing wear while allowing the softer metal to exercise its non-slipping qualities. Lead in this particular is the safest material known, even when greasy, or otherwise rendered in a condition where other metals would provoke accident. The tendency to slip on greasy M. S. chequer plates is very pronounced. Asbestos being immune from any tendency to fire, and since it can be procured wire-woven it is a little surprising that the ordinary commercial material used everywhere for engine packing should be unknown as a brake lining. Perhaps it is the initial cost of such high grade packing, but the results of any tests would prove interesting. The material marketed under a trade name is certainly cheaper to produce so far as a detailed examination would show, but if engine packing of the type indicated serves the same purpose this should exert a salutary check upon any undue price. It certainly seems open to the engine packing maker to heavily adulterate his product with alien fibre of cheaper character and make this up in suitable dimensions. To add to its resistivity some drying oil or resinous substance may also help its friction qualities.

In the death of Julius E. Waterous, which took place at his home, Bonnythorpe, Brantford, on January 11, the city lost one of its industrial leaders. He was one of the founders of what is now the Waterous Engine Works, one of that city's largest industrial plants, with which he was connected as mechanical manager and vice-president until he organized the Waterous Works, which he successfully conducted until he retired from active business in 1910. He was seventy-five years of age at his death. He is survived by his wife, formerly Miss Annie Van Someren, and two sons, Reginald and Bertram, who have just returned from overseas, where they were connected with the Canadian Artillery. Among the works with which Mr. Waterous was connected were the waterworks plants at Windsor, Orangeville and Lindsay, constructed under his supervision, following the installation of waterworks in his home city, the first in Canada.

Armature Testing and Trouble Localization

The Following Article Describes Various Methods in Use For Locating Faults Which Are Likely to be Encountered in A.C. Armature Circuits and Gives Means For Their Quick Localization

By TERRELL CROFT,
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DIRECT-CURRENT armatures can be tested for the common troubles with the arrangement of Figs. 1 and 2. Terminals *b* and *c* are clamped to the commutator at opposite sides and connected with a source of steady current through an adjustable resistance and, preferably, but not necessarily, an ammeter. The terminals of a low-reading voltmeter (a galvanometer can

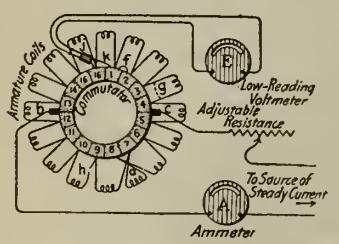


FIG. 1—METHOD OF TESTING AN ARMATURE

often be used) are connected to two bare metal points, or "exploring terminals," which are separated by an insulating block *j*, Fig. 1. Exploring terminals may also be arranged as shown in Figs. 2 (*II*) and 3. In use, the current is adjusted to produce a convenient deflection of the voltmeter when each of the points rests on an adjacent bar. The points are moved around the commutator and bridged across the insulation between every two bars. If the voltmeter deflection is the same for every pair of bars it indicates that there is no short circuit in the armature.

In testing armatures where only alternating current or low-voltage cells are available, a telephone receiver (Figs. 4, 5 and 6) may be used instead of an electrical-measuring instrument for a detector. The variations in or appearance or disappearance of the sound in the receiver, as the test is being conducted, enables the operator to localize the trouble. The alternating current (Fig. 4) will cause a hum in the telephone receiver and the pulsating current produced by the vibrator (Figs. 5 and 6) effects the same result. The vibrator may be an ordinary vibrating bell or buzzer conected in series in the circuit as shown in the illustrations.

High-voltage alternating current for testing armatures is sometimes used (Fig. 7) for high-resistance grounds which may not be detectable where a low e.m.f. is used for testing. Such high-resistance grounds may not in normal operation make their presence known until there is also a ground on the supply system feeding the motor. In using this apparatus the procedure is merely to connect one terminal, *A*, of the high-voltage source to the commutator, and the other terminal, *B*, to the shaft. When the high voltage, *EH*, is impressed on the armature, this will, usually, break down the insulation at the weak point and render the location of the ground apparent by the smoke which will emanate from the point of breakdown. Fuses, er circuit breaker C_1, C_2, should be inserted in the supply circuit to prevent the disastrous effects of a short-circuit.

An alternating-current inducing coil is sometimes used for localizing armature troubles. Such a coil is illustrated in Fig. 8, while the methods of its application are illustrated in Fig. 9. The inducer is merely an alternating-current magnet having a U-shaped core composed of sheet steel laminations. The laminations should be interleaved and hinged at the point *H* so that the core may be opened or closed to most effectively accommodate armatures of different diameters. In use the core should be opened to such a width that its two poles, P_1 and P_2, will have a separation corresponding to the throw of one armature coil. As shown in Fig. 9 the poles should not touch the armature iron when a test is being made, but an air gap of approximately ¼ inch should be allowed.

The principle of operation of the inducer is this: The alternating flux developed by the current in the inducer winding sets up an e.m.f. in the armature coils and if a coil is short-circuited it will cause a current to circulate in that coil. Thus, in making a test the excited inducer is held over the armature, which is rotated. Now, if the armature is slowly rotated, while a small piece of metal is held lightly on the commutator so that it will bridge the segments between each of the bars there will be, as the armature is rotated, an arc produced each time one of the segments is bridged, provided the segments connect to a normal coil. But, if a coil is open, short-circuited or reversed, there will be no sparking. To determine whether the difficulty is due to an open or a short-circuit, the small iron test strip is bridged across the armature slots. Where the coil is short-circuited the induced current which will flow in it will create a flux around the sides of the coil which can be detected with an iron test strip which is moved over the armature coil slots. Furthermore, a short-circuited coil will be quickly heated by the local current flowing in it.

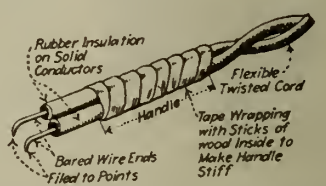

Rubber Insulation on Solid Conductors
Flexible Twisted Cord
Handle
Tape Wrapping with Sticks of wood Inside to Make Handle Stiff
Bared Wire Ends Filed to Points

FIG. 3—A TYPE OF EASILY MADE EXPLORING TERMINAL. THE FLEXIBLE CORD LEADS ARE SOLDERED TO THE SOLID COPPER WIRES WITHIN THE TAPE WRAPPED HANDLE.

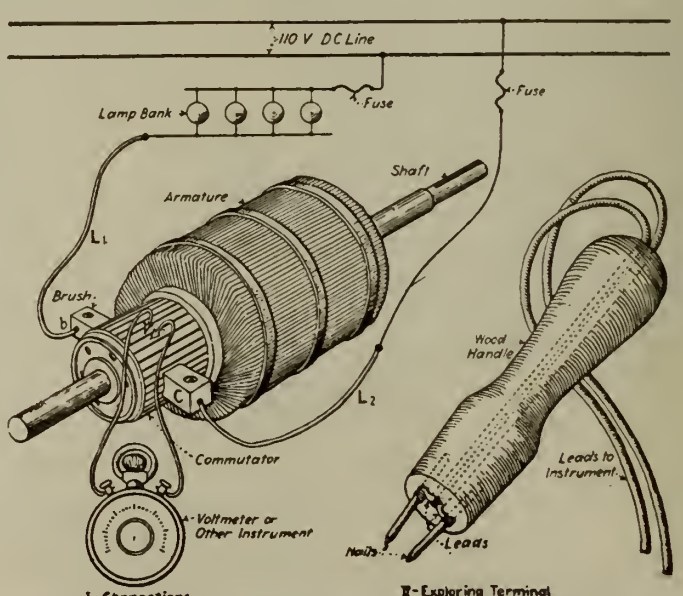


FIG. 2—CIRCUIT AND EQUIPMENT FOR TESTING DIRECT CURRENT ARMATURES FOR TROUBLE WITH DIRECT CURRENT.

The telephone receiver detector used with the inducer, Fig. 9, affords a more

accurate but somewhat slower method than that described in the preceding paragraph. To locate a short-circuit, Fig. 9, *I*, an exploring terminal connected to the receiver is held on the commutator while the armature is rotated. When the exploring points are bridging a normal coil there will be a hum in the receiver due to the induced alternating current flowing through it. When the points bridge a short-circuited coil there will be little or no hum in the receiver, depending upon the number of short-circuited turns. When the exploring needle points bridge on open coil, an alternating current of considerable intensity will flow through the receiver and a loud click will be heard. Where a coil is reversed several of the coils adjacent to it will test "silent." To definitely locate the incorrectly connected coil it will be necesary to raise some of the coils and trace them out by inspection. To locate a ground, the connections are made as shown in Fig. 9 *II*, and the armature is slowly rotated. When, as the armature is rotated, contactor C is on the segment connecting to the grounded coil, no sound will be heard in the receiver but at other locations there will be a sound, the sound diminishing in intensity as the segment connecting to the grounded coil is approached. For locating partial grounds this method may be ineffective, in which case that involving a high alternating voltage whereby an insulation breakdown may be produced, should be employed.

A rack for testing small armatures using the methods of Figs. 1, 4 and 5 is detailed in Fig. 10. Ordinarily a man and a helper are necessary in testing out an armature, but with the appliance shown one operator can locate the faults

A convenient arrangement of a test lamp and exploring terminal is shown in Fig. 11. The flexible cord and the indicating lamp, which also serves as a resistor for limiting the current, and the exploring terminal, can be cut in series with the supply circuit by means of a fuse connector as detailed in Fig. 12. With this arrangement the testing set can be quickly cut in service at any point where there is a cut-out. Where it is used it may be necessary to close the line with a temporary switch or otherwise on the load side of the cut-out. An Edison plug or a ferrule contact fuse can be used instead of the knife blade contact fuse of Fig. 12 by adopting obvious modifications.

A poor connection between a bar and coil leads will cause a considerable deflection of the voltmeter (Fig. 1) when one of the points rests on the bar in trouble and the other rests on either of the adjacent bars.

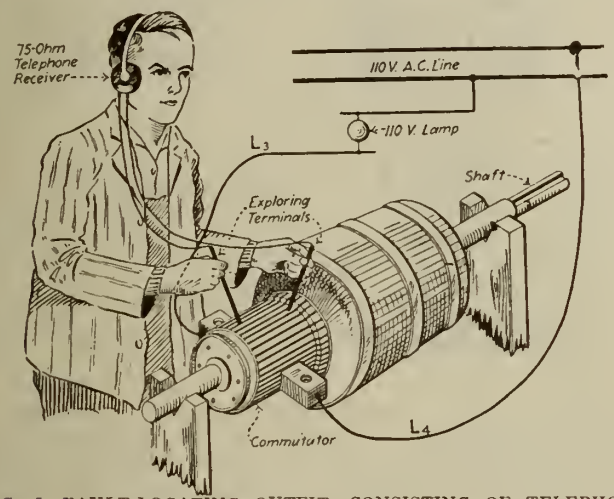


FIG. 5—FAULT-LOCATING OUTFIT, CONSISTING OF TELEPHONE RECEIVER, VIBRATOR AND DRY CELLS.

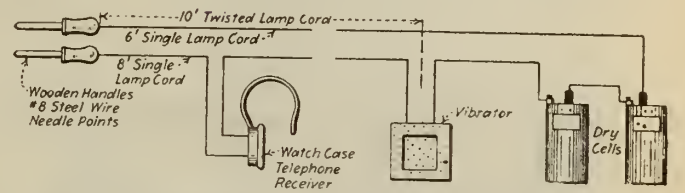


FIG. 6—CIRCUITS FOR LOCATING FAULTS IN AN ARMATURE WITH A LOW VOLTAGE SOURCE AND A VIBRATOR.

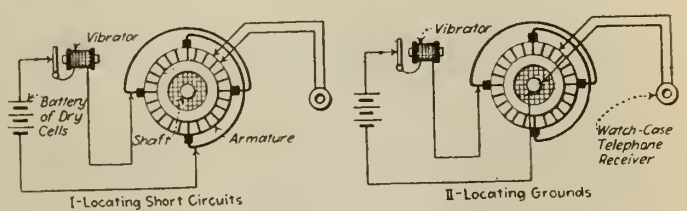


FIG. 7—METHOD OF OBTAINING AND APPLYING HIGH POTENTIAL FOR ARMATURE FAULT LOCATION.

An open-circuited coil, as *h*, Fig. 1, will prevent the flow of current through its half of the armature. There will be no deflection on that half of the armature until an "open' is bridged, when the voltage of the testing circuit will be indicated.

Tests for Open Armature Circuits.—Another method, (Fig. 13), is to apply to the commutator at two opposite points, a low voltage, say from a battery or from a dynamo with a suitable resistance (incandescent lamps for example) in series. Place an ammeter in circuit and clean the surface of the commutator so that it is bright and smooth. The terminal ends leading the current into and out of the commutator should be small so that each rests only on a single segment, Fig. 13. Note the ammeter reading and rotate the armature slowly. At the point where the open circuit exists the ammeter needle will go to zero if the leads to the commutator bar have become entirely open-circuited. This is because the segment is attached to the winding through the commutator leads.

If the armature does not show the above systems try connecting a low-reading voltmeter or a galvanometer to two adjacent segments while the current is passing through the armature as described from some external low-voltage source, Fig. 14. Note the deflection. Pass from segment to segment in this manner, recording the drop between the successive pair of bars. This drop, if the current is maintained constant from the external source, should be the same between each pair of adjacent segments. If any pair shows a higher drop than the others near it, a higher-resistance connection exists there, perhaps causing sparking of the commutator insulation to a less degree, probably, than with an actual open circuit, but enough, perhaps, to cause trouble.

The test for armature short-circuits, described in the preceding paragraph, is called a "bar to bar" test. It is most valuable in locating faults in armatures. It is the method to use if a short-circuit from one segment to another is suspected. When the section in which the short-circuit, or partial short-circuit, exists comes under the contacts, a low or perhaps no deflection is shown on the galvanometer or voltmeter, thus locating the defective place. Such short-circuits, if they occur when running, owing to defective insulation, burn out the coil short-circuited. When the coil passes through the active field in front of the pole-piece, an immense current is induced in it, causing a destruction of the insulation. When this occurs the coil should be open-circuited if the burning has not already short-circuited it. If practical it should be bridged over.

If two bars or a coil is short-circuited as at *f* and *g* (Fig. 1), respectively, there will be little or no voltmeter deflection when the two bars connecting to the "short-circuit" are bridged by the point.

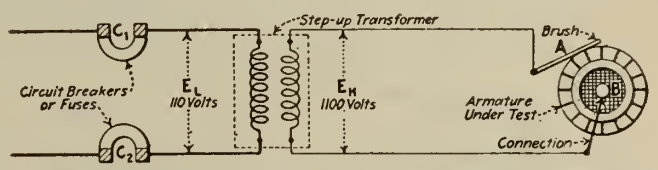


FIG. 4—ILLUSTRATING A METHOD OF LOCATING FAULTS IN AN ARMATURE WITH ALTERNATING CURRENT.

A grounded armature coil can be detected in practically the same manner as indicated in Fig. 15 for a field coil. Fig. 16 shows the connections. Impress full voltage on the terminals *A* and *B* clamped to the commutator. Ground one side

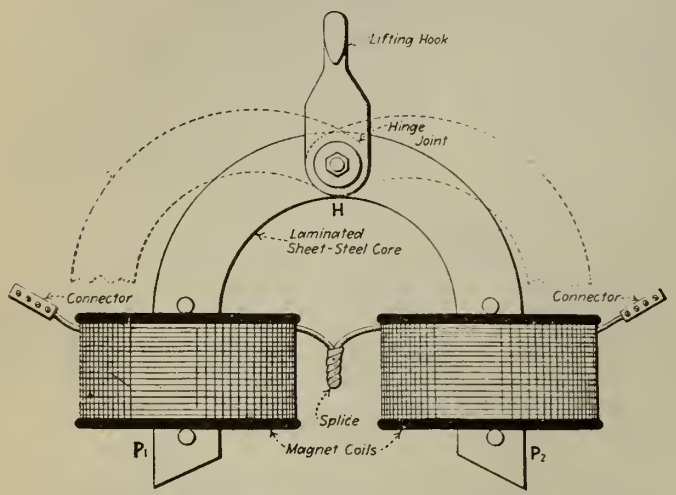


FIG. 8—"INDUCER" USED FOR LOCATING FAULTS IN A DIRECT CURRENT ARMATURE WINDING—INDUCES AN ALTERNATING E.M.F. IN THE ARMATURE WINDING.

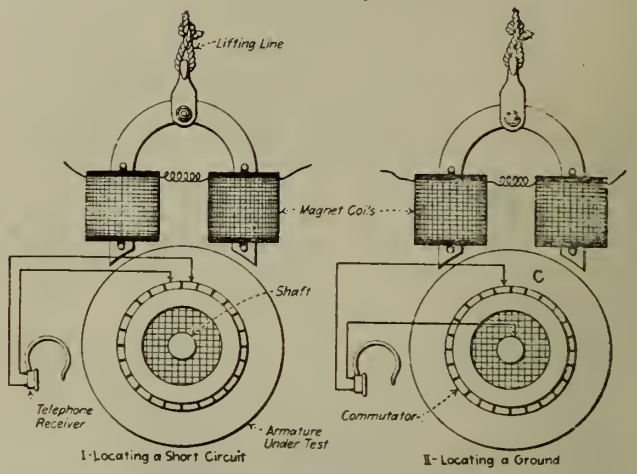


FIG. 9—ARRANGEMENTS FOR LOCATING SHORT CIRCUITS AND GROUNDS WITH ALTERNATING CURRENT INDUCER.

of the voltmeter on the shaft or spider, as at *C*, and touch a contactor *C* connected to the other side of the voltmeter to all the bars in succession. The minimum deflection will obtain when the bars connecting to the grounded coil are touched. A battery of dry cells, *E*, (Fig. 16), having in series a resistor, *R*, may be used as a

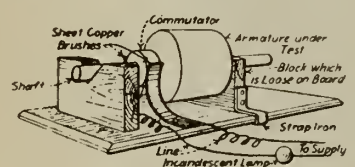


FIG. 10—RIG FOR TESTING SMALL ARMATURES (ELECTRICAL REVIEW).

source of energy. A bank of lamps connected in parallel will serve as a resistor. Instead of using a voltmeter as in Fig. 14, a galvanoscope, *F*, (Fig. 16) may be used. Such a galvanoscope may be improvised by winding a coil of wire around a pocket compass, but where this device is employed the galvanoscope must be used far enough away from the machine under test so that the compass needle

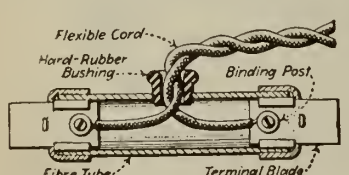


FIG. 12—SECTIONAL ELEVATION OF FUSE CONNECTOR.

will not be affected by the magnetization of the machine under text.

Crossed coil leads as at *g* (Fig. 1) are indicated by a twice normal deflection when the points bridge the bars to which the crossed coils should rightly connect. The crossing of the coil leads connects two coils in series, hence causes twice normal drop. Bridging the bars to which coil *h* connects will produce a normal deflection, but it will be reversed in direction.

Reversed armature coil.—Instead of the armature winding progressing uniformly around from bar to bar of the commutator, there may at some point be a coil connected in backward. Such a reversed coil often causes bad sparking. One way to locate such a trouble is to pass a current through the armature, at opposite points on the commutator. Then with a compass explore around the armature the direction of magnetism from slot to slot. If a coil is reversed when the compass comes before it, the needle will reverse, giving a very definite indication of the improperly connected coil.

Heating of armature.—Heating of the armature may develop from any of the following causes: (a) Too great a load; (b) a partial short-circuit of two coils heating the two particular coils affected; (c) short-circuits or grounds on armature or commutator.

Hot Armature Coils. — Sometimes, when a new machine is started, local heating occurs in the armature, following the exact shape of the armature coil. This may be because, in receiving its final turning off the commutator bars were bridged with copper from one segment to another by the action of the turning tool. An examination of the commutator surface will reveal this bridging. When it is removed, satisfactory operation will ensue if the trouble has not gone too far and seriously injured the insulation of the soil.

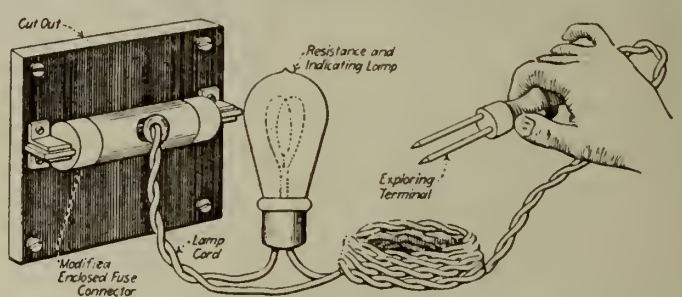


FIG. 11—SHOWING APPLICATION OF THE MODIFIED FUSE CONNECTOR FOR CONNECTING TEST LAMP IN SERIES IN THE TESTING CURRENT.

"Flying grounds," "flying short-circuits," and "flying open-circuits" sometimes occur in armature windings. These are intermittent troubles which may assert themselves when the machine is hot, after running under load, and its component parts expanded. Then, when it cools, the trouble may automatically correct itself. Sometimes the reverse con-

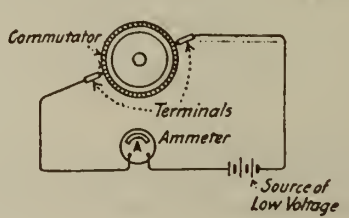


FIG. 13—TESTING FOR ARMATURE OPEN CIRCUIT WITH AN AMMETER.

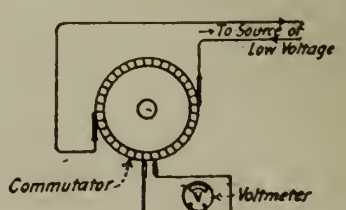


FIG. 14—TESTING FOR ARMATURE OPEN CIRCUIT WITH A VOLTMETER.

dition occurs, that is, the fault will be present when the machine is cold, but will be temporarily corrected when it is hot. Furthermore, centrifugal force, due

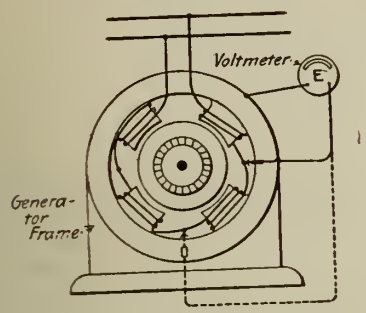


FIG. 15—LOCATING A GROUNDED FIELD COIL.

to the rotation of the armature, may be a factor in the situation, in which case the defect may be present when the armature is rotated at normal speed, but not present when the armature is stationary. Obviously such troubles are very difficult to locate. About the only

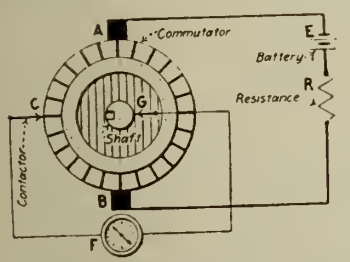


FIG. 16—ARRANGEMENT OF CONNECTIONS FOR LOCATING GROUND IN AN ARMATURE.

way to localize them is to run the machine until the defect has "burnt itself out" or otherwise rendered its presence sufficiently evident that it can be located by the usual testing methods described above.

QUICK-MAKE STARTING SWITCH

One of the new equipments brought out by the Westinghouse Electric and Manufacturing Company during the past year is an interesting starting switch. The switch is designed for use where squirrel-cage motors are started with a full line voltage. The switch is known as the Quick-Make (and quick-break) Starting Switch (Type 816). Its characteristics are 10 to 100 amperes, 25 h.p. maximum, three-phase, 220, 440, and 550 volts.

This switch is extremely flexible in its applications; in addition to being a motor starting switch it can also be used to control feeder circuits; it may be supplied in any of the following combinations, each having the "quick-make and quick-break" feature, for either hand or shipper-rod operations:

(a) Non-automatic switch.
(b) Switch with low-voltage protection.
(c) Switch with inverse time element overload protection.
(d) Full automatic switch with low-voltage and inverse time element overload protection.

It is especially suitable for shipper-rod operation on account of the positive action of the contacts. It is impossible for the operator to retard the motion of the contacts after they have started to close—there can be no "teasing" of the contacts. Workmen who are accustomed to starting machines from line shafting by means of shifting belts have no confusing details to learn. They may start the motor-driven machine with the same starting motion they use in shifting belts.

Contacts are opened and closed in oil, thus effectually suppressing arcing. The contact is made or broken so quickly that the eye cannot follow the motion. A rolling action confines the arc to the tips of the contacts and prevents pitting or roughening of the seating parts where final contact is made. A strong spring holds the contacts firmly in the closed position. These features result in greatly prolonged life for the contacts.

Construction.—Drawn-steel construction is used, giving maximum strength with light weight, and assuring uniformity and interchangeability when new parts are needed for replacement or repairs. The oil tank is supported by snap ring-latches. Removal of the tank clearly exposes the contacts and makes them easily accessible. When necessary to replace contacts each may be removed by taking out a single screw.

Contacts and contact supports are of the same construction used for Westinghouse type A auto-starters and magnetic contractors. This minimizes the number of spare parts that should be carried.

SWITCH COMPLETE

These starting switches are dust-proof.

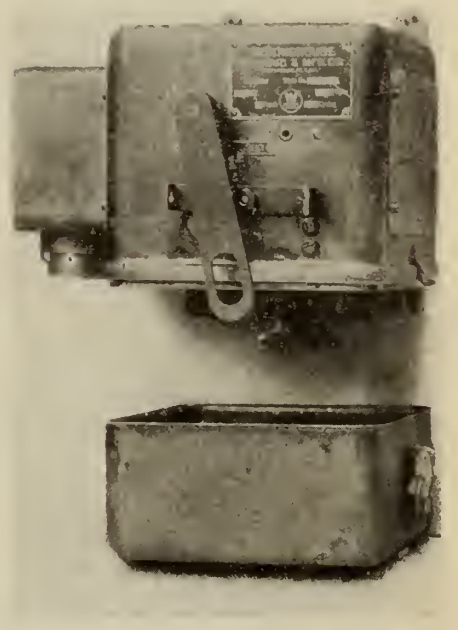
Openings are provided for conduit wiring into the top of case; terminals for connecting motor and line wires are accessible when cover at top of starter is removed.

Micarta insulation is used throughout.

Overload and low-voltage attachments may be added with no change in switch mechanism, as the toggle trip is common to all combinations of this switch.

Low-voltage protection not only opens the contacts on failure of power, but makes it impossible to close them again until return of voltage. Since the low-voltage coil is connected in the line circuit continuously, means have been provided to close the armature of the low-voltage circuit when the switch is in the "off" position, thereby giving protection to the coil and preventing burnouts. A safety stop may be provided by connecting one or more push buttons in series with the low-voltage coil.

Overload Relay.—The overload relay



SWITCH WITH CASE REMOVED

is the same as that used on Westinghouse type A auto starters. It has the inverse time element feature and is equipped with a regulating device, adjustment of which controls the degree and duration of the overload possible on a motor or feeder circuit. This adjustment can be made without opening the switch cover.

Hand Reset. — This is an additional safety feature which makes it necessary to set the mechanism before the switch contacts can be closed. Whether the contacts have been opened through the operation of the low-voltage coil, the overload relay, or by moving the switch handle to the "off" position, it is impossible to close them again until the switch handle has been moved to the "reset" position. Thus protection is afforded workmen and valuable machinery which might be injured by accidental starting of the motor.

The Puget Sound Traction, Light and Power Company's Western Avenue plant in Seattle, a central heating station containing 10 boilers aggregating 4,100 horsepower, has replaced oil fuel with pulverized coal. The pulverizing plant is situated directly across the Avenue, the product being conveyed underground and delivered to feeding bins above the boilers. Coal prepared at this plant is also distributed by truck to a number of large buildings having their own heating plants. The station is believed to be the largest of its kind that is using powdered coal.

The Control of Large Amounts of Power II

The Author, in a Paper Read Before the Institute of Electrical Engineers, England, Gave Some Interesting Remarks Regarding Control of Large Amounts of Power and the Use of Reactances

By E. B. WEDMERE

A STUDY of the data now given will bring out the disadvantages associated with the low power factor prevalent in distribution schemes in this country, and it will appear that the requirements for maintaining supply, as well as the conditions for diminishing losses, will be improved if a higher average power factor, such as 90 per cent., is obtained. In these respects present-day American practice has the advantage.

The Interconnection of Stations

Where relatively small and remote sources of power are coupled to a large system they improve the supply in their immediate neighborhood. It will generally be found that the inherent reactance in the feeders and transformers is sufficient to prevent excessive increase of short-circuit currents in the neighborhood.

Where the source is near a large station, it may be treated like a generator tied direct to an extension of the busbars, but will probably have more reactance than a single machine of equal output.

Where large stations are tied together this connection is similar to that between adjacent sections of busbars in an individual station, but differs in that a relatively smaller energy transfer is required, so that higher reactance may be employed. The energy transfer is made only for purposes of economy, and the individual station is already a self-contained economical unit. The short-circuit currents from individual sections in either station will not be materially affected if there are already three or four sections or more.

If the stations are not tied directly, but only through the distribution system, intermediate points will be subject to the short-circuit outputs of both stations.

Limitations Affecting Parallel Running:—The question now arises how will the employment of reactances between sections affect parallel running. This becomes particularly important in the case of stations remote from one another tied together for economy. Such ties may not be of large cross-section and may, therefore, introduce considerable resistance.

The theoretical treatment of this and similar cases has not been entirely satisfactory, but we may recognize that there are lower and upper limits to the reactance between which we can get satisfactory operation. It has been found that it is not generally practicable to obtain stable running conditions where the ohmic value of the total reactance in circuit between the machines is less than about twice the resistance. This necessitates the employment of external reactance in series with long underground tie cables of small cross-section. Where, however, there are step-up and step-down transformers in the circuit there will be ample reactance.

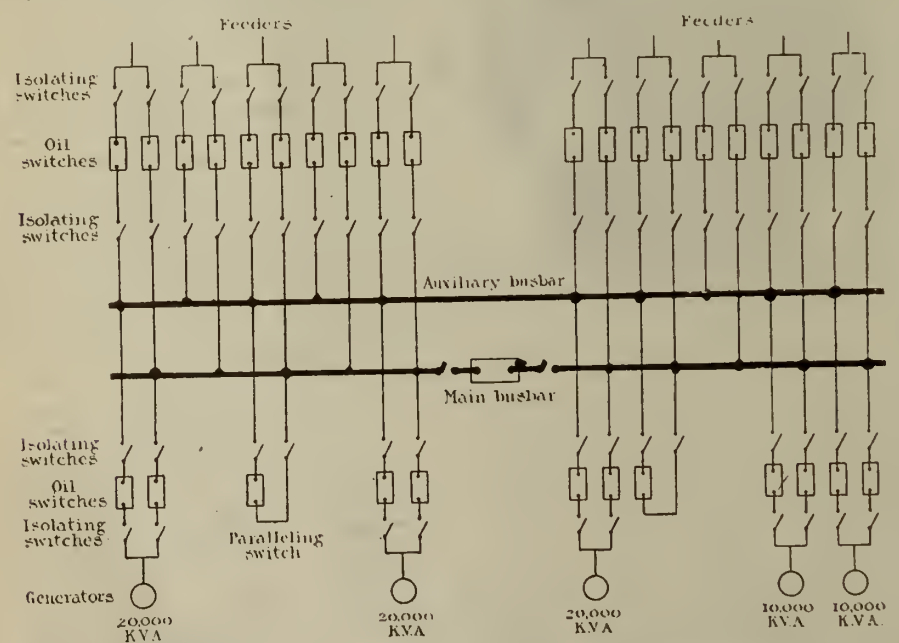


FIG. 7—ARRANGEMENT OF SWITCH GEAR, SHOWING DUPLICATE BUSBARS.

There must be an upper limit also, and this also is not easy to determine. It is evident that if two systems are running steadily at about the same frequency and voltage, a very small transfer of energy and magnetizing current passing through a high reactance will bring the two systems into synchronism. If now one system is seriously disturbed it will get out of phase with the other, but the small currents transferred will be insufficient to disturb the sound system and

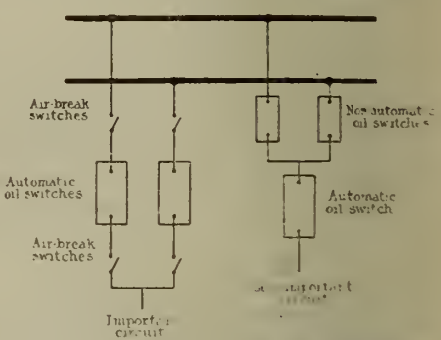


FIG. 8—DUPLICATION OF OIL SWITCHES.

will eventually bring the system into synchronism after conditions have become normal and steady. Here we have parallel running without trouble but without utility.

If now we reduce the reactance in the tie we get heavier synchronizing currents and some disturbance of the sound system, but the two systems take time to settle down after a fault is cleared on one of them, and during this time there is much phase-swinging. This oscillation tends to throw out synchronous machinery and is more serious than mere loss of voltage. The limiting values of reactance are somewhat indefinite, but experience indicates that they are well above the value contemplated in this paper. It is known that with the star design quite satisfactory results can be got with busbar reactances of 40 per cent. and more based on the section output, and upwards of 100 per cent. has been employed in a tie line between two stations.

Influence of Live Load on the Short-Circuit Current

In estimating the effect of reactance on the short-circuit currents no account has been taken hitherto of the influence of running machinery able to feed current back into a fault. This factor is generally a relatively small one. It complicates the issue but must not be lost sight of. In determining the short-circuit current that may flow at any point it is necessary to add the current, due to such machinery, which will flow through the impedance of any feeders, transformers, etc., located between the machines and the point in question.

The short-circuit current, for example, near a large substation with rotary converters may be considerably increased by

the current the converters can pump back.

Limited Effect of Fault Resistance

One must not expect to find any protection from internal resistance of faults, except when the fault is to earth through a poor earth connection or includes a long open arc.

Where porcelain insulators are mounted in brick or stone the supporting wall reinforces the insulation, and, even if a cracked insulator discharges, the current at 6,000 volts will be quickly reduced from perhaps 5 amperes to a negligible figure as the wall dries by the heat generated.

The development of a fault is sometimes stopped at an intermediate stage by quick-acting switchgear set to operate at a few amperes, but this is not a means which can be relied on for effectively limiting the stresses at a given point in the system.

Limiting Stresses by Preventing Faults Between Phases:—As faults to earth can be positively limited by the employment of resistance in the earth connection, it is only faults between phases that present a serious problem. The likelihood of such faults occurring can be greatly minimized by appropriate design.

When conductors are air-insulated they may be separated by substantial insulating barriers and kept clear of earthed metalwork. The barriers should be sufficiently large and substantial to confine the disturbance arising on failure of the apparatus they separate.

Conductors surrounded with insulating material may be further separated by earthed metal barriers so arranged that a fault to earth is confined to the phase on which is occurs.

A good example is found in a machine in which the conductors throughout their length, including the end turns, are covered with insulating material and separated by earthed metal parts with which they are in intimate contact. A breakdown on such a machine must arise as a fault to earth, and is localized by the formation of a good enclosed conducting path to earth. The risk of open arcing is minimized, and consequently the risk of the fault spreading to other phases of consuming the whole machine.

Limiting Disturbances by the Use of Protective Relays and the Like

The advantages obtained by the use of selective protective apparatus on large distributing systems are now generally recognized. They play an important part in economical distribution and an essential part not only in localizing disturbances but in limiting their duration. This latter function is useful in preventing the development of disturbances due to unstable conditions, as, for example, in parallel running, but is especially important on large plants where the factor of safety against overheating on short-circuits is likely to be small.

The use of such apparatus throws a severe duty on the switchgear, as switches have to clear faults whilst the currents are in the neighborhood of maximum value (see Fig. 1), and the onus of clearing each particular fault is thrown on the individual switch or switches nearest to it.

For these reasons it is necessary to employ with the selective protective apparatus a system of stand-by protective apparatus which comes into use in case of failure of switchgear or selective apparatus. This takes the form of a system of fixed time-limit relays with graded settings which will come into operation only after failure in the first line of defence. A plant so protected will be as well off even on failure of the selective apparatus or distribution switchgear as plants have been in the past which were protected solely by the apparatus now used as a stand-by.

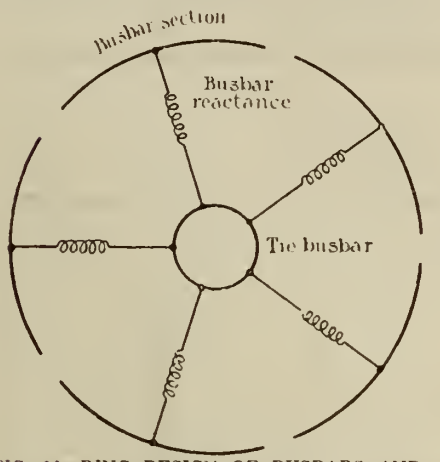


FIG. 10—RING DESIGN OF BUSBARS AND REACTANCES.

It is clear, therefore, that the provision of an adequate stand-by system justifies working with a lower factor of safety on the smaller circuits, especially if the conditions are favorable and the plant well designed in the first place to minimize the occurrence of severe faults. Existing switchgear may be retained on extension of plant, by relying on the stand-by protection to save the plant, if the margin is not too small.

For example, switchgear rated at 20,000 k.v.a. might be employed to clear faults of 30,000 to 40,000 k.v.a. with stand-by protection, as, if the conditions are favorable to the switch, even the larger faults may be cleared satisfactorily and the severest disturbances should be few and far between.

Rating of Reactances

In discussing the use and characteristics of reactances it is most convenient to rate them in terms of the percentage reactive voltage drop they will give on the full-load rating of the part of the plant with which they are associated. Thus we speak of a transformer with 4 per cent. reactance. In the same sense a reactance for a generator and rated at 10 per cent. is understood to absorb 10 per cent. of the normal voltage when carrying the rated current of the machine.

In the case of busbar reactances each reactance is associated with a section of the busbar and should be rated on the total generator capacity attached to the section, as its current-limiting effect is independent of how that capacity may be subdivided.

For example, in Fig. 5 the generator and transformer reactances are rated 10 per cent. and 4 per cent. respectively on their individual outputs, and the busbar reactance is rated 14 per cent. on a busbar section rating of 40,000 k.v.a. It will be seen that the reactance drop is the same for a fault on either busbar section although the generator capacity

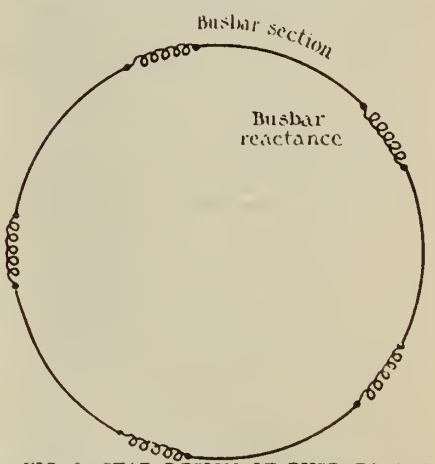


FIG. 9—STAR DESIGN OF BUSBARS AND REACTANCES

on one side is made up of two machines.

A feeder reactance may be rated at 3 per cent. when associated with the feeder, but if its effect on short-circuit is considered in connection with a generating plant of 10 times the feeder rating, it at once becomes 30 per cent. When rated in this way it may be added to the reactance of the generators expressed in the same terms. If, for example, the generator reactance is 10 per cent., the the same terms. If, for example, the tor rating, and limits the maximum short-circuit current to 2½ times the rated output of the generators.

Thus this method of rating enables the employment of reactances to be discussed in general terms and without reference to the size and voltage of the plant.

The current-carrying capacity which may be given to a reactance has no effect on its current-limiting action, and is determined by consideration of the amount of power to be transferred through it.

The actual dimensions of a reactance will, of course, depend both on its ohmic value and on its current capacity, and the individual reactance is best rated in amperes, carrying capacity, and ohms reactance at a given frequency, with the addition of working voltage, the working voltage determining the insulation required.

Arrangement of Busbars

In the provision of busbars and switches, something more is required than a simple straight busbar, or even a single ring busbar with one switch per circuit. Additions are made both to give duplication for safety and to provide flexibility. An extreme is reached by a design like an arc plug-board with provision for coupling any circuit or group of circuits independently to any machine. Such a design has been provided for (proceedings of the Ameri-

can Institute of Electrical Engineers, 1916, vol. 35, p. 886) and gives maximum flexibility with something more than duplication. In a station with 5 machines and 10 feeders, 15 busbars would be required, and 50 oil switches, as against one busbar with 15 oil switches.

The first essential is a spare busbar arranged so that any section can be shut down without interfering with supply. In the matter of switches it is recommended that all normal switching operations should be done by means of oil switches, and that air-break switches should be used only for isolating parts already made dead by oil switches. By this course adequate duplication is provided and the risk of serious trouble due to operator's mistakes in routine work is reduced to a minimum.

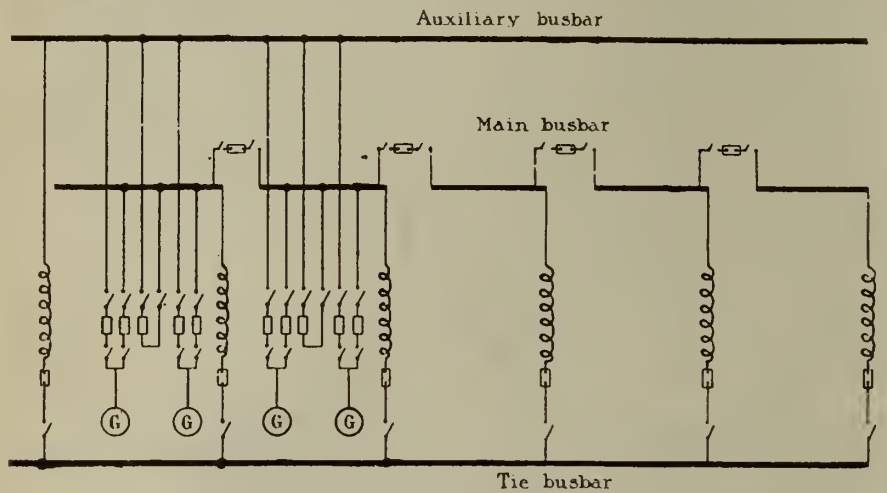


FIG. 11—ARRANGEMENT OF SWITCH GEAR FOR STAR DESIGN.

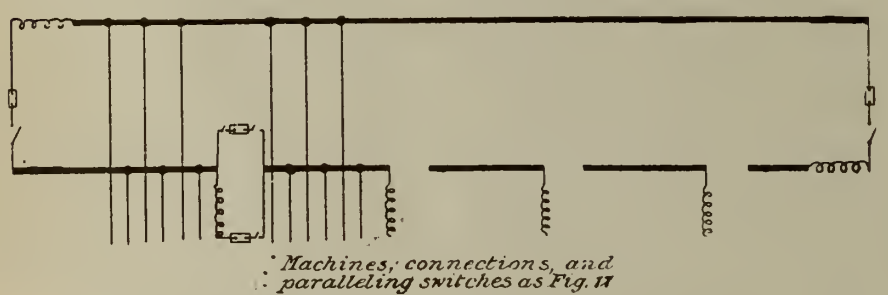


FIG. 12 ARRANGEMENT OF SWITCHGEAR FOR RING DESIGN.

Thus with provision for busbar paralleling and sectionalizing, a station such as described may usefully employ, say, 33 oil switches without reactances (see Fig. 7).

Each addition to the primitive arrangement should be made to give a definite contribution to the results obtainable, and it is a general law of design that there will be increased economy if there is differentiation of function as well. For example, in the illustration given, one of the busbars is regarded as the main busbar and given a section switch. The other is regarded as the stand-by and would be used as a hospital busbar and for testing. The arrangement has all the advantages of a single ring busbar and at the same time provides a stand-by. It does not look like a ring because coupling switches are not shown at the ends, but each section is in fact coupled to both its neighbors, and the paralleling switches are located midway in the length to keep down the cross-section of copper. For the same reason the machine and feeder switches are alternated.

If oil switches are not duplicated, the fact of an oil switch being put out of commission for any reason prevents the corresponding machine or feeder being employed, and thus must lead in the long run to greater expenditure on spare plant or a greater risk of serious lack of spares on emergency.

For this reason large machines should have at least two switches, but on less important circuits a compromise can be effected by employing one automatic oil switch and two inexpensive non-automatic oil-break selector and isolator switches as in Fig. 8, but economy is effected in first cost thereby only where the main oil switches are required to be of large rupturing capacity. It will be understood that the oil-break selector switches will break load current without danger, which an air-break switch would not do.

Arrangement of busbar with reactances.—Busbar reactances may be employed in either of two ways, conveniently described as the star and the ring designs.

In the star design the busbar reactances are paralleled by tying them to a common point or tie busbar as in Fig. 9, whilst in the ring design each busbar section is tied to the next through a reactance, as in Fig. 10.

In introducing reactances, two oil switches will be required with each. One is for paralleling through the reactance and the other for paralleling without the reactance. These switches are so employed that the number of machines tied direct to any group of solidly parallel sections does not exceed the number proper to one section, and is not appreciably less. For example, with two machines per section, two sections should not be solidly paralleled unless at the time they have only one machine running on each. They will be separated by reactance immediately a third machine has been coupled to them. At times of heavy load all the reactances will be in use. At times of light load they will all be short-circuited. This is necessary, for it will be found that with reactances of the ohmic value required it is not always practicable to transfer light load through them without excessive drop of potential.

The complete switchgear in accordance with these recommendations is shown in Figs. 11 and 12, in which the feeders are omitted for simplicity.

It will be seen that, with the five sections shown, six reactances are required in each case. With the star arrangement the sixth is used to tie in the auxiliary busbar. With the ring arrangement a tie is required at both ends so as to ensure a reactance between this busbar and each adjacent busbar. Each arrangement is in effect a six-section busbar.

Each reactance as here shown is associated with a particular busbar to which it is solidly tied, but an isolating switch can be introduced at this point at small cost, giving greater flexibility.

The paralleling switches shown are all essential if duplicate main oil switches are not employed, but where the busbars can be paralleled through one or more pairs of these duplicate switches, the paralleling switches are not essential. The two end one should be retained for uniformity in the equipment for completing the ring main. Their use throughout as shown is recommended, however, as it simplifies and unifies the operations and the amount of thought required.

Advantages of the star arrangement with its extra busbar will be brought out by a study of these diagrams. Whatever sections are employed are paralleled

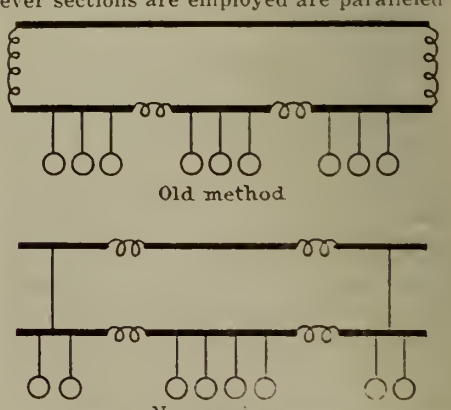


FIG. 13—DISTRIBUTION OF MACHINES IN RING DESIGN

by the simple operation of coupling them to the tie busbar, whereas in the ring arrangement it is not possible to maintain the ring formation when one sec-

tion is shut down, or easy to follow the load-transfer conditions. Mistakes are more easily made which will leave the reactances cut out and too many machines operating in parallel on a section.

The third or tie busbar needs to be at least as well made as the other two, as a fault on that busbar involves all the sections and is fed through all the reactances. It is not duplicated, but may be ringed and broken up with air-break switches. It can be made dead at any time by a temporary sacrifice of economy in running.

There is no doubt, however, on the other hand, that in many situations it is easier to make a good design with two busbars than with three, so that there is a use for the ring arrangement. It will be shown that the load-transfer capacity of the reactances required in the ring arrangement may be as much as that required in the star arrangement, and the ohmic value is doubled for the same protective value, so the k.v.a. rating of reactances for the ring design may be twice that required for the star design and the cost consequently about 50 per cent. higher. This is partly or wholly offset by the omission of the third busbar. The ring arrangement, however, has the defect that under working conditions the ring cannot always be maintained closed. On shutting down any section of the busbar the ring is broken. If the design gives the correct limits with a closed ring it will now be found that there is too much reactance isolating the end sections of the open ring and consequent excessive pressure drop, whilst if the reactances are selected to compromise for this, clearly this can be done only at the expense of the protection afforded. The balance of advantage lies with the star design.

The defect in the ring system can be partly offset by making the end sections 30 to 50 per cent. smaller than the middle section and arranging them as shown in Fig. 13.

To be Continued

LARGE INSTALLATION OF TRANSFORMERS

The Toronto station of the Hydro-Electric Power Commission of Ontario, on Strachan Ave., was originally laid out for two banks of 1,250 kva. transformers with one spare unit, but the load grew so rapidly that in 1913 considerable expansion was required. Accordingly, the station was doubled in length and accommodated three additional banks of 2,500 kva. transformers. In addition to the transformer equipment two new sections of the H4 double bus switch structure were put in commission, serving the 13,200 volt out-going feeders as well as a K 12 remote controlled oil switch structure which served the 2,300 volt load.

Two of the 2,500 kva, banks were installed, but before the last bank was ordered, the decision was reached to again double the unit capacity, and accordingly, fifteen 5,000 kva., 25 cycle 110,000 volt transformers were ordered from the Canadian General Electric Co. This brings the total capacity up to 75,000 kva. on the basis of 40° C. rating of approximately 100,000 kva. on the basis of maximum rating.

To instal these transformers in the original transformer pockets it was necessary to increase the height dimensions very materially.

The transformers are now 24 feet high from the rails to the top of the high tension leass, which accounts for the slim appearance of the tank as shown in the accompanying cut. The floor space limitations also precluded the possibility of using core type construction.

The transformers are shell type units and have reinforced steel plate housings and supports. The economy in weight made possible by this construction, standard with the C. G. E. made it possible and safe to utilize the existing foundations without material change in spite of the fact that the main weight of the transformer is carried over to the central foundation wall by a short cantilever construction.

The transformers have button type spacers between coils and the coil ends extending above and below the core are firmly braced against distortion from short circuit strains. Particular attention is drawn to the appearance of the core shown in the accompanying illustration, which hardly does justice to the unusually fine results obtained in the piling of sheet steel laminations.

The transformers were made at the Peterborough Works of the Canadian General Electric Company and the tanks, which it will be noticed are without horizontal seams, were made at the Davenport Works, Canadian Allis-Chalmers, Ltd.

TRANSFORMER ASSEMBLY. NOTE THE NEAT PILING OF THE LAMINATIONS.

COMPLETE TRANSFORMER

To be Continued

SICILIAN ELECTRICAL COMPANY ENLARGES

A company formed to produce and distribute electricity from water-power in the eastern provinces of Sicily has been so successful even during war times that it recently decided to enlarge so as to include in its scope the entire Island of Sicily, according to the last bulletin issued by the Italian Bureau of Public Information. The "Societa Elettrica delia Sicilia Orientale" was established in 1907, and by 1917 its capital was $3,000,000 and its income $1,000,000. Despite the decrease in industrial development, due to the war, the company was able to declare a dividend of 5 per cent. in 1914-15-16, and in 1917 a dividend of 6 per cent.

The enlarged scope of the company has necessitated an immediate increase in capital to $6,400,000, and by 1919 the company expects to have a capital of $8,000,000.

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Fuel Economy is Still Desirable

THE past year has been one of many vicissitudes for the power house engineer, the owner and those having to do with the purchase of power. The coal famine of last winter, with hte resulting tie-up of Canada's industrial life for a short period, will be remembered by all and the conservation campaign waged here to some slight extent, and vigorously in the United States, was the outcome of the necessity for conserving manpower and releasing fuel and energy to the makers of munitions of war.

The lessons learned through this necessity may well be kept in mind during the peaceful days ahead of us. The wise and proper operation of boiler equipment, the success and economy attending upon the use of mechanical stokers and other labor-saving appliances, and above all the absolute necessity for the use of proper boiler room recording and indicating equipment, has time and again been pointed out and should ever be kept before us.

The conservation of fuel is as important for Canada's success in the coming years as it has been for her successful efforts in the past period of strife. This is so for two reasons, the economic struggle for the world's markets, or a proportionate share of them will go to the country which can produce cheaply, and the wasting of a country's natural resources is a thing not likely to be excused for any reason.

Coal is a commodity which once used up can never be replaced except by the substitution of some other source of obtaining heat and energy and the world's supply of coal, while vast in extent, is not by any means everlasting, and at a date measurable in terms of a few hundred years the world will have to turn to some other source. The same is true of fuel oil and other present-day sources of heat and energy such as our at present untouched deposits of peat.

Help This New Feeling Along

THERE is undoubtedly a new feeling arising in regard to the conditions that should exist between capital and labor. In fact, the new feeling is such that it will likely put the boots to that phrase "capital and labor."

It's a poor phrase at best. It draws a line right at the starts that hurts insteads of helps.

It survives the old days when the man in the office looked upon the man in the shop as the human part of the machine.

There has been a wonderful softening influence in the last few days and years.

The son of the man in the shop has gone under in France, and the son of the man in the office marched away and will not return.

The employer who has had much to do with turning out munitions in the last three years in Canada has learned that it is good policy for the people in the shop to make good wages.

An employee who is making good wages is likely to be contented. The employee who is kept down to the lowest possible wage is not going to be contented. He will quit just as soon as the chance comes, or if he stays he will be looking for a chance to strike.

It is only human nature. In these days of living at its highest point, with the purchasing power of a dollar shot to pieces, the man who cannot provide for his home in decency is going to listen hard to the doctrines of Bolshevism. He will become an agitator, whereas decent conditions and a square deal would have made of him a good citizen, and of his home a centre for good influences in the community.

Manufacturers are realizing this point. They are speaking of it openly. They have had a demonstration of the fact that good wages and good conditions will iron out more trouble in the shop than all the deputations and labor departments in the world could ever hope to do.

It is well that this feeling should start now and grow with the new industrial Canada that is coming. Encourage it. See that it gets a chance to develop. It will do more to prevent strikes and lockouts than all the legislation that could ever be piled into the books of the country.

The bigger the margin that can be maintained between the worker and starvation the greater the efficiency of the worker and the success of the concern with which he is connected.

Association and Personal

Walter V. Turner, manager of the engineering department of the Westinghouse Air Brake Company, of Pittsburgh, and an inventor of note, died following a brief illness. Mr. Turner had more than 400 patents granted for various inventions. One of these, the "K" triple valve, is said to be valued at $28,000,000.

George Gray, assistant general manager of the Acadia Coal Company, Halifax, was presented by the company and staff with a chest of silver and an address signed by the executive management and his fellow officials. The occasion was the thirty-fifth anniversary of Mr. Gray's connection with the coal mining industry in Nova Scotia, and particularly with the Acadia Coal Company.

G. H. Duggan has been appointed to the presidency of the Dominion Bridge Co., to fill the vacancy created by the retirement of Phelps Johnson, the former president. Mr. Duggan has had a long service with the company, and for the past several years has acted in the capacity of vice-president and managing director, and has been closely associated with most of the important developments and extension of the Dominion Bridge Co. Mr. Johnson will remain on the board of directors of the Bridge Co., and will also serve on the executive committee.

William J. Galbraith, a well known Montreal civil engineer, died at his residence, 4145 Dorchester street, Westmount, on Dec. 21st from pneumonia. The deceased gentleman, who was only 32 years of age, had enjoyed a very successful engineering career. He graduated from McGill in 1909, and at the beginning of 1910, was engaged in the Rocky Mountains with the Geological Survey, and in the fall of the same year, he entered the firm of M. P. & J. T. Davis, as assistant engineer on caisson work for the Quebec bridge, remaining there till the spring of 1912. He then started in construction work for himself, and carried out many important works for the Dominion Government. At the outbreak of war he entered the Foundation Company of New York as superintendent of construction, in which position he remained until his death. He was a member of the British Institute of Civil Engineers, and leaves a widow and one daughter.

Major F. L. C. Bond has been appointed chief engineer of the Grand Trunk Railway system with headquarters at Montreal.

Lieut. Lloyd M. Archibald of the Royal Flying Corps, well-known representative of the Dart Union Company of Toronto, as he appeared as a prisoner of war in Germany (on the right). Word has just been received by his brother, Charles P. Archibald, of Charles P. Archibald & Co., machinery dealers, Montreal, announcing his safe arrival in England after being a prisoner in Germany for over a year.

Major Bond, who succeeds Mr. H. R. Safford, recently appointed engineering assistant to the regional director of the central western district, United States railroad administration, has just returned from overseas after two years' service with the 10th Battalion Canadian Railway Troops. He was born in Montreal in 1877. He was educated at Montreal High School, the Collegiate Institute and McGill University. Upon graduating from McGill in 1898, he entered the service of the Grand Thunk as assistant resident engineer of the eastern division, and in 1901 was appointed engineer in charge of double track construction. In 1902 he was night superintendent on the construction of the Park Avenue tunnel of the New York subway, but returned to the Grand Trunk as resident engineer, eastern division, a position which he held until 1913. From 1913 to 1916, when he went overseas, Major Bond was division engineer, eastern lines. He holds a high reputation in railway and engineering circles and his work with the Canadian expeditionary force won the highest commendation.

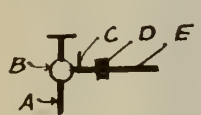
The Operators' Point of View

PROTECTING HEATING PLANTS FROM FROST

By J. E. McCORMICK

DURING the cold winter months the chances of a pipe or valve being burst by frost are remote indeed in those plants which are used entirely for heating dwellings or for heating shops which contain goods or merchandise of such a nature as to become damaged even by slight freezing, but in isolated steam plants (and there are many of them throughout the country), used for mill or factory power, but not for heating dwellings, and which are therefore idle from Saturday noon or night until Monday morning, as well as during fourteen to sixteen hours out of every twenty-four during the week, the engineer must be more or less on guard against damage by frost, especially when the thermometer outside stands at many degrees below zero for a time, as is often the case in many Canadian localities.

There is also more or less chance of frost doing damage in those plants which, in addition to furnishing power, are used for heating shops or factories during working hours, the steam being shut off from the heaters and radiators during nights and Sundays. In such plants I have found the steam lines to be much more liable to damage than the water lines are. The water lines are shorter, and good insulation by means of some kind of covering will do much to protect them and they can generally be so planned that those which must necessarily contain water may, when they do get cold, or nearly so, be warmed up again by opening slightly the necessary valves and allowing water to flow slowly through them from towards the boiler for a little while. This will warm them up and leave them full of hot water again. A slight leakage through the lines, a drop or two per minute if otherwise permissible, will sometimes aid in maintaining the temperature of covered pipes.



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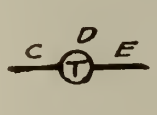

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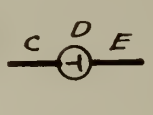

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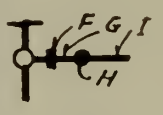

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But with steam lines it is different. According as the boiler cools down and the pressure goes off, the steam in the lines condenses. Generally a little leakage in the valves allows the most of this condensation to escape, and the remainder freezes in the lines in the form of a shelly ice or of a hoar frost. This is in lines not long enough to require to be trapped. My experience with such plants leads me to believe that except in exceptionally cold weather, covered pipes will not burst with this shell ice, and so long as the boiler is not fired enough at a time to raise any steam, and more especially if the accumulating air pressure caused in the boiler by expansion of the water, while heating, is allowed to escape through the upper gauge cock or other vent while the water is heating, said vent being closed again when the fire has been banked; then the boiler and the water pipes may be kept warm for days without danger of damage to the steam lines. If, however, any steam is raised, it is, in most of these layouts, imperative that enough be raised to thaw out all the steam pipes containing any of the shell ice and that care be taken to see that they are thawed out. I generally find that it is at the valves that the ice seal is most apt to exist and that some hot water poured over the body of these will thaw them enough to open, and this will allow steam to flow, which will soon thaw the intervening pipes. If steam is raised without the lines becoming thawed out before the steam goes off again water will form in the steam pipes and will flow into the spaces in the shell ice already existing and fill these spaces up; then, when this freezes, something is almost certain to burst. Of course if the valves next the boiler were absolutely steam tight no steam could enter the lines to condense them and do damage, but this ideal condition cannot be fully maintained without undue expense for renewal of valves and parts, hence, in general, the principle applies. I have several times known steam lines to suffer damage in this way and had similar experiences myself in plants I had charge of before I learned the real cause and its cure. It is noteworthy that in each of these instances the water lines remained intact.

And now for a simple remedy, which obviously does not consist of maintaining a constant steam pressure on the lines, thus involving excessive standby consumption of fuel if kept up during all holidays. The instance sketched is for taking steam direct from the top of the dome or boiler if desired, but the principle can be applied to other positions. In Fig. 1, A is the upright nipple, B is an angle valve, C is another nipple, D is a three-way stop-cock, and E is the continuation of the line. The side outlet of the three-way cock opens to the atmosphere. In operation—during the time the line is in use, the stop-cock is turned to let steam pass directly through it into the line (Fig. 2). When steam is turned off the line by means of the angle valve B, the stop D is turned so as to give a free passage from B to the atmosphere (Fig. 3) and the line is also drained. Now any further escape of steam from the valve B passes out through the side outlet of D into the atmosphere and escapes instead of entering the line to condense and do harm. Any drip from the side outlet of the stop-cock D can be carried away by means of a neat metal trough. Fig. 4 indicates an arrangement calling for more parts but which may be preferred by or be more easily available to some. A, B, and C are as before; F is a tee; D is nipple, H is a globe valve, and I is the continuation of the line. The tee F is supplied with a nipple and a globe valve to provide an escape for leaking steam when B and H are closed. Perhaps quite a number of engineers can benefit as much by the use of this device this winter as I could have benefited years sooner had I known of it and its advantages then.

CARBON AND COMMUTATOR WEAR

R. E. HELLMUND,
Westinghouse Electric and Manufacturing Company

Carbon manufacturers, as well as manufacturers of dynamo electric machinery, have made numerous tests to determine contact resistances, friction losses, etc., of various carbons. While such tests are of interest, they contribute very little towards the real practical need; namely, a carbon which can stand high current densities and high sparking voltages with small wear.

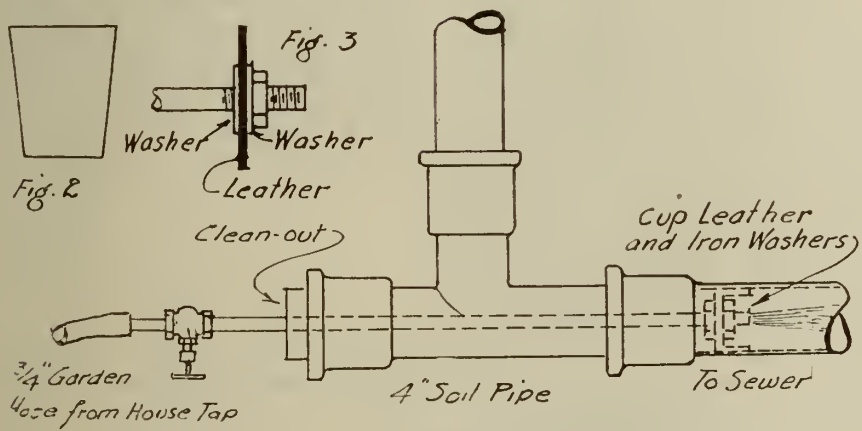
In order to develop such carbons, it would seem essential to first make tests determining how the carbon wear is affected by current density, sparking voltage and peripheral speed. Present indications are that with many commercial carbons very appreciable densities can be used if there is no sparking voltage, while sparking voltages up to 15 or even 20 volts across the brush cause very little wear at certain speeds, if the current density is low enough.

More data along this line should be of great advantage both to the carbon manufacturer and the designing engineer.

CLEANING SEWER

By J. E. NOBLE

A few days ago I was watching a plumber trying to clear an obstruction from a 4-inch sewer pipe. His method was to run the end of a hose into the end tee, after removing the clean-out cover, and plugging rags or clothes around the hose to prevent the water backing out. Why will men use such crude methods when a few minutes' work will supply them with a really good tool for this style of a job? An idea of the tool can be formed by a glance at the sketch; I used this tool with fine success when I worked at the plumbing business as long as twenty years ago (perhaps I should use modern terms and call it sanitary engineering, but from personal observation the old plumber is "in it" to the neck with the sanitary engineer, in numerous cases at least). It is nothing more or less than a cup leather held on the end of a piece of ¾-inch iron pipe by two iron threaded washers, the other end of the pipe being attached to a hose, which in turn is coupled to one of the house taps. A valve can be placed on the end of the pipe so that the flow of the water can be controlled without going to the other tap. To make cup leathers, form a piece of sheet tin or galvanized iron in the form shown at Fig. 2, size on top 6½ inches, bottom 4 inches; this will do for cup leathers 6 in. to 4 in. To make the cup, cut the leather 2 in. over the size required; that is, for a 4 in. cup make the leather size 6 in. Now place the leather between two iron washers and bolt them together as in Fig. 3. Next, place it in a dish of warm (not hot) water for a few minutes, this will soften up the leather. Next remove from the water and force down into the form, Fig. 2 and leave there for half an hour or so until the leather gets time to set into shape. This makes as good a cup leather as can be bought. Of course judgment must be used in picking your leather; use a piece of firm, flexible leather, sole leather is too hard, and belly leather too soft; use side leather.



ARRANGEMENT USED IN CLEANING OUT OBSTRUCTED SEWER.

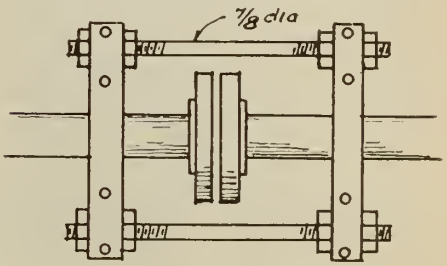
MAKING HARD GASKETS DO THE JOB

Some time ago we got some of the "moulded" black rubber gaskets for hand holes. Owing to a certain amount of unevenness in the metal surfaces these were required to come to a fit by being screwed up tight enough to force the highest spots to imbed themselves in the gaskets. This particular lot of gaskets were particularly hard, and it was found difficult to get them tight enough without danger of stripping the bolt threads. These gaskets would even break by bending them back and forth for a while, and for a time they lay discarded and supposed to be useless. Finally it was found that they would soften in hot water, so next time one was needed it was placed in hot water just before required; then, when soft, was taken out, put in place and the nut screwed up quickly, before the gasket had time to cool. They are all used up now but one and there has been no trouble with them since the hot water cure was adopted. Heating the hand hole cover thus as well as the gasket, retards the cooling action while putting in place and gives a little longer time to work without the gasket becoming too cool. The pressure carried on the boiler was from 90 to 110 lbs. per sq. in.—J. E. M.

RENEWING WORN GASKETS IN LARGE FLANGE JOINTS

By S. E. Burd

It is a matter of some difficulty at times to renew joints in large pipe, especially in tight corners where space is limited. As will be seen from the illustration, four pieces of heavy flat iron are shaped to fit around the pipe as shown in the illustration and each pair are clamped on the pipe by ¾ in. bolts. These bolts have 15-16 in. fillers threaded on them so that the ⅞ in. rods will be an easy fit. The ⅞ in. rods are inserted while the fixture is being placed



on the pipe and the nuts between the clamps are then screwed up. This forces the flanges apart to the proper distance and the new gasket can then be inserted easily.

After the gasket is in place, if there is no spring in the pipe the inside nuts can be slacked off and the flanges pulled together again by the outside nuts.

After making this outfit it only takes one man a short time to repair a leaky joint. It can be used for different size pipes by putting packing between clamp and pipe within reason.

HOW I BROKE INTO PRINT

By D. A. HAMPSON

Under that none-too-elegant title we would expect to find a ten cent "work" for the instruction of budding authors, shelved beside the other "how" books in our news stands and book stores. So far as trade and business paper writing is concerned, there is no "how" to it at all—it is simply a case of Do and Do Again.

Right here in POWER HOUSE we see appeal after appeal to the men on the firing line to open up and share the interesting experiences and the trade kinks that they have met with in their work. Whenever two or three mechanics get together one of the subjects of conversation is how they did this difficult job without the proper tool or how the boss in their shop discovered a new, quicker way of doing a time-honored piece of work. And these mechanics are just as bad as so many women—they can't wait for one to finish to get in another experience equally as good or better—if nothing prevented, they could and would talk a whole day without exhausting the subject.

These are the experiences the editor wants. Write them just as you would tell them—the editors will smooth off the rough edges and put on the polish if which may be common property of the needed. The very methods and tools shops in your vicinity may be unknown elsewhere and local pride, if nothing more, should want to put that vicinity on the map and bring it that much credit

for mechanical initiative. Over and over again some acquaintance has told me of reading something of mine in a certain paper; invariably my reply has been, "Yes," but, Will, you have been so much farther than I and have had such varied experiences that you should have material for a year's writing, all of it being more valuable than mine."

Those people who have such goods to sell—and it's a selling proposition—rarely get down to the point of actually trying, or if they do try once and get turned down by an editor, they become disgusted, like the Grouch that complained in a recent issue. Why, one of the standing jokes in our household was for me to be met at the door with, "You've got another R. M." R. M. standing for returned manuscript, a highbrow name for what was often but half a sheet of paper.

There are articles that lack merit and subjects that are hackneyed, but anyone who reads the paper he expects to contribute to can select an experience or two which steer clear of these dead lines. And then the old matter has to be brought up ever so often for the benefit of the younger generations in the trade. Basic principles and operations remain the same for long, long years, and will bear repeating at intervals, for all technical papers strive to educate the newcomers as well as the older men. These basic operations are subject to new and ingenious applications with the modern advances in the art. All of these things can be worked into articles that the editor is glad to receive.

Two of us as apprentices subscribed to POWER HOUSE. We found a world of information in it to discuss and compare—I'm afraid often on the shop's time, but then we were pushers and ready to try anything new or quicker for the shop. Sometimes we had a job to do that seemed as goo das those we read about and naturally one of us remarked, "Let's send it to POWER HOUSE." That got to be a joke, but finally I took a picture of a planer job that turned out well and wrote a couple of hundred words about it and sent it to the editors without saying anything around the shop. When that appeared in print and I showed the cheque for four dollars that went with it, the idea ceased to be a joke any longer. Following that first successful instance, there was a long list of rejected "articles" and a few money orders for fifty cents, but the editors were courteous and the rejections only served to spur on to better efforts—to be frankly critical of one's own work is the first step toward success.

And it pays the author in every way. The Buick Six that serves as a splendid refresher after a long day inside could be bought with the money received from writing and its maintenance and that of the cars I have owned before more than covered by the same source. And then there is the self-improvement side of writing—"writing makes a ready man," and as he writes he is sure to stumble on points of doubt upon which he must read up before he turns out the completed article. Often a single point entails many evenings of study, to the ultimate good of the student. Then anything that is written fixes itself much more firmly in the mind than what is simply read. All of these things help the writer as much or more than the ones who read them and have a distinct broadening effect. Added to the foregoing is the fact that some one is waiting for what you write—glad to read it, and some one else is ready to pay for it at substantial rates.

TEMPORARY REPAIR OF A BROKEN STOP VALVE

By T. H. F.

AN interesting repair of a bad break came under my observation when sailing as 3rd engineer of "S.S.———." We were bound from Cardiff to Nagasaki, Japan, though as we were carrying Welsh coal for the Japanese navy, and Japan then being at war with Russia, our ostensible destination was Shanghai for orders. However, we had come down the Red Sea with its usual discomforts, across the Indian Ocean, and were making up for Colombo to coal. We sighted the harbour about 7 a.m., and about 7.30 the first officer gave orders to the bo'sun to get steam on the windlass, preparatory to anchoring. Now the bo-sun had sailed in steamers so long that he was, in his own mind, something of an engineer. Therefore, instead of notifying the engineer on watch that steam was wanted on deck, he undertook to put steam on himself. The two valves controlling steam to the fore and aft deck were situated in the fidley, at the bridge deck, and easy of access to anyone. The gallant bo'sun, whose engineering knowledge really was all comprised in the ability to turn a wheel to the right or left, which would open or shut a valve, naturally never thought of the fact that the steam had not been on the deck pipes since leaving Suez, so he stepped into the fidley, took the wheel in his tarry hands, gave it a mighty twist, and then things happened. It was here that the chain of events reached me personally. The messroom steward had just entered my room to call me, and I was sitting on the edge of my bunk, rubbing the sleep from my eyes, when a terrific report, followed by the roar of escaping steam burst on my ears. I jumped from the bunk into my engine-room slippers, and in pyjamas and slippers, made for the engine-room. After the first shock my ear could still distinguish the beat of the engines, and there was no sign of steam in the engine-room. Going on the top grating I opened the door leading to the boiler tops, but though the noise was plainer here, there was no steam. As I turned back again, the second came up from below, and made toward the door, beckoning me to follow. He went to the auxiliary stop valve on the port boiler and motioned me to the starboard boiler. These were shut off, and quietness reigned once more. This sounds simple, but any of my readers who have gone on boiler tops in tropical weather clad in pyjamas and slippers will appreciate the pleasure of it. As we came out onto the top grating again, I asked the second what was damaged, and elicited at first a very complete and highly ornamental biography of our bo'sun, bo'suns in general, deck officers and skippers, winding up with the announcement that the donkey boiler stop valve had been blown off. This was the case.

Steam for the winches and windlass was taken from the main boilers, through a reducing valve, and from the donkey boiler. The pipe from the reducing valve joined the donkey boiler pipe close to the valves controlling the deck steam. The donkey boiler was situated on the main deck, and from the donkey boiler stop valve to the bridge deck where controlling valves were situated, was about 30 feet in length, with a rise of about 3 feet. Now it was the practice to leave steam when at sea,

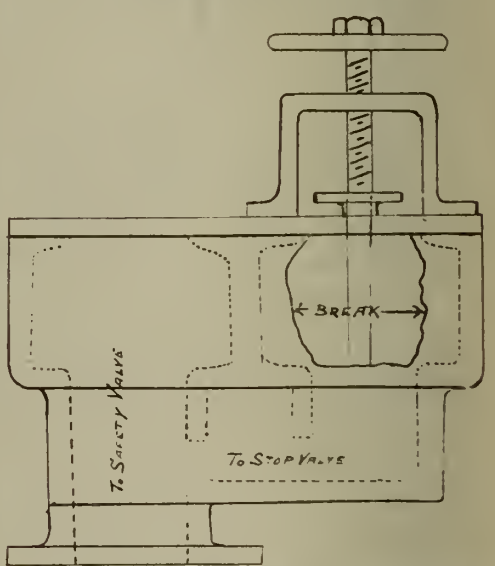


FIG. 1—SHOWING BREAK IN STOP VALVE WALL.

open on the main boilers to the reducing valve, and up to the fidley, so that if steam was needed on deck, it could be opened without anyone having to go on the boiler tops. As no one but an engineer was supposed to touch the valves on deck, there was no danger. When the bo'sun threw open the valve a slug of water started off, and the first obstacle it struck was the donkey boiler stop valve, which surrendered. The stop valve was contained in the same casting as the safety valve, which made it more awkward. The first thing to be done was to blank the pipe off between the donkey boiler and the supply from the reducing valve, so that steam could be put on deck to handle the anchor in Colombo. This little job being done, a

hurried visit to the messroom was paid, where the dried up remains of breakfast were bolted just as the stand-by rang for the pilot. This was the beginning of a perfect day, the remainder being spent between tallying coal and doing little jobs in the engine-room, such as packing the H.P. gland, etc., with the sweat forming pools wherever one stood. The delights of a coaling port ending like anything else, we were under way again about 8 p.m. with the next stop Singapore.

Next morning after breakfast, the chief, second and myself went forth to inspect the damage, and see what could be done. It was essential to have the donkey boiler at work in port, so that the main boilers could be cleaned. The side of the stop valve wall had been blown clean out as shewn by the sketch, but the lower port and safety valves were intact. The cover was good, and the valve itself not damaged. The first thing suggesting itself was to make a patch out of some plate we had, ¾-inch thick, but upon going further into the matter found this would be a job of some considerable magnitude, and other means were looked for. It was finally decided not to attempt a patch, but to use a temporary expedient that would serve till we arrived at a home port, where we could get a new casting. Looking through the stores we found a cop-

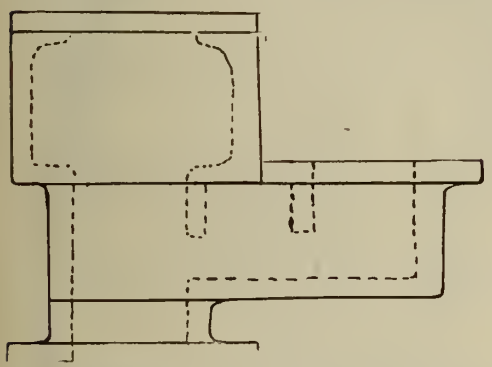


FIG. 2—SHOWS STOP VALVE BOX WELL CUT AWAY TO RECEIVE FLANGE.

per bend 90°, with flanges each end. This was the right size, 4 inches, if I remember rightly. The whole casting was taken from the donkey boiler top and lowered down the fidley, and taken to the engine-room vice bench. The broken wall of the stop valve was drilled all round and cut off with a chisel, leaving a flat face. The seat of the stop valve was drawn out, and holes drilled for studs to fit the copper flange. Of course, this took time, as it had to be done by the engineers in the course of their watch off. However, it was finally completed, and the casting replaced. The bend being bolted on to the casting its vertical flange came in approximately the same position as the stop valve flange had been, and the pipe was connected up with a blank flange in between. The method of working was as follows; On arriving in port the steam for the winches would be used from the main boilers during the remainder of the day of arrival. When cargo working for the day was finished, steam was shut off from the main boilers, the blank flange was removed and the donkey boiler lit up, steam being ready for the morning. When getting ready for leaving the modus operandi was reversed. The main boilers would be, of course, lit up and steaming and when cargo was finished the donkey boiler was blown down, the blank flange put in again, and steam opened up from the main boilers. By this means there were no delays, and the time of putting in and removing the blank was about 10 minutes. As we called and worked cargo at Moji, Hong Kong, Moulmein, Fiume, Aggiamarina, Tripoli, Tunis, Tarbis, Holmis, before we arrived at Antwerp, some months later, where our casting was awaiting us, we got quite used to the blank flange drill, and somewhat missed it after the new casting was placed.

A DIAGRAM DETERMINING THE COST OF COAL FOR GENERATING STEAM

The accompanying diagram furnishes the power plant operator accurate information on the cost of coal for generating steam. Knowing the price and the amount of coal burned and the quantity of water evaporated, the solution is easy. Start with the cost of coal per ton and project vertically, intersecting the oblique line corresponding to the evaporation from and at 212 degrees Fahr. being obtained from the boilers, then move horizontally to the left margin, where the cost of coal to evaporate one thousand pounds of water from and at 212 degrees Fahr. is given. The chart can also be used to determine the evaporation required to generate steam at a certain cost, by reversing the above process. This chart should awaken interest in the relative efficiency of a mechanical stoker as compared with hand firing. The stoker shown in the illustration attacks Mr. Wasted Fuel from the following angles:

1. Smokeless combustion and a high percentage of CO^2.

2. Volatile substances in the coal are distilled before they are introduced to the incandescent fuel bed.

3. A forced draft system of air control supplies the correct amount of air mixture at all times.

4. Carbon often wasted in the ash is burned before dropping the dumping grates.

GETTING A REAL DRAFT

A good draft is one of the most essential things about a boiler plant, and special attention should therefore be paid to it when the plant is laid out. It is easy to cut the draft down if it is too strong, but if it is too feeble the owner of the boiler is faced by a serious situation. The value of a powerful draft is particularly appreciated when some emergency makes it necessary to force the boilers beyond their normal capacity for a time. A strong draft also makes it feasible to burn relatively cheap and low grade fuels.

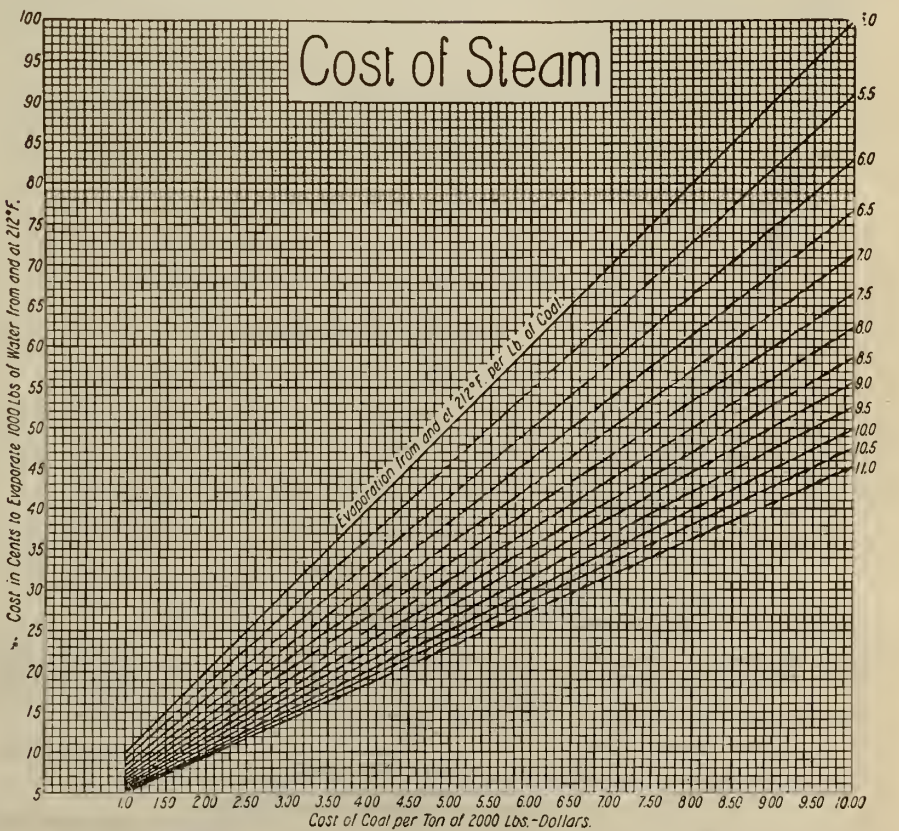


CHART SHOWING THE COST OF GENERATING STEAM.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$32 00	$.....
1¼ in.	36 00	.....
1½ in.	39 00	32 00
1¾ in.	39 00	32 00
2 in.	45 00	32 00
2¼ in.	48 00	34 00
2½ in.	50 00	40 50
3 in.	58 00	45 00
3¼ in.	.....	52 00
3½ in.	70 00	54 00
4 in.	80 00	67 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$7 00	$7 00
Tank plates, 3-16 in.	8 50	8 40

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size	Black Per 100 feet	Galvanized Per 100 feet
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	$ 6 00	$ 8 00
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard	Lapweld	
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 60%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$4 90
Steel bars, base, Toronto	5 00
Steel bars, 2" to 4" base	**6 00**
Iron bars, base, Montreal	4 55
Steel bars, base, Montreal	5 0..
Reinforcing bars, base	**5 25**
Small shapes	**5 75**

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28	$ 8 00	$ 7 00
Sheets, Black, No. 10	8 00	8 50
Canada plates, dull, 52 sheets	9 00	8 65
Canada plates, all bright	9 50	9 50
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	9 00
Premier, 10¾ oz.	....	9 30

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	18½
Palacine	21½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	80
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	13½

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers, list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass, add	20
Machine screws, o. and fil. hd., brass, add	25
Nuts, square blank, add	$1 50
Nuts, square, tapped, add	1 75
Nuts, hex. blank, add	1 75
Nuts, hex. tapped, add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	0 43
Solder, guaranteed	0 45
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	5 20
White lead, pure, cwt.	16 20
Red dry lead, 100-lb kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A. list plus	20
Emery Cloth, list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon	1 80
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	57 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless	0 55
Tubin, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	20
Peerless	21
Grand	19¾
Superior	19¾
X L C R	18½
Atlas	18½
X Empire	17¼
Ideal	17¼
X press	16
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets, list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws, list plus	20
Collar screws, list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts, add	40, 10
Cold pressed nuts to 1½ in., add	$4 50
Cold pressed nuts over 1½ in., add	$7 00

METALS

	Montreal	Toronto
Lake copper	$25 00	$25 00
Electro copper	31 00	29 50
Castings, copper	....	21 00
Tin	65 00	65 00
Spelter	9 00	9 00
Lead	7 25	7 25
Antimony	10 00	10 00
Aluminum	40 00	40 00

Prices per 100 lbs...

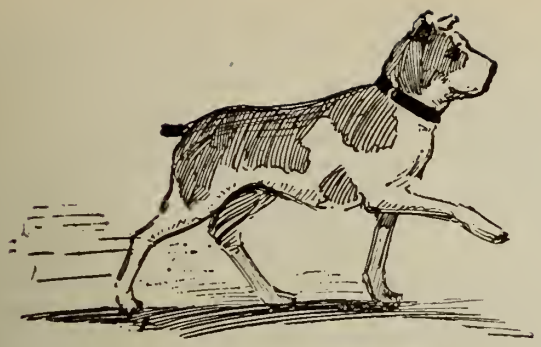
ROPES AND PACKING

Packing, square braided	$0 38
Packing, No. 1 Italian	0 41
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.



The Columbia Mills, Inc., have Lignum-Vitae Step Bearings on their large hydro-turbines. Solids in the water scar these bearings. A Twin Filter is used to guarantee a continuous supply of really clean water.

"Clean Water" was the cry—

These plants had water filled with oil and grease. They needed clean water for one purpose or another. They got it with Twin Filters. Read this abridged list of users—remember that you will get the same satisfaction with

TWIN FILTERS

A few Users:

American Felt Co.
American Glue Co.
B. & O. R. R.
Battle Creek Sanitarium
Bethlehem Steel Co.
Columbian Mills, Inc.
Crocker-Burbank & Co.
General lChemical Co.
Great Western Power Co.
Hartford City Paper Co.
Illinois Traction Co.
Lehigh Coke Co.
New Process Gear Corp.
Pabst Brewing Co.
Pacific Gas & Ellectric Co.
Turner Falls Power & Elec. Co.
Tennessee Coal, Iron & R. R. Co.
Union Bag & Paper Co.

The Twin Idea means continuous service. Twin Filters have two filtering chambers. When one needs cleaning you simply throw the other one into service. No interruption—no delays. Bulletin —— has complete facts.

You'll be proud of Twins in your plant

ELLIOTT COMPANY
435 Grant St. Pittsburgh, Pa.

If any advertisement interests you, tear it out now and place with letters to be answered.

The LONG Patent Steam Trap

Automatically drains jacket kettles, separators and steam mains. Nine hundred to 1,500 feet of one-inch pipe isn't beyond its ability. Also used with splendid success in drying room systems.

Only One Movable Part

Works against 1 and 200 pounds of pressure—no possibility of freezing. Has **two outlets** so it can be installed in any position.

Circular gives full particulars.

Write to-day.

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84 Adam Street
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If your dealer does not sell it, write direct

R.D.Wood&Co.
Philadelphia, Pa., U.S.A.

Water and Gas Work Supplies,
Cast Iron Pipe and Castings,
Mathews Hydrants and Valves,
Hydraulic Presses and Accumulators,
Operating Valves,
Mechanically Operated Gas Producers.

TRADE GOSSIP

New Pulp Mill for Chicoutimi—The Price Bros. Ltd. are about to construct a large pulp mill at Chicoutimi, on the Saguenay River, a few miles west of the village. Power for the new mill will be obtained from the Shipsaw River.

Tottenham, Ont., has recently passed a by-law for the establishment of a commission for the administration of all works undertaken by the corporation for the distribution and supply of electrical energy consequent upon the contract entered into with the Hydro-Electric Power Commission of Ontario. A vote will be taken in January for the election of two of the members of the Commission.

London Saves Money—The general manager of the Hydro-Electric Power Department of London in his report shows that London saved about $15,000 by the enforcement of the power conservation regulations during the past year. The normal peak load of 10,000 horsepower was cut to 8,000 horse-power, but since the signing of the armistice the 10,000 is again being used.

London, Ont.—Although the power load, raising all week, reached the 10,000 horse power mark, no harsh measures were adopted by the Hydro-Electric Power Commission. The city thus reached practically its pre-war consumption, and this would appear as though the falling off of munition-making load had largely relieved the power shortage that has existed for so long.

Ottawa.—No less a sum than $1,100,000,000 has been expended by Imperial Munitions Board during the war, and 75 per cent. of this amount has been spent in Canada. The board still has the plants which it has erected in its own name, and these will be most likely disposed of to private manufacturers and adapted to the needs of peace industries. With the exception of selling these plants the board's business is practically wound up.

Coal Production in B.C.—A decrease in production of coal in British Columbia during November amounted to approximately 49,476 tons, as compared with the October total. The falling off is attributed chiefly to the lower output of the Island collieries, caused principally by the Spanish influenza epidemic. November production is estimated at 168,006 tons, as against 217,482 tons for October. For the eleven months ending November production in British Columbia amounts to 2,372,161 tons, which is 222,186 above the 1917 record.

Government Announcement. — Additions to federal buildings throughout the country, which had been planned before the war, will soon be started, according to an announcement from Ottawa. The Government bought, just before the war, property on the northwest corner of John and Main street in Hamilton, for an addition to the Custom House, and it is surmised this work will be included in the work mentioned in the announcement.

Promoting Empire Trade.—Measures are being taken by the "Bulletin" of the Imperial Institute to familiarize tanners in the British Empire with the good qualities of the Indian hides. Before the war these hides were collected by German agents and were exported principally to German tanneries. Investigation has been made regarding the possibility of finding British markets for the Indian raw materials, and information is given out to the representatives of the leather industry so that this trade can be kept within the Empire when normal conditions are restored.

Chemical Director Talks—The director of the Chemical Division of the War Industries Board of the United States, Mr. C. H. McDowell, has recently revealed the reason why American farmers received only 66,778 tons of nitrates instead of 100,000 tons through the $10,000,000 appropriation made by Congress. The remaining 42,000 tons were commandeered by the War Department when the German drive became a menace last spring. Military necessity has kept the details a secret hitherto, but it can be told now that the sacrifice of the fertilizer made possible a much greater supply of explosives.

Hamilton's Output.—Hamilton munition plants turned out 3,471,425 shells during the war for the allied forces. The largest output of individual shells was that of the Dominion Steel Foundries, which turned out 1,316,430 18-pounder shrapnel shells. The heaviest shells manufactured here were the 60-pounder high-explosive shells, manufactured by the Canadian Westinghouse. Limited, and the Sawyer-Massey Company. Nine local plants turned out 18-pounders, the production of which far exceeded that of any other kinds. Manufacture of munitions in Hamilton began in 1915 and ceased in December, 1918.

London, Eng.—Lloyd Harris is visiting the Continent to look over the situation in Belgium and France and to confer with the Governments of those countries. Large supplies of all kinds are needed for rebuilding in the ruined areas and for equipping national industries, and there is sound ground for expecting that a considerable proportion of these goods will be bought in Canada, the Government in each case being the purchaser and assuming responsibility for all payments. There would appear to be openings for Canadian trade in the Balkans and Roumania. As for trade generally between Canada and Great Britain there

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is every indication that it will develop rapidly on normal business lines once restrictions upon imports are removed.

Halifax.—During the fall of a very high tide about a month ago the electric welding tug "Albert C.," owned by the St. Lawrence Welding Co., was caught on a wharf and tipping over, sank. The method used in raising her was rather ingenious. After the water had been pumped out several times and she had been raised to the surface only to sink again on account of the tackle with which she was held, slipping, she was finally dragged up on the Dartmouth beach at high tide by means of cables passed around her by divers. When the tide went down and left her high and dry she was pumped out. The work was done by Beazley Bros. It was found that the apparatus aboard her will have to be scrapped. However, a new plant from Montreal is now in Halifax ready to be put aboard. The air compressors and auxiliary machinery suffered little or no damage and the hull and engines are in excellent condition. A large gang of workmen are now at work building the new housing which will be ready in about a week. The St. Lawrence Welding Co. have secured a site on one of the central wharfs in Halifax and will move into their new shops in about ten days. A complete staff has been secured and a competent foreman superintendent from Montreal will arrive in the city shortly to take charge. Managing Director A. M. Barry has been in the city for the past month directing the removal from the Dartmouth side to the Halifax shops.

CATALOGUES

The Link Belt Co., Toronto, have issued a catalogue on the equipment for the handling and separation of coal at the mine. Their long connection with this business has enabled them to specialize in the equipment for the handling, separation and loading of coal at the mines. The catalogue shows the various types of coal-handling equipment made by the company and shows many complete installations that they have installed in the past. Eighteen pages are devoted to illustrations showing various coal tipples and loading chutes of various coal companies. The illustrations of complete equipment are followed by detail pictures, which show to good advantage the various types of conveying, sorting and cleaning apparatus. Box car loaders are shown, coal feeders and continuous centrifugal driers are illustrated.

The Link-Belt Company, Toronto, has issued a new booklet entitled "The Economical Handling of Coal and Ashes and Reserve Coal Storage." This book from the wealth of details and the illustrations it contains is a valuable reference work on the subject. The modern power plant contains much equipment which is the result of real engineering genius, but it is only recently that the boiler-room has begun to receive the attention which it deserves. The development of the electric generator, the steam turbine and its various accessories has proved a greater attraction to inventive genius than the more prosaic problems of fuel saving and labor saving in the boiler-room. As a matter of fact, however, boiler-room savings probably offer greater possibilities than further savings in the generator room. Many of the large power plants are built by corporations employing competent engineers, who are familiar with the best modern practice, and who obtain the co-operation of specialists in selecting and arranging the various parts of the equipment. In many of the smaller plants, however, the owner is apt to rely largely on his own judgment or on the judgment of an architect or engineer whose experience is not broad enough to ensure the best results. To both of these classes of power plant owners the subject matter of this book should prove of unusual interest, as it brings together in a compact form the various systems and devices used for the handling of fuel and ashes. The various types of equipment manufactured by the company are shown and power plant layouts are in all cases given, so that various arrangements of the conveying equipment may be readily seen and understood. The Peck carrier, belt, conveyers, scraper conveyers, and other forms of conveying apparatus are described in detail and weighing devices, measuring apparatus and other apparatus which goes to make up a complete coal and ash handling plant are described and illustrated.

STARRETT BOOK IN ITS FOURTH EDITION

The fourth edition of the Starrett Book for Machinists' Apprentices, published by the L. S. Starrett Co., of Athol, Mass., has just been issued. The book, now in its thirty-fifth thousand, is a well illustrated volume of 176 pages, bound in red Athol leather and designed to answer in an authoritative manner questions as to how to do the every-day work of the average machine shop. The different classes of work are taken up separately, the most common errors pointed out and the correct practice indicated. Much attention is given to the proper use and care of tools, the reading of micrometers and verniers, bench work, lathes and lathe tools, grinding, belts, gears, etc. The book is essentially for the apprentice rather than the expert machinist, though the latter will find much of interest and value, and is intended to provide the answers to the many questions usually asked of the foreman or superintendent. Distribution is being made exclusively through the hardware dealers handling the Starrett line of tools, the price being 50 cents per copy. The briefest examination of the volume will convince the ambitious apprentice or machinist of its value in his every-day work.

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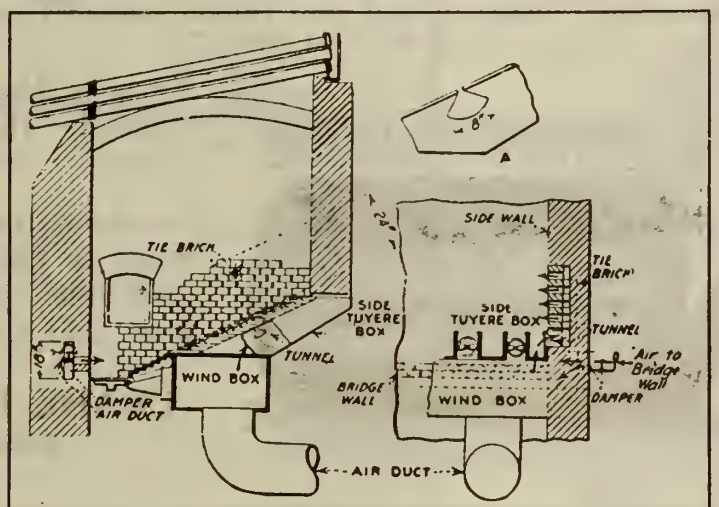

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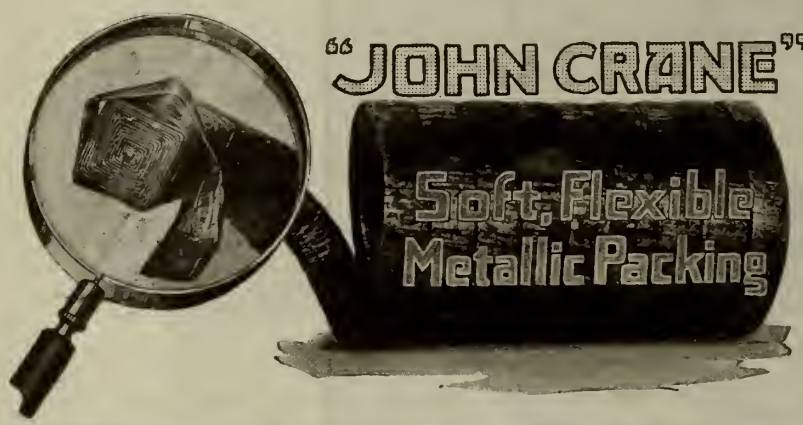

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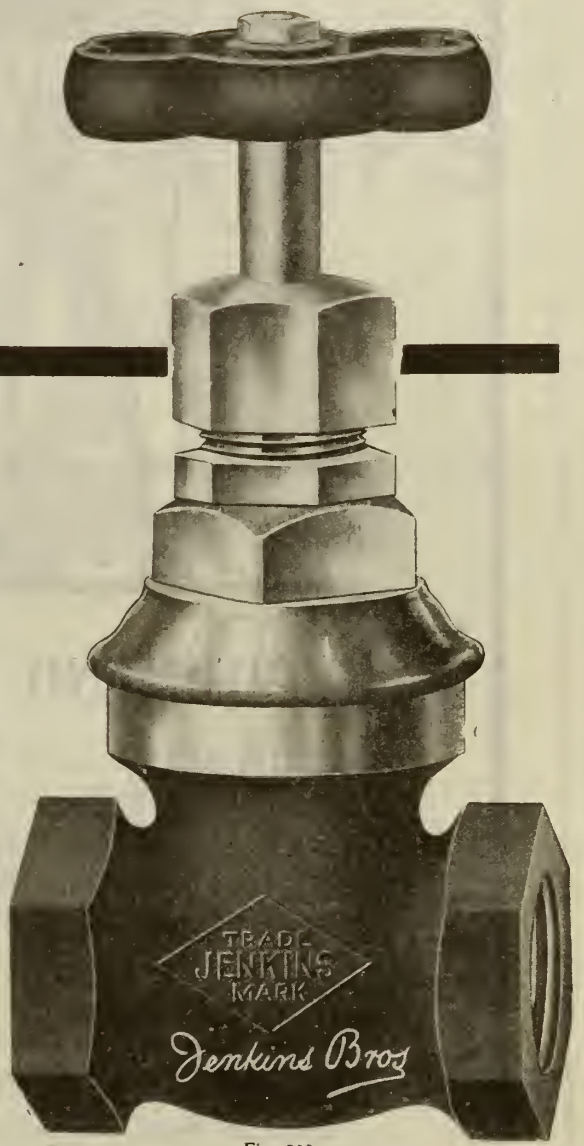

Fig. 300

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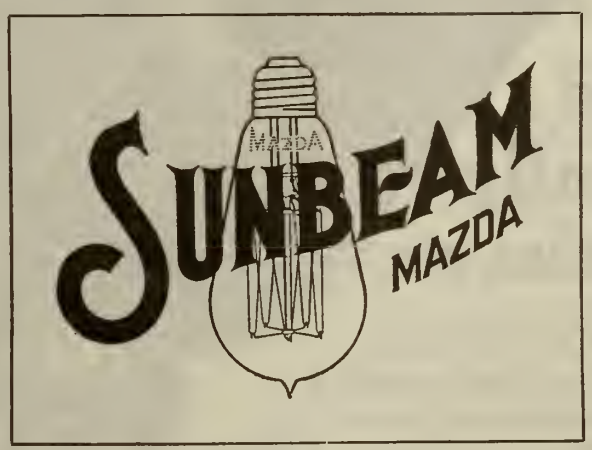

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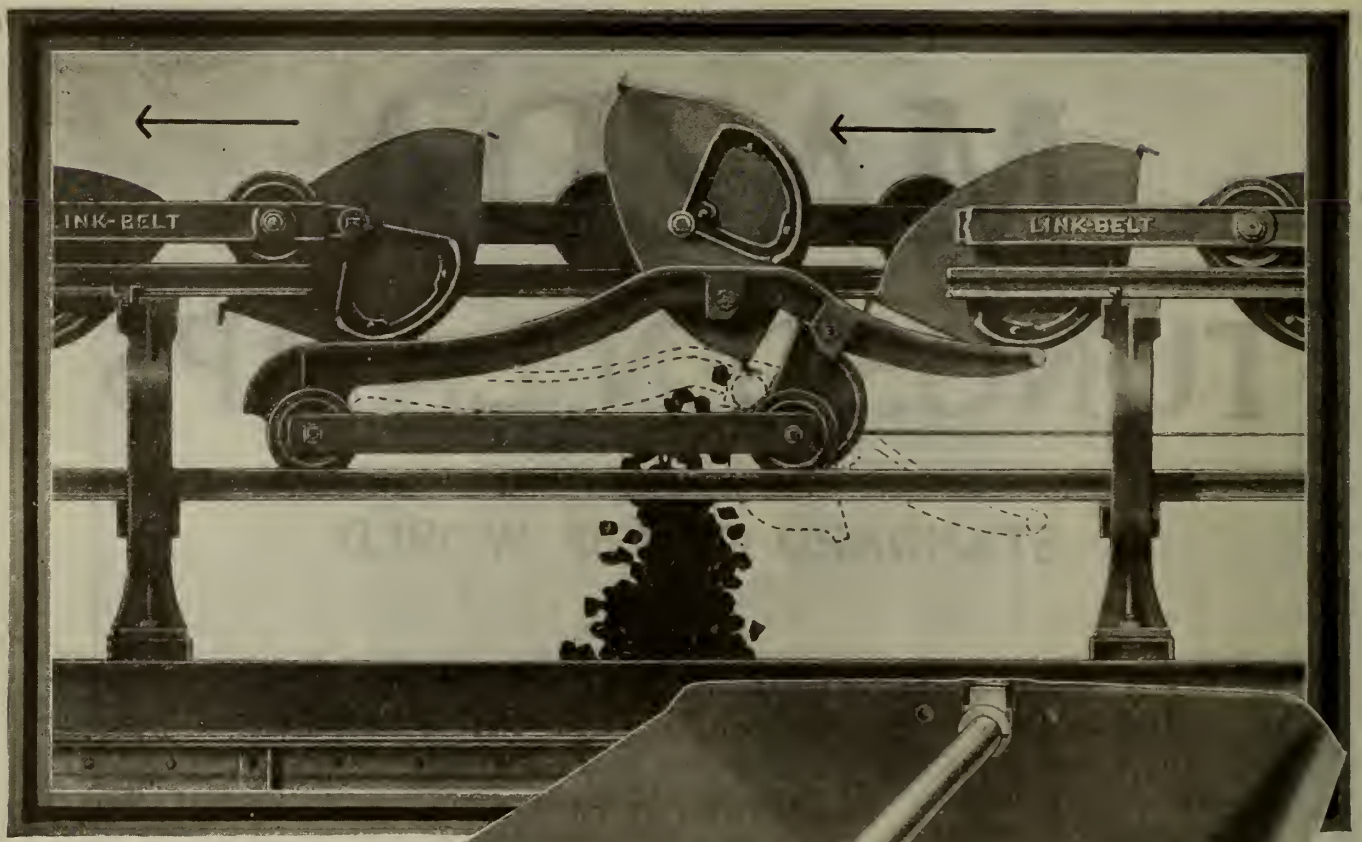

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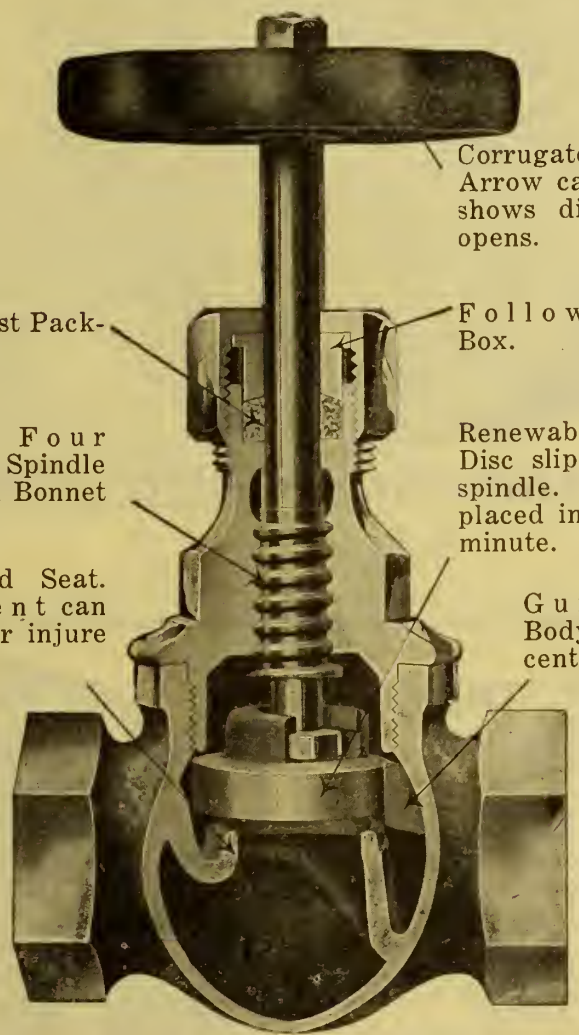
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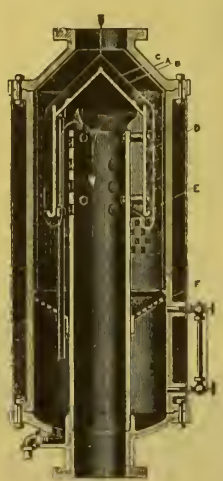
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y.

General Sales Agents:
Canadian Fairbanks-Morse Company, Limited
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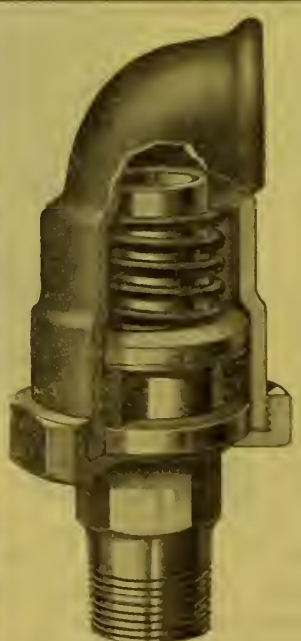

Tuxeda
SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
New York City
General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Put a Belt as Good as this on *Your* Pay-roll

This Graton & Knight 40" 3-ply Heart Brand Belt is five years old. It is running every day on heavy duty for the Milford Light and Power Co., Milford, N.H. The cost of this belt in cash has been $1.81 a week, or .004 per delivered horse-power per week.

Put a belt as good as this on your pay-roll. Its low cost of upkeep is the result of Graton & Knight Standardization. That means the proper belt for any given requirement. It means the right quality of leather and the right kind of tanning for a given purpose. It means true economy—full delivery of power, without waste.

Leather is the ideal belting material. It has a characteristic pulley-gripping quality. It has pliability with light weight. It has the stretch and the come-back that gives and takes. It stands mauling by shifters and the gruelling strain of main drives. It is firm and strong. It is tough, but tractable. These are the characteristics that good belting must possess.

Every year nearly 300,000 hides are tanned in the G. & K. factory. That gives uniformity. The more stock handled, the more latitude there is for picking equal-quality material for a given specification. And G. & K. Tanning is of a fixed standard of quality for specific requirements. We make all kinds of leather belting, for every use—large and small.

Load carried and conditions of operation must figure largely in the length of service of any belt. Some drives limit belting to a few months or even a few weeks. Graton & Knight Standardized Series Belts are made to give the longest possible delivery of efficient power at the lowest possible cost. And they do it. It may be that belts all look alike to you—and it may be that you are spending more than is necessary for some belting requirements. We can and will help you find out.

Many of the best-belted plants ask us to specify the belting for every drive. Try the plan yourself. Then, when buying, call for "Graton & Knight——Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for new book about Standardized Leather Belting

THE GRATON & KNIGHT MFG. COMPANY, Worcester, Mass., U.S.A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Packings, and Specialties

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Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria.

GRATON AND KNIGHT

GRATON AND KNIGHT

GRATON & KNIGHT
Standardized Series
LEATHER BELTING
Tanned by us for belting use

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

U. S. S. "Faith," 5,500 Tons, San Francisco Shipbuilding Co.

DURABLA

DURABLA
TRADE MARK REGISTERED

ASBESTOS SHEET

In the nation's service

Durabla is again proving its high quality.

This is the S. S. "Faith," the first concrete ship built in America.

Every joint is packed with Durabla. There was not a leak on her trial trip.

Durabla Manufacturing Co.
New York

Distributors for Canada
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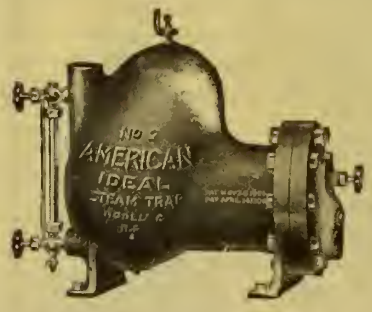
CONTINUE CONSERVATION

SAVE STEAM



Use American Ideal Steam Traps

to keep Steam Lines free from condensation.
Do not fail to carry out your plans to SAVE COAL, STEAM, MONEY.

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VALVES AND ASBESTOS PACKED COCKS
FEED WATER HEATERS, HOT WATER GENERATORS,
POWER PUMPS

PRATT & CADY COMPANY, INCORPORATED, HARTFORD, CONN.

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The Reconstruction of Industry

will demand a very careful consideration of the economy of operation, and real economy lies in the length of service you secure from the materials you use.

TRADE MARK
"PALMETTO"

is really the last word in packing economy, because the high-grade materials of which it is made have been maintained in spite of war conditions.

The great tensile strength and graphite grease lubricant carried in each separate strand insure long service even under very hard conditions.

Why not let us send you working samples to test for quality? No charge.

Braided for Rods

Two Forms
Both the Same Quality

Twist for Valves

Greene, Tweed & Co.

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CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

50% More Heat—Alberger

The small, corrugated copper tubes in this heater expand into floating heads independent of the cast iron shell. This feature is proof against expansion or contraction strains and the resultant trouble.

The Alberger Multi Head Water Heater gives 50% more heat than any plain-tube heater of a similar size. We make this statement and ask you to investigate thoroughly this heater.

ALBERGER HEATER COMPANY
BUFFALO N.Y. U.S.A.

General Sales Agents: Canadian Fairbanks-Morse Company, Limited
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Calgary, Windsor, Vancouver, Winnipeg, Victoria.

Wanted—

Engineers to Contribute to Power House

THIS is a practical paper for practical engineers. It is an educational medium and out to help its readers. It is a technical school and a social meeting place combined. It is first, last and all the time an engineer's paper.

If you should meet two or three or a dozen of your brother engineers you would swap ideas—you'd tell of some idea you had worked out in your plant. Others would describe some pet schemes they had devised. And so you would be mutually benefited.

Why not make Power House your monthly meeting place? Why not describe in this paper some kink or scheme you have worked out and found successful? We will pay you for it and you, in turn, will be multiplying the usefulness of your idea five thousand fold!

Never mind polishing up your letters—just give us the idea; that's the main thing. Never mind how crude your pencil sketch may be. We have draughtsmen who will finish up your drawings so they may be reproduced.

Try this idea a time or two and see how much satisfaction you'll get out of it. Start the ball a-rolling and thus help other engineers, yourself and your paper.

POWER HOUSE, 143-153 University Avenue, Toronto, Ont.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

SKF equipped motor and hoist made by Warner Elevator Mfg. Co. The lower illustration shows the SKF 3 11 Bearings used.

SKF

On Elevator, Hoist and Motor

Freedom from bearing trouble is essential to the safety and efficient operation of Elevator Hoists.
S K F Ball Bearings enable the elevator mechanism to operate without frequent attention and eliminate the danger from overheated bearings.

Canadian SKF Company, Limited

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St. John Quebec Montreal Ottawa Toronto Hamilton
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

THE "NEW" MACLEAN'S

Starting with the January issue, MACLEAN'S MAGAZINE comes out in a new size—11 x 14¼—same size as *The Saturday Evening Post.* This change will enable us to give readers more entertaining articles and stories, and a very much enlarged "Review of Reviews" Section. You will find this January issue of MACLEAN'S more pleasing and instructive than the great majority of magazines you find displayed on news-stands—and

contents are carefully censored—no sex stories—you can take it into your home with the utmost confidence.

A word about the contents—

"Why Laurier Will Wait"

In discussing the policy of the Liberal leader during the coming session of Parliament, J. K. Munro predicts, in January MACLEAN'S, that Laurier will allow Union Government a free hand. In this policy of inactivity "he sees the way open to the accomplishment of all his purposes. If he is half the politician his friends believe he is, he will sit and smile and wait—yet a little longer."

All Canada is interested in what is going to happen in Ottawa. J. K. Munro, veteran press gallery man, is a shrewd observer, and his political articles in MACLEAN'S have stirred up more comment than anything else appearing in the press of the country. He knows politics from the inside. "Why Laurier Will Wait" is a forecast of the near future that bristles with interesting points. A few of the other "head-liners" in this issue:

Bolsheviks at Work in Canada

A sensational article on activities in subterranean circles. There are foreigners in Canada ready to wave the red flag.

Achievements of the Canadian Army

Since the Canadian Division was formed, they have not retired a foot nor lost a gun—a marvellous record. An inside story of how this great army was handled and controlled is told by H. F. Gadsby who spent a month at Headquarters during the last great offensive.

The Grave Dangers of Peace

An article by Agnes C. Laut on the insidious new propaganda being launched by the Germans to split the Allies.

Jock in a Juggernaut

The most interesting war article in a long while, because it is new—it deals with experiences in the tanks.

AND THESE AS WELL:

The Dance Halls of Dawson - By E. Ward Smith

My Hour - - - By Robert W. Service

The Strange Adventure of a Rialto Rainstorm - By Arthur Stringer

The Minx Goes to the Front - - - - By C. N. and A. M. Williamson

The Three Sapphires - - By W. A. Fraser

Mr. Craighouse, of New York, Satirist - - By Arthur Beverley Baxter

The Intercepting Spark, By Mary Josephine Benson

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I accept your offer. I am enclosing $1.00 to pay for MACLEAN'S MAGAZINE for six full months. Please start me off with the big January issue.

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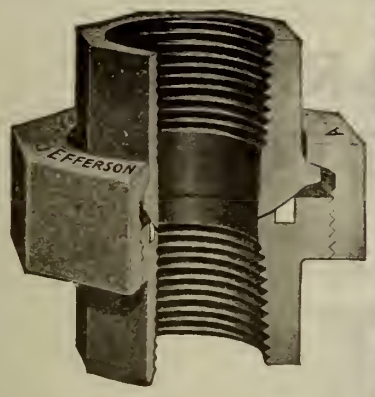
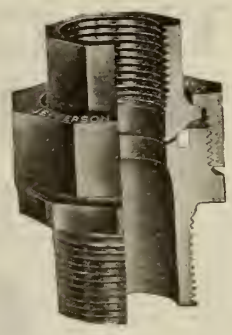


"Look for the Name on the Nut"



"Look for the Name on the Nut"

Buy Thrift Unions—

JEFFERSON UNIONS

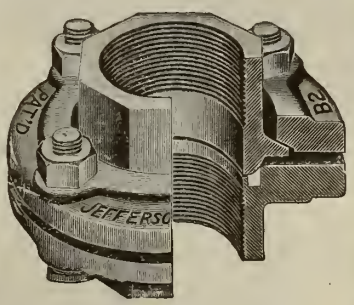
THRIFT—our national watchword—must be practiced on every opportunity and from every angle. It is of utmost importance that waste of labor and materials be eliminated. JEFFERSON UNIONS are Thrift Unions because they conserve labor and materials. "Just-as-good" unions require almost as much material as "JEFFERSONS," shipping and installation costs are equal—but when the defective union breaks down, there is the added expense for repairs.

"SAFETY FIRST"—Insist on getting dependable unions. It's too late to investigate when superheated steam sizzles out of the "just-as-good" connection. The best sounding promise is valueless after the damage is done.

Your jobber has "JEFFERSONS" in stock that will meet practically every condition about the mine. Just look them over and you'll see why it's always safer to "look for the name on the nut." Write to-day for our Catalog. "UNIONS," which shows every JEFFERSON style and type.

"Look for the Name on the Nut"

Jefferson Union Company
Lexington, Mass.



"Look for the Name on the Nut"

The CHAINS that CARRIED THE TANKS TO VICTORY

Tanks are All Propelled by

COVENTRY ROLLER CHAINS

An achievement which places them ahead of all others.

Made in all pitches and sizes for aeroplanes, petrol, steam and electric lorries, agricultural tractors, fire engines, municipal vehicles, shop trucks, motor-cycles, cycles, etc., of English, Continental and American manufacture.

Write for List

"THE COVENTRY" CHAIN CO., LTD., COVENTRY, ENGLAND

Cable: "Chains Coventry" Codes: A.B.C., 4th & 5th Edns., Western Union & Marconi

Williams' "Vulcan"

Drop-Forged

Chain Pipe Vise

MADE entirely of drop-forgings and wrought steel, these Vises are unbreakable, compact, rapid in action and positive in gripping pipe. They are attachable *anywhere*—any handy bench, post, or other support will answer. Remember, Williams' Chain Pipe Tools have been *Standard* for nearly half a century—they are all backed by our absolute and unconditional guarantee of service.

Vises in 3 sizes for ⅛ to 8-inch pipe.

Descriptive Booklet on Request.

J. H. WILLIAMS & CO.

"The Drop-Forging People"

78 Richards St., Brooklyn, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, British Columbia and Alberta

Western Office and Warehouse: 78 So. Clinton St. Chicago, Ill.

Stop Those Packing Leaks

Vulcabeston Red Fibre Sheet Packing is positively unsurpassed in endurance and effectiveness. Whether used in saturated or superheated steam, compressed air, gas, acid, or ammonia systems—low pressure or high—it invariably makes a tight joint that remains perfect throughout all degrees of moisture and temperature. It is made by a special process from long fibre asbestos and is thoroughly heat resistent and impervious to moisture and chemical action. The result is a general utility packing that *works* right in *every* class of service.

VULCABESTON
RED FIBRE SHEET PACKING

is easy to cut and apply, resilient and pliable, yet unlike rubber, cannot squeeze out or stretch. Where other packings have failed to permanently seal a joint and where unusually difficult conditions exist you can confidently depend on it. Use Vulcabeston once and like hundreds of other men, you will never do without it. Send direct to us or have our nearest dealer supply you.

The Johns-Pratt Co.
HARTFORD, CONN.
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REG IN US PAT OFFICE
RED FIBRE
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AMMONIA
SHEET PACKING
MFD EXCLUSIVELY BY The Johns-Pratt Co HARTFORD CONN USA

21-13

VULCABESTON

If any advertisement interests you, tear it out now and place with letters to be answered.

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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London Engine Supplies Co., London, Ont.
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Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
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American-Marsh Centrifugal Pump.

American Steam Pump Company

Battle Creek, Mich.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

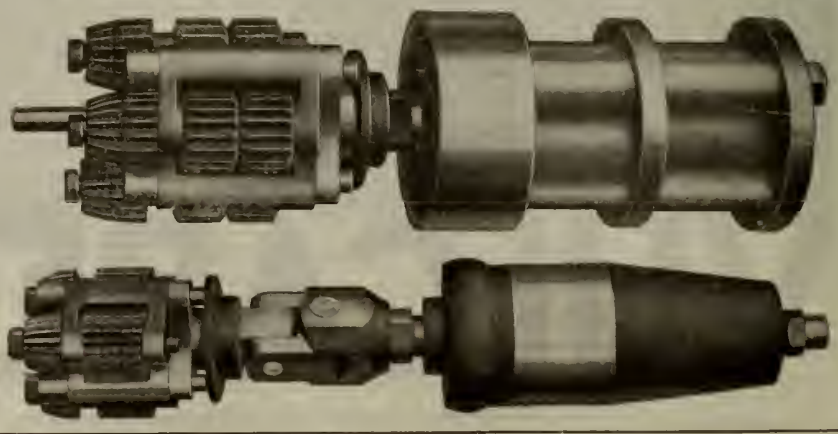
Practically Frictionless

In Cotton Tubes

ROTO TUBE CLEANERS

Type A.D.—Driven by Air or Steam
Type W.D.—Driven by Water Pressure

The use of Roto Cleaners is essential to the most efficient operation of Boilers, Condensers, Economizers, Evaporators, etc.
Roto succeeds where all others fail. It is faster, safer, more thorough and the standard of the largest steam power plants.



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HARTFORD, CONN.
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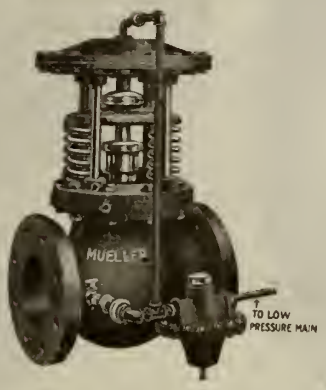
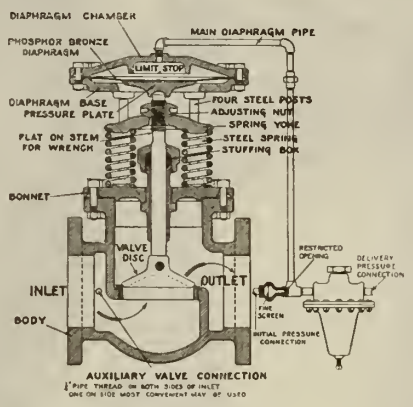
MUELLER Reducing and Regulating Valve

SINGLE SEAT; AUXILIARY OPERATED





E5030 for Water, Gas and Air
E5130 for Steam
(Flanged or Screwed)

Very Popular with Shipbuilders

USES

This valve is for use on exacting installations. It will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations of the initial pressure.

CONSTRUCTION OF STOCK REGULATORS

All valves have iron bodies, bronze stem and stuffing box, phosphor bronze diaphragms, seats of composition suitable for the required service; iron diaphragm chamber and steel springs. The main valve is controlled entirely by the small auxiliary valve. This auxiliary valve closes and opens the main valve by admitting initial pressure to, and releasing it from, the diaphragm chamber of the main valve according to the demand of the delivery side. Regulators of this description are suited for pressures up to 150 pounds, and will be furnished at above prices. When regulators are required for pressures in excess of 150 pounds we will furnish suitable material. Prices upon application.

STRAINER

In all cases it is advisable to use a strainer to prevent obstruction from grit, scale, cuttings, etc. Blow out pipes thoroughly before installing valve.

INFORMATION IN ORDERING

In ordering give highest and lowest initial pressure and required low or delivery pressure, approximate quantity or volume to be used per minute, size of high pressure pipe and low pressure pipe.

In ordering flanged end valves give diameter of flanges and bolt circles and the number and size of bolts.

INSTALLATION

Note.—Any proper working regulator acts as a check valve. Where the building up of the pressure is to be avoided use our diaphragm operated relief valve E5060.

We will not be responsible for improper selection of valves.
Consult us regarding the best type for your service.

H. MUELLER MFG. CO., LIMITED

SARNIA - CANADA

ESTABLISHED 1862

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ANTWERP 1894

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During the period of the war, our every effort was centered on the one most important object,—VICTORY FOR AMERICA AND THE ALLIES—and we practically confined our entire output to war necessities.

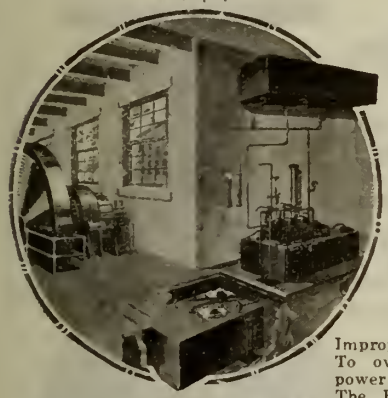
Obviously, during this period, it was impossible for us to fully meet the requirements of the commercial trade and we were forced to ask that orders be confined to absolutely essential needs.

In graciously complying with our request, OUR PATRONS HELPED US TO HELP WIN THE WAR and we take this opportunity of sincerely thanking them for their co-operation.

Victory has left us free to readjust conditions within our plant and we will soon be in a position to fully meet the demands of the trade, when we hope to demonstrate by faithful and prompt service, our appreciation for the consideration shown us by our patrons during the war.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI

Conservation of Power



6 F TYPE OIL FILTERING AND CIRCULATING SYSTEM

With the

BOWSER ESTABLISHED 1885

OIL CIRCULATION and FILTERING SYSTEMS

Improper lubrication causes friction. To overcome friction and carry the power house load, extra power is used. The Bowser System stops this waste of power by providing an unvarying supply of oil for the bearings at all times.

You can see how Bowser will save for you—save power, save shutdowns, save repairs, add to the life of your machinery, increase your production.

Bowser Engineering Department at your Service.

S. F. Bowser & Co., Inc.

Toronto, Ont.

Sales Offices in all Centres *Representatives Everywhere*

USED STEAM ENGINES

FOR SALE

One Left-Hand Improved Horizontal Simple Automatic Laurie Corliss Engine.

Diameter of Cylinder	28″
Length of Stroke of Piston	48″
No. of Revolutions per minute	75
Fly Wheel	18′ x 12½″ Face
Weight	40,000 lbs.
Rated Horse Power	625
I. H. P.	700
Max.	950

One 25″ x 50″ Left-Hand Wheelock Engine.
One 20½″ x 46″ Left-hand Wheelock Engine.

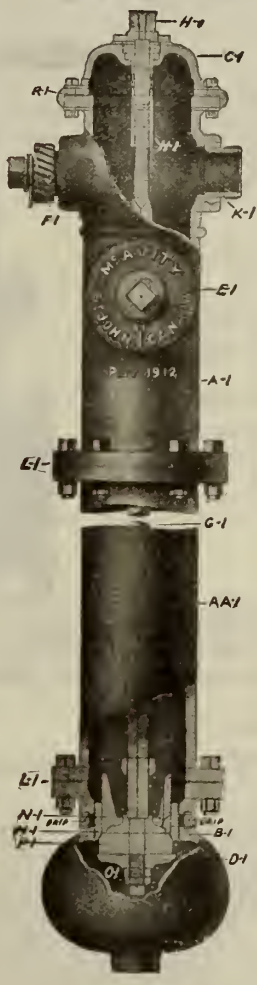
These engines are in excellent condition. Photograph and full particulars will be sent on application to

GUTTA PERCHA & RUBBER

LIMITED

Toronto, Canada

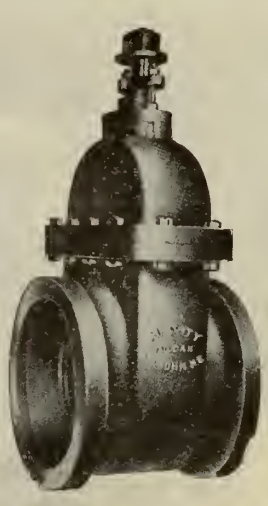
"McAVITY"



New Improved Fire Hydrant

(Patd. 1912)

The latest improved Compression or Matthews type Hydrant which is used without Frost Case, owing to Removable Seat, Valve and Fittings.



"McAVITY" GATE VALVES

with Iron Body, Bronze Fittings, with either BRONZE or HARD WHITE METAL SEATS RENEWABLE.

T. McAVITY & SONS

LIMITED

Hardware and Metal Merchants
Brass and Iron Founders

ST. JOHN, N.B.

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157 St. James St.

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Harvard Turnbull & Co.
207 Excelsior Life Bldg.

WINNIPEG

If any advertisement interests you, tear it out now and place with letters to be answered.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightes trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

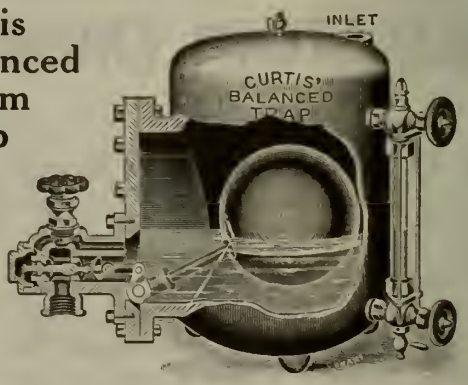
Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Quarter Turn

Absolutely tight—no leaking or dripping. The reason for the success of the "Homestead" valve is its ability to stand up under stresses greater than the specifications call for. The Homestead valve is "at home" under severe strains.
Order a Homestead to-day and learn what satisfactory service means!

Homestead Valve Mfg. Co.
Homestead, Pa., U.S.A.

Curtis Balanced Steam Trap



Five Superior Features of the Curtis

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lb.

Write for catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.
Agencies: 216 Fulton St., New York City
174 N. Market St., Chicago, Ill.

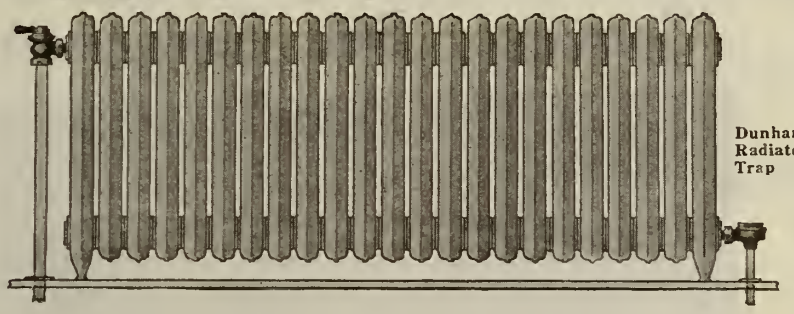
Heating Service that Boosts the Efficiency Curve

Noise in a steam heating system indicates inefficiency; so do leaky valves and partly-hot radiators. No matter how good the boiler and radiators may be, they cannot do good work unless the steam circulates properly through the entire system.

By eliminating heat-waste—whatever the cause—Dunham Heating Service contributes to the efficiency that must be obtained for profitable peace time production.

Thousands of industrial plants, office and government buildings have Dunham Heating Service, which is recommended by leading architects everywhere.

Dunham Packless Radiator Valve



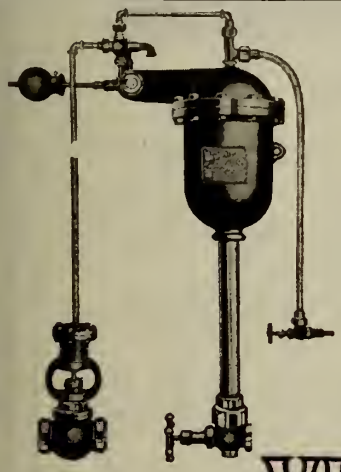
The Dunham Radiator Trap automatically permits the discharge of air and water—keeps in the steam. The Dunham Radiator Valve is really packless—cannot leak.

Write for complete details of Dunham Heating Service which covers the planning and installation inspection of heating systems that give satisfaction.

The DUNHAM HEATING SERVICE

C. A. DUNHAM COMPANY, LTD., Toronto, Ontario

Halifax Montreal Ottawa Winnipeg Vancouver Calgary



VIGILANT

Can you keep your boiler water within a ¼" of middle gauge? That is what the Vigilant does regardless of the load or firing. The Vigilant Automatic Feed Water Regulator has many points of interest economically.

Our catalogue will interest you —write for it.

The Chaplin-Fulton Manufacturing Company

28 Penn Avenue - Pittsburg, Pa.

DAVIS

BACK PRESSURE VALVES

are designed to maintain a constant back pressure of steam for heating, drying, cooking or other purposes where light pressure is needed. On the exhaust line of a non-condensing engine, the Davis Back Pressure Valve fills the need. For use with condensing engines or turbines the Combination Back Pressure and Exhaust Relief Valve maintains the back pressure when running non-condensing and acts as an exhaust relief when operating condensing. Noiseless and absolutely reliable — cannot stick or bind.

These consistent steam savers are all illustrated and fully explained in the new Davis Engineering Booklet. For your free copy address the G. M. Davis Regulator Co., 434 Milwaukee Av., Chicago. Branches in principal cities.

DAVIS VALVE SPECIALTIES

STEAM SAVERS SINCE 1875

Conveyor Belt Service Almost Tripled

From 6 Months' Service to 16 Months' Plus

The famous Dome Mines in South Porcupine, Ontario, were not dissatisfied with their conveyor belt service. Their belts had been averaging six months' service, even on a difficult shuttle conveyor—a rigorous test.

However, in August, 1916, they were induced to try their first Goodyear Extra Duty Conveyor Belt on this shuttle conveyor, driven by a motor at either end. It distributes ore from a long conveyer to the stamp mill bins, handling 750 to 800 tons a day.

The belt we recommended was 80′ of 8″ x 5 ply Extra Duty with ⅛″ face.

When the plant closed sixteen months later that belt was still in use and good for months of additional service.

Almost three times longer service than other conveyor belts gave.

Three simple, but very important reasons explain the remarkable service given by Goodyear Extra Duty Conveyor Belts in Dome Mines as in every other plant where these belts are used.

1. Durability and resiliency of white face made as tough as a tire tread.
2. The complete adhesion of cotton and rubber making the belt a permanent unit.
3. A rubber cushion edge that protects conveyor against wear on the edges—wear that on ordinary belts frequently causes disintegration.

If your conveyor costs appear high—if you appreciate uninterrupted conveyor service in your plant, then write, wire or telephone for a Goodyear belting man to discuss your conveyor problems with you.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches : Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina Calgary, Edmonton, Vancouver.

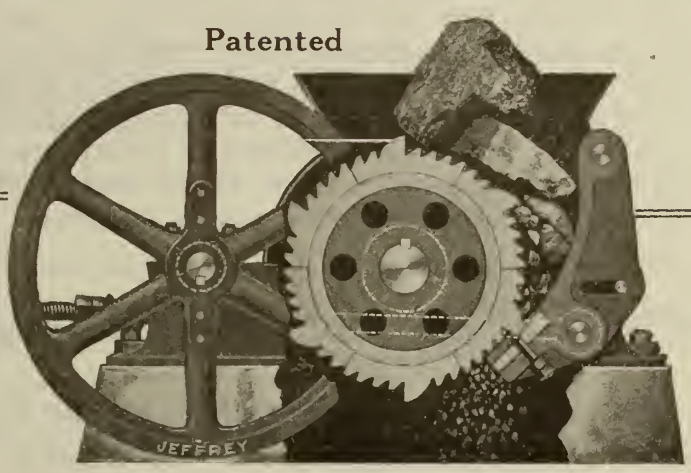
GOODYEAR

MADE IN CANADA

CONVEYOR BELTING

The Jeffrey Single Roll Crusher Is An Indispensable Instrument In the Production of Stoker Coal

Patented



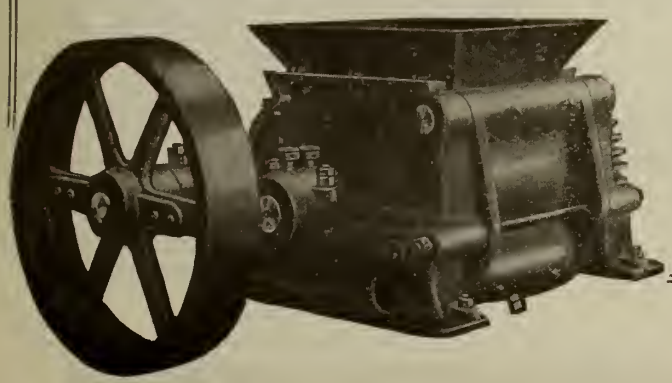
With another winter's coal shortage approaching thousands of plants are virtually at the mercy of the mines for a supply of stoker coal.

The higher efficiency obtained by sized coal over that obtained by using slack is recognized everywhere—and the demand is so great that coal operators are unable to meet it, even under normal conditions.

Make Yourself Independent of Mine and Traffic Conditions by Crushing Your Own Stoker Coal—Right in Your Own Plant.

THE JEFFREY SINGLE ROLL COAL CRUSHER WILL REDUCE Run-of-Mine or Lump Coal in One operation to the proper size for maximum heat efficiency in stokers.

Write for Bulletin No. 141-4 giving complete information.



The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

The Financial Post on Business Government

"LET us demand that the standard of efficiency in the Government be raised to the highest possible point by the calling in of more of the business executives of the country to take the place of the arm-chair politicians who win to position by the ability to win votes rather than to serve the interests of voters. Let these men assist in the negotiations for reconstruction business from Europe, the financing of such orders on a business basis, the establishment of proper trade relations with foreign markets, the readjustment of taxation and the tariff to a more intelligent basis in relation to individual industries, the efficient demobilization of the soldier and other problems of policy, but let every individual meet for himself those other problems which concern those whose welfare depends upon him and solve them to the best of his ability. Reconstruction begins at home. Let us have confidence in ourselves."

Beside the vigorous leading article from which the above is quoted,

The Post Review and Outlook Number This Week Contains:

The following special articles prepared by members of the staff of THE FINANCIAL POST *and of associate publications in the MacLean group of Specialized Business Newspapers.*

Peace Brightens Prospects for Loan Companies.
Hydro Reviewed for Maine People.
Canadian Car Earned Enough to Wipe Out Arrears.
Want Increase Considered on Per Cent. Basis.
Imperial Oil's Plan Based on Dollars and Cents.
Smaller Net Profits by Consolidated Smelters.
Decline in Net Earnings of C. P. R.
Bank Clearings Again Ahead of Last Year.
Meeting Client on His Individual Business Ground.
Bankers Looking to the Far East.
Should Banks Buy Victory Bonds?
Using the Trade Acceptance in Retail Business.
Edmonton Bond Dealer Sentenced.
Bond Market Has Been Quiet But Very Strong.
Liquidation of Life Company May Be Probed.
N. F. U. Organizes Loss Information Service Bureau.

(SPECIAL SECTION)

The Government is Organizing a Comprehensive Machine for the Repatriation of Canada's Army.
Let Us Have Confidence in Ourselves—Editorial.
Banks Are Blazing the Trail for Development of Export Trade in Markets of the World.
Opportunity for United States to Play Part of "Big Sister" to Canada in a Financial Way.
Not So Much a Problem of Who Will Emigrate, But Who Will Prove Desirable to Canada.
The Business of Bringing the Boys Back Home.
Canada's Borrowings During 1918 Reach a Total that Establishes a New Record.
Bond Market Has Experienced Peculiar Year
Beating Swords of War Into Plow Shares of Peace.
British Can Build Cheaper Vessels Than Canadians.
War and the "Flu" Cause Abnormal Death Claims.
Canada's Banks and Question of Larger Capital.
Now the Stock Exchanges are Taking the Rough Jolts Out of Financial Reconstruction.
Canada Made a Remarkable Record in the Production of Shells and Other Munitions.
The Menace of the Bolsheviki! Insidious Influences Threaten Relations.
Price of Wheat and Production of Livestock.
Comparative Price Records of Canadian Securities for Past Eight Years.
Activity in Renting Workingmen's Houses and in Dealings in Farm Lands Distinguishes Realty Market.
Steel Is King When Nation Goes to War.
Canada's Exports and Their Part in Beating the Hun.
January Dividend Payments.
Canada's Part in Beating the Submarine Peril

Above mentioned are a few of the more important contents of this issue of THE FINANCIAL POST. Send a subscription to THE POST and note its business value to you. Use this form in sending subscription, which is $3.00 per year.

— —

The MacLean Publishing Co.,
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Send me THE FINANCIAL POST every week, beginning with the Review and Outlook Number, 1919, till further ordered. I will pay subscription price, $3.00 per year, on receipt of bill, or you may draw on me for this.

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P.H.

Fuel Economy—

is a subject of increasing importance and one requiring careful study by every power plant operator and owner.

We are prepared to furnish a complete line of equipment for increasing the efficiency of power plants, including—

Green's Economisers
Radial Flow Forced and Induced Draft Fans
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Superheaters
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Our Engineers will be glad to inspect your plant at any time and submit suggestions for your consideration, or furnish information regarding the equipment listed above.

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TORONTO

MONTREAL **WINNIPEG** **VANCOUVER**

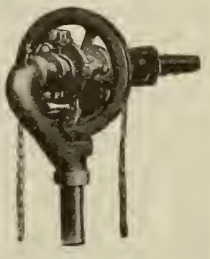
SAVE 4 to 8 PER CENT FUEL

COST MORE AND WORTH MORE

STANDARD OF THE WORLD

The Prophets May Be Right or May Be Wrong

A Message to the Canadian Power Users

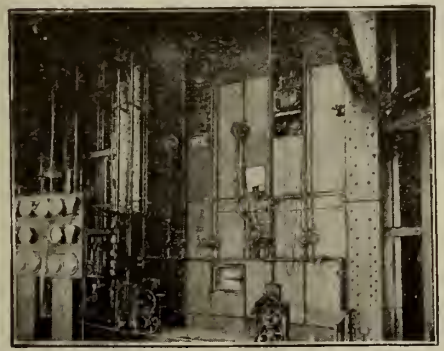


They Say That 1919 will be the biggest year in the history of Canadian Industry; that our factories will be taxed to the limit of their productive capacity in the effort to supply goods needed for deferred domestic demands, such as building construction, re-habilitation of railroads, ship-building, automobiles, replenishment of depleted stocks etc., in addition to an extremely heavy export demand from all over the world.

If They Are Right Your factory will undoubtedly be called upon to carry its share of the general burden. This burden will be a profitable one. You can make it more profitable by developing greater productive capacity from the equipment used. As the best illustration we know of, take your boilers. They are not operating to capacity if the heating surfaces are coated with soot and ash.

Diamond Soot Blowers installed in your boilers will, as compared to the best possible efforts of your fireman with the hand lance, effect the following economies.

1. FUEL: A saving of 4 to 8%
2. BOILER EFFICIENCY: An increase of 4 per cent.
3. LABOR: A saving of many hours per day.
4. LONGEVITY: An increase in the length of service of boiler tubes, through the prevention of corrosion.
5. STEAM: A saving of 25 to 75 per cent of steam used for cleaning.



Diamond Soot Blowers at Plant of Buffalo General Electric Co.

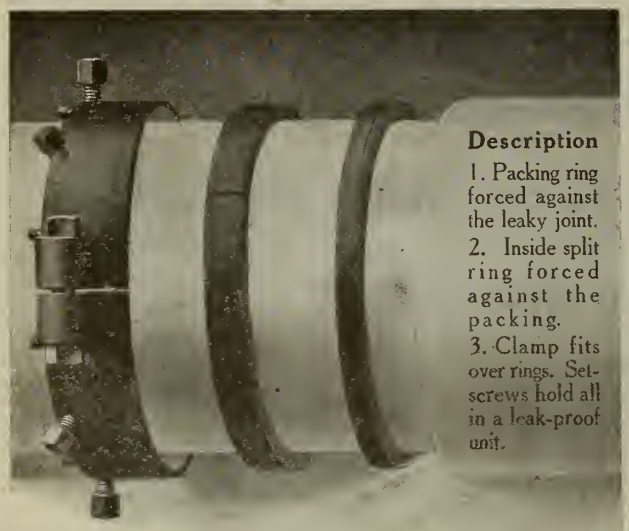
If the prophets are right DIAMOND SOOT BLOWERS will enable you to produce a greater volume of goods.

If They Are Wrong If business does not reach unprecendented new levels—if your plant is not called upon to produce to its fullest capacity—your only hope of material profits lies in reducing your production costs. DIAMOND SOOT BLOWERS will cut the cost of power and will earn you 100% to 250% annually upon your investment.

Hundreds of plants in the Canadian field are now equipped with DIAMOND SOOT BLOWERS. For full information write for Bulletin 119.

Diamond Specialty Company
Windsor **Ontario**

MADE OF CALORIZED STEEL


Description
1. Packing ring forced against the leaky joint.
2. Inside split ring forced against the packing.
3. Clamp fits over rings. Set-screws hold all in a leak-proof unit.

You Can Stop That Leak

—And stop it permanently—with a Simplex Pipe-Joint Clamp.

It does not make much difference how big the opening may be—provided, of course, it is not beyond repair. Nor does it matter a great deal what is in the pipe—water, steam, gas, air, oil, ammonia, brine, etc.—the leak will be stopped absolutely.

And as long as the Yarway is left in place that joint will remain tight.

The principle of the Yarway Pipe-Joint Clamp (formerly Simplex) is very simple. There are but three parts, as shown above—one packing and two iron rings.

Any workman can make the attachment without difficulty in a few minutes.

As an example of the way in which this serviceable clamp makes good, read what one user says:

> "The fact that from the date of its installation, we have not realized that there is a steam joint at the point where placed, is sufficient evidence that it fills the bill."

Try a Yarway for 30 days subject to return if not satisfactory in every way. Write to-day stating size of line.

YARNALL-WARING COMPANY
7604-20 Queen Street
Chestnut Hill - Philadelphia

Canadian Representatives Carrying Stock:
A. McLellan, 301 Read Bldg., Montreal, Canada; Cunningham Hardware Co., New Westminster, B.C.; Jas. Robertson Company, Montreal, Canada

YARWAY
PIPE-JOINT CLAMP
Formerly the SIMPLEX

Forming a jointless, gas-tight lining for the combustion chamber.

No Mystery About BETSON'S

REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

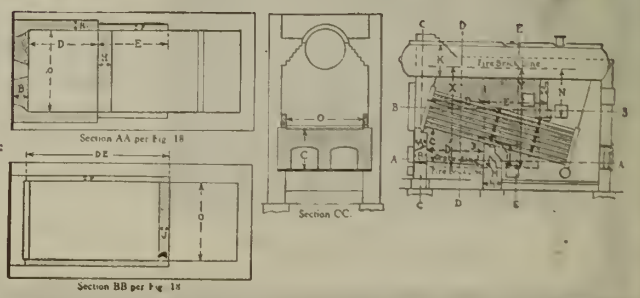
It is merely an exceptionally high-grade compound of the best fire clays, given a special mechanical preparation which eliminates expansion and contraction and thus renders it suitable for one-piece boiler-furnace linings. It comes in bulk in barrels in a plastic condition, ready for use, and is placed in chunks and pounded into place with a mallet and afterwards smoothed with a trowel. No special skill is required. Almost anybody can put it in place, the work is so perfectly easy and simple. There is no waiting for expert brick layers, or for shipments of special fire brick or blocks.

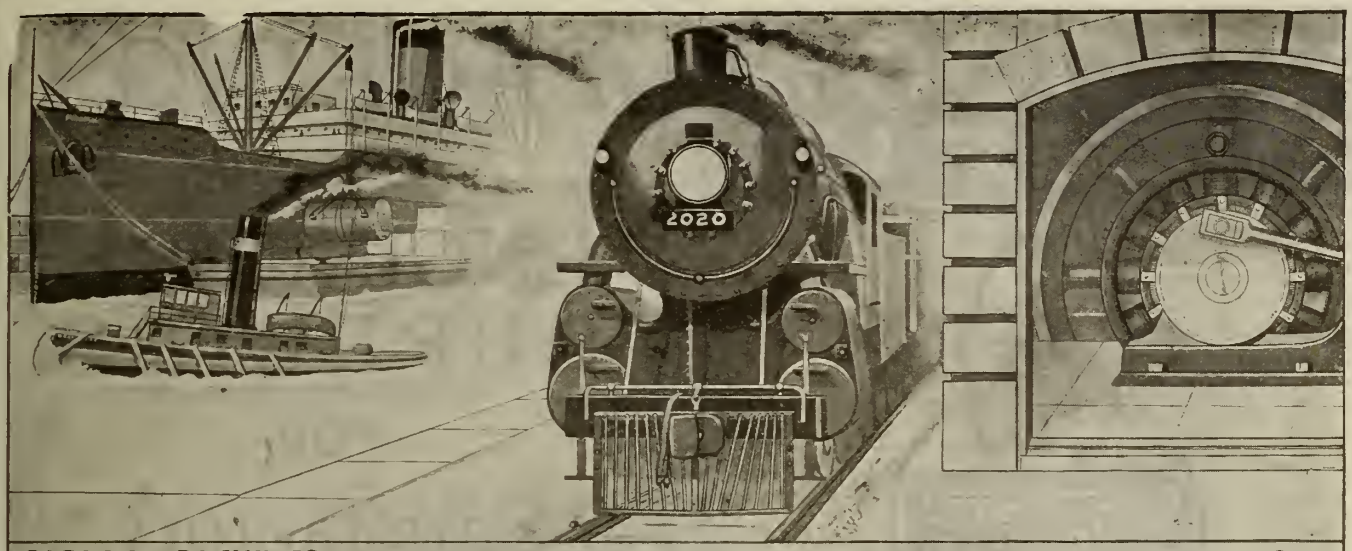
A sketch of your setting, like the one herewith, showing the dimensions and present thickness of fire brick, will enable us to estimate upon the quantity required. If you are not ready to replace an entire lining, order a barrel or two for repairs, which will demonstrate its superior durability and tightness. Then when you are ready to reline you will surely use Betson's.

Ask for Booklet "R."

Canadian Distributor:

International Chemical Company
44-46 Lombard Street
Toronto, Canada





GARLOCK PACKINGS ARE USED EXTENSIVELY BY THE GREATEST RAILWAY AND STEAMSHIP LINES AND IN THE LARGEST STATIONARY POWER PLANTS THROUGHOUT THE WORLD

IN THE THREE GREAT BRANCHES OF STEAM ENGINEERING

Where speed and economy are paramount, where a hot rod or blown-out gasket might mean a schedule broken or contract lost,

GARLOCK PACKINGS

are used generally. Under the most trying conditions of service Garlock Packings have proved their superiority. Let us suggest a cure for that rod or joint that "won't stay packed." We invite you to submit your packing problems.

The Garlock Packing Company - Hamilton, Ontario

Branches :

Montreal, Quebec.....409 Shaughnessy Bldg.
Toronto, Ontario.....404 Continental Life Bldg.
Winnipeg, Manitoba.....Galt Bldg.
Calgary, Alta.....211 Eighth Avenue, W.

If any advertisement interests you, tear it out now and place with letters to be answered.

40,000% PROFIT

Enormous Profits In Stopping Belt Slip

Ever hear of anybody making 40,000 per cent. profit on Wall Street? We haven't.

Well, this is the way you can do it: One man kept his belt in a slipless condition with Cling-Surface for over eight years at an average cost of 27 cents per year. Based on the formula published in our ad in Power House last month the annual saving was $108.

108÷0.27=400=40,000 per cent. profit.

Every user of Cling-Surface is making similar profits. It is impossible to do otherwise.

In order to save $108 anywhere else the average business man would perhaps spend $90 or $100. Why should belt users, then, hesitate to spend 27 cents to save $108?

But the "beauty of it" is—that isn't all. The profits are even greater. When a belt stops slipping it lasts longer. Belt wear is due entirely to friction—internal or external. So, although these additional profits depend entirely upon conditions, doesn't it seem possible that the final profits may be 50,000 per cent. or even more?

Cling-Surface keeps belts in NATURAL condition. It makes and keeps them pliable and "grippy" without making them the least bit sticky. It PENETRATES the belt, surrounds, lubricates, and thus protects every tiny fibre. Cling-Surface is the logical, proper treatment that every belt man should apply to stop slip, save belts, increase output, and save much money.

Write TO-DAY for a 50-lb. can. Use one month. If results aren't satisfactory return the remainder at our entire expense.

Cling-Surface Co.
1057 Niagara Street
Buffalo, New York
U. S. A.

PACKINGS
AND
ENGINEERS' SUPPLIES
FOR
Satisfactory Service

Thomson-Gordon Limited
Hamilton, Ont.

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has just rounded out a half century of usefulness. Its incomparable record of lubrication service during the past 50 years stamps it as a most efficient and economical lubricant. For

50 YEARS

Albany Grease has been used by engineers on the bearings of engines, motors, pumps, compressors, line shafting and all their other equipment. If you are not using Albany Grease send for samples and try it.

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LUBRICATING
COMPANY
708-10 Washington Street
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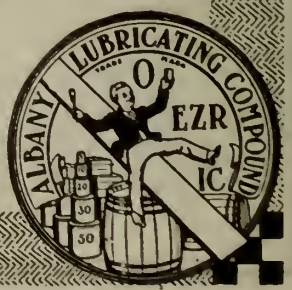
Established 1868



If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

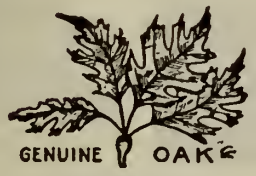
That Belt you're going to Buy—

HAS IT THE QUALITY THAT MAKES FOR LONG SERVICE?

IS IT BUILT TO HUG THE PULLEY TIGHTLY AND PREVENT POWER WASTE?

IS IT BUILT TO REDUCE STRETCH AND ATTENTION TO A MINIMUM?

To convince you that *D. K. McLaren's Belting* service answers this problem to the last letter we'll gladly put you in touch with many of the largest Canadian power plants.



REGISTERED TRADE-MARK

This trade-mark guarantee is on every piece of D. K. McLaren's Leather Belting. Look for it.

D. K. McLAREN'S

Genuine British Oak-Tanned

LEATHER BELTING

is made exclusively from close-trimmed butts of the finest selected hides, tanned by the old-fashioned but the proven most effective British Oak Tanning Process.

Try one belt—and you'll want to buy more.

D·K·McLAREN LIMITED

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Dominion Belting Company, Limited

Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

TRADE MARK

TRADE MARK

BEST HE EVER USED

WORCESTER, MASS.
9 Concord Street.

June 26, 1918.

Gentlemen:—

Your metal was first introduced to me by a retired engineer some 17 years ago.

That day when I broke in on this job we lined both main bearings on this engine (Harris Corliss Compound) while we shut down on account of a two-day holiday. I remained on this job 3 years and 4 months, and I did not have any bother with those bearings after that. How long they lasted I do not know, but that was the best metal I ever did use and will always use and recommend it to all engineers who are not acquainted with its wonderful wearing qualities.

Very truly yours,
MATTHEW F. EARLY.

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Over 600 Pages

A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.

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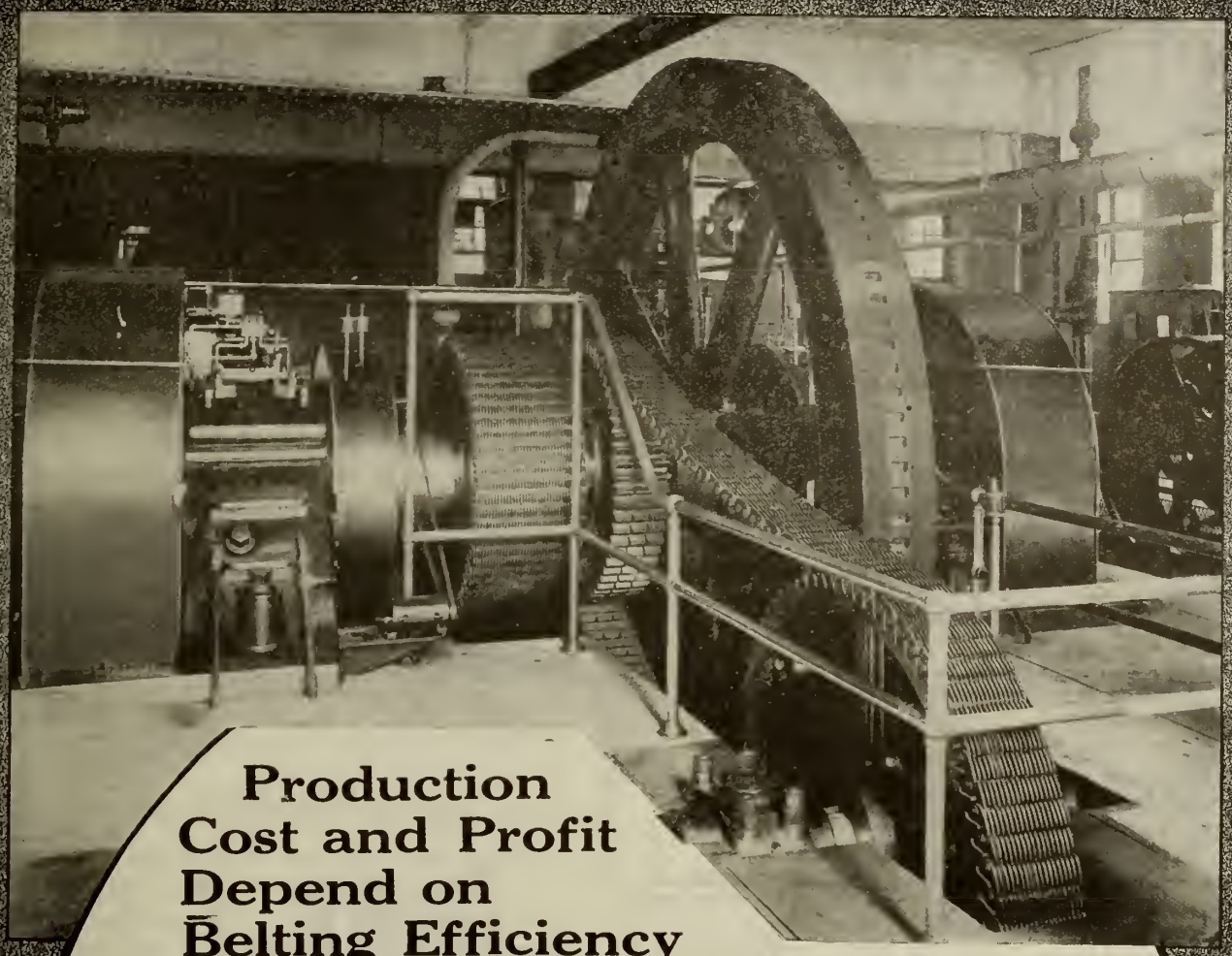

Production Cost and Profit Depend on Belting Efficiency

The "MORSE" Rocker Joint Silent Chain is the only 99% efficient transmission known.

The more severe the duty the more need of "MORSE" Drives. The Drive that will do the most work, the steadiest work, the best work. Producing more with less COST. The Perfect Drive. Flexible as a belt. Positive as gears. Oil Baths not required.

Continuity in operation, Cost of production, and Quality are the basis on which to select your drives.

Let us have your general layout and design drives to save space, light and power while increasing your production.

Our booklet is illustrated with cuts of engines and drives and covers the subject of the number of teeth and links, lubricating and covering, chain and sprocket materials, chain widths, chain contacts, chain adjustments, etc. It will be sent FREE.

MORSE CHAIN COMPANY
ITHACA, NEW YORK
Our 1919 Vest Pocket Memo and Data Book Free to Officials and those in authority 10¢ to all others

Morse Chain Co. Largest manufacturers of silent chains in the world **Ithaca, N.Y.**

Morse Engineering Service. Address Nearest Office. Assistance Without Obligation

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Kansas City, Mo.	Long Bldg., Morse Engineering Co.
Minneapolis, Minn.	Third St. S., Strong-Scott Mfg. Co.
St. Louis, Mo.	Chemical Bldg., Morse Engineering Co.

Licensees for Europe and the Eastern Hemisphere: The Westinghouse Brake Co., Ltd., London, N.

MORSE CHAIN CO., ITHACA, N. Y., U. S. A.
Gentlemen: As per your advertisement in Power House, please send copy of Pub. No. 14, "Large Power Drives."
Company.....
Individual.....
Position.....
Address.....

If any advertisement interests you, tear it out now and place with letters to be answered.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.

W. A. RIDDELL, M. A; PH. D., Superintendent, Trades & Labour Branch.

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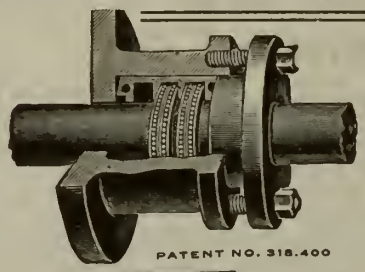

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PAT. NO.	500,899	PAT. NO.	829,118
" "	534,104	" "	830,530
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" "	654,541	" "	876,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775,193	" "	905,103
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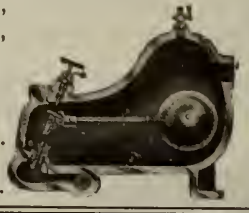

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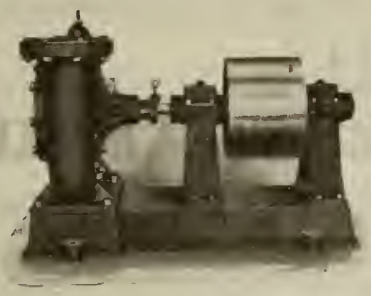

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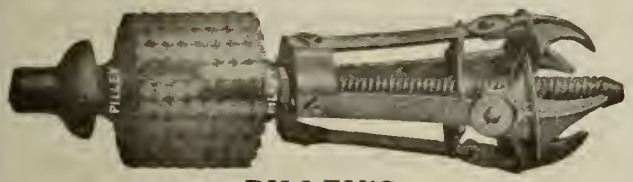

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Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

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Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID.
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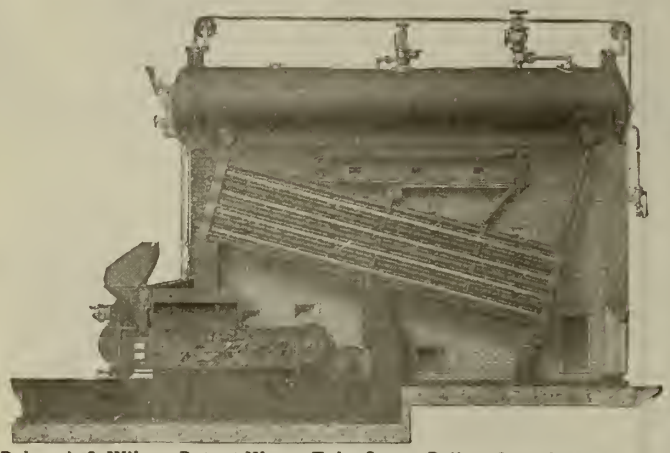

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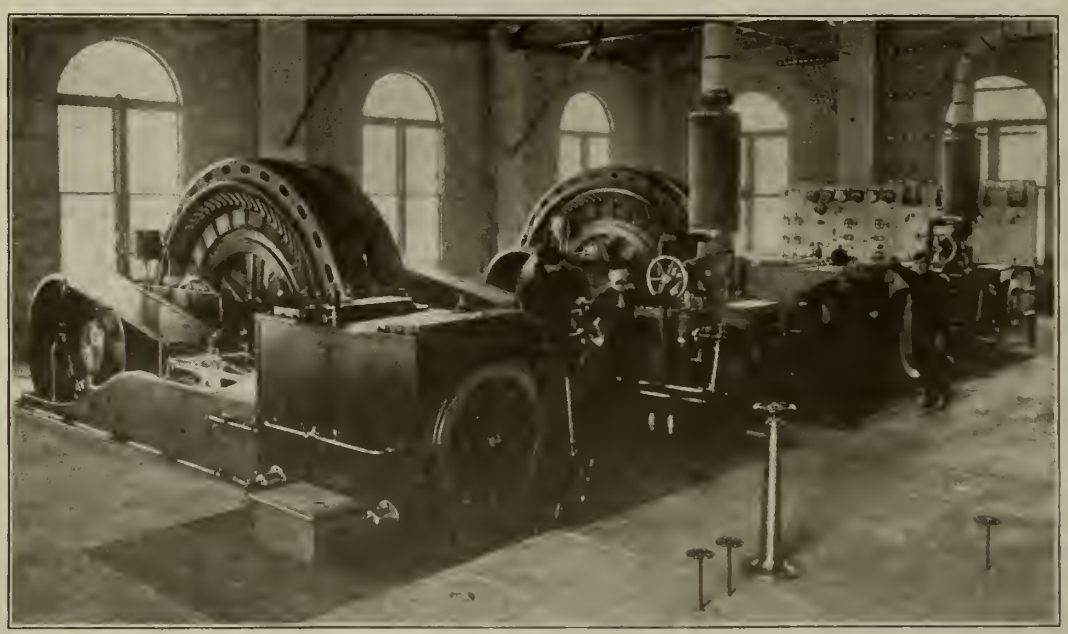

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Mason Regulator Co., Boston, Mass.
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MacGovern & Co., Inc., New York.

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Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
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The best advertising is the kind that leaves an indelible, ineffaceable impression of the goods advertised on the minds of the greatest possible number of probable buyers, present and future.

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ACHIEVEMENT
ECONOMY
renewable FUSES
have played a noteworthy part in North America's wonderful industrial progress of 1918 by effectively safeguarding millions of important electrical circuits against the fire and accident hazards of overloads and short circuits.
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Write for Catalog 24
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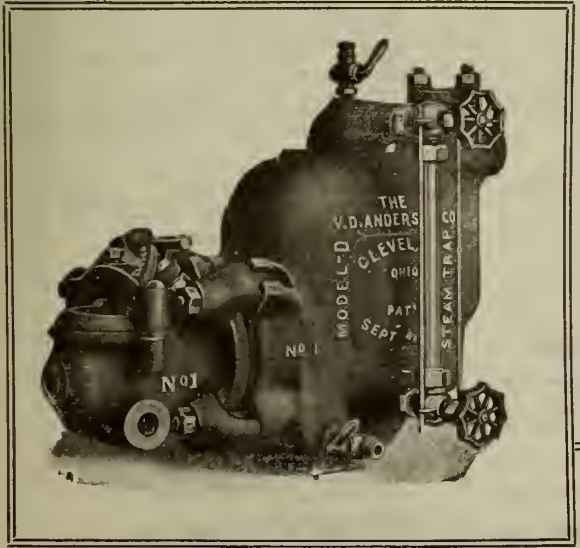
Monufocturers in Conodo of S. & C. High Potential Fuses—to 150,000 volts.

The Trap that Stays Tight

It means something to you in time, labor and expense to have a trap in your steam-room that will stay tight from the day you put it in. This dependability under high and low pressure is found in the

Anderson Model "D" Steam Trap



Features of this trap include simplicity of design, quick action and large capacity. It is operated by a counterbalanced LAKE SUPERIOR COPPER FLOAT. Has large air valve that will not wire draw and is always under deep water seal.

A self-contained strainer, an outside gauge glass, a self-contained by-pass and complete accessibility to all parts are other outstanding features of the Anderson Model "D" Steam Trap.

If you are troubled with condensation or any boiler room trouble, get in touch with us and secure our co-operation.

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Green's Economiser, Ltd., Toronto, Ont.
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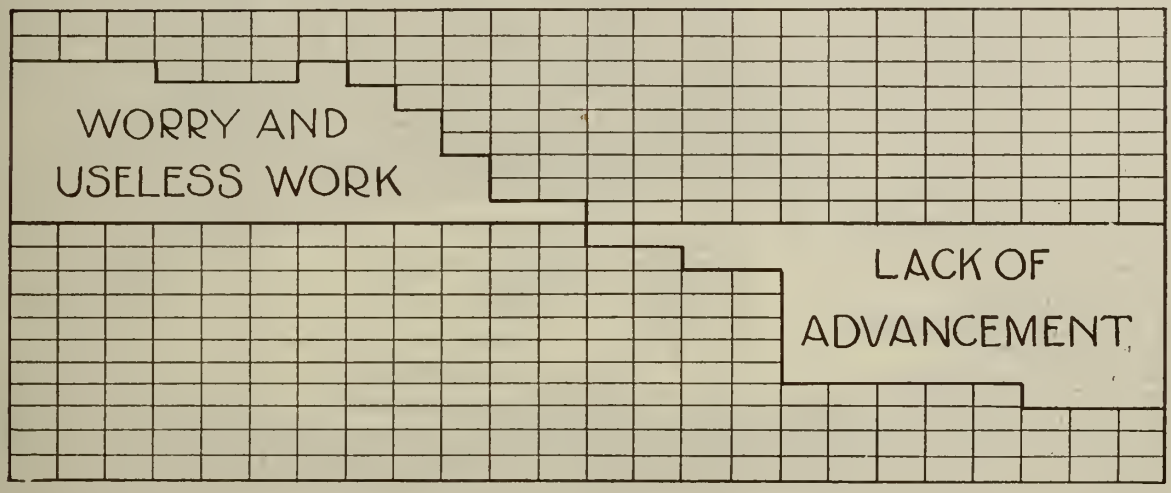

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J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

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Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
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Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

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Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Albany Lubricating Co., New York City.
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

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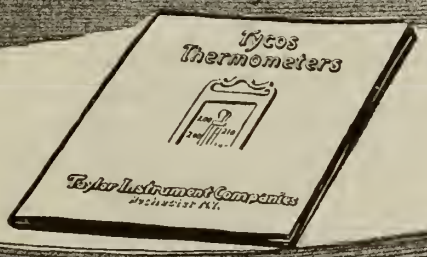

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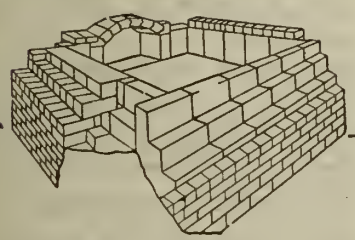

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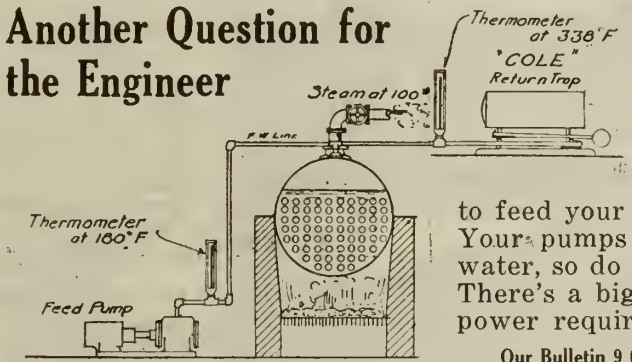

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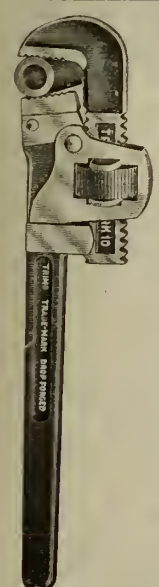

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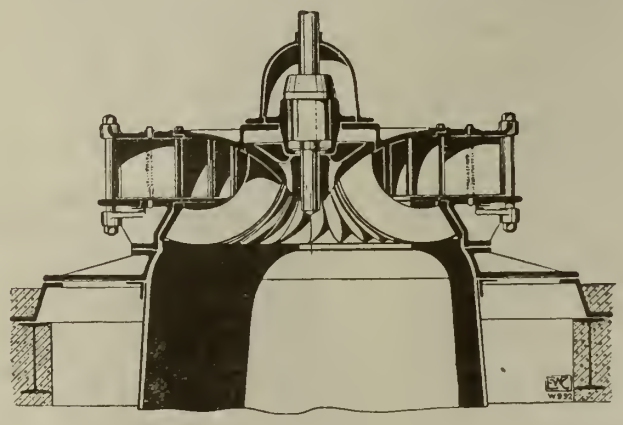

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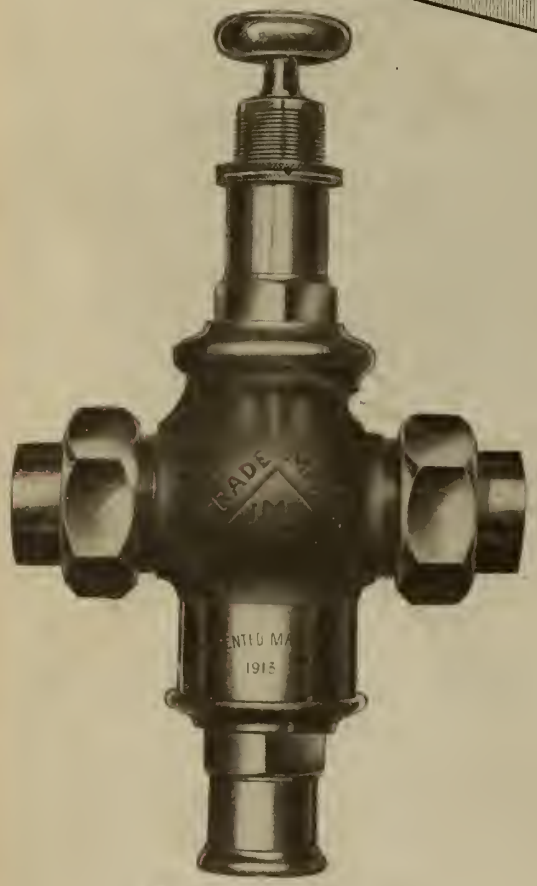

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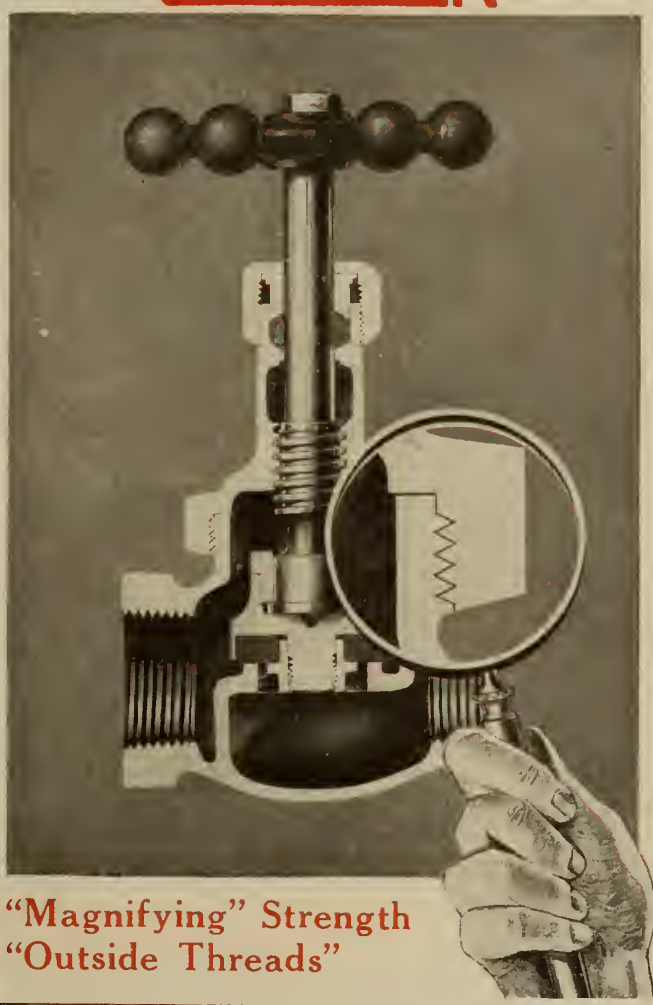

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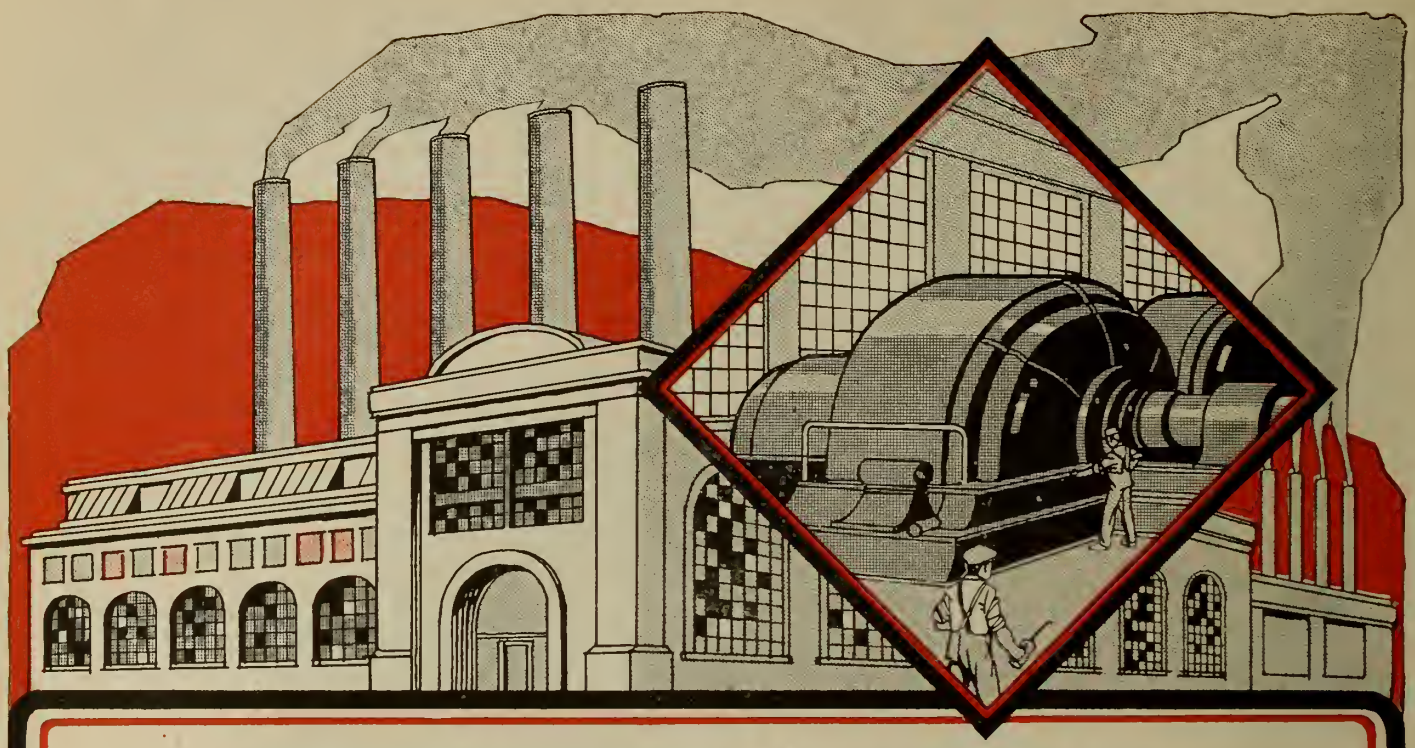

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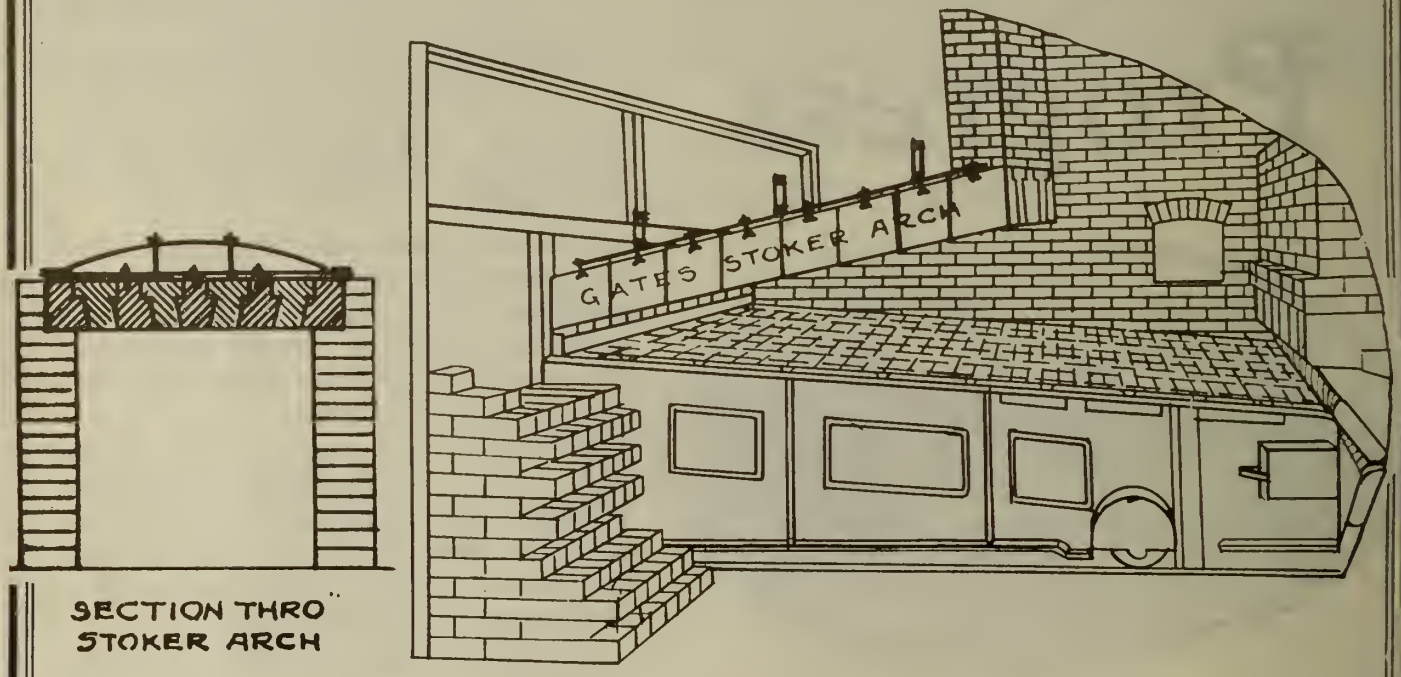

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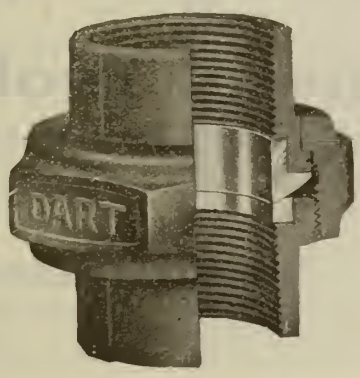

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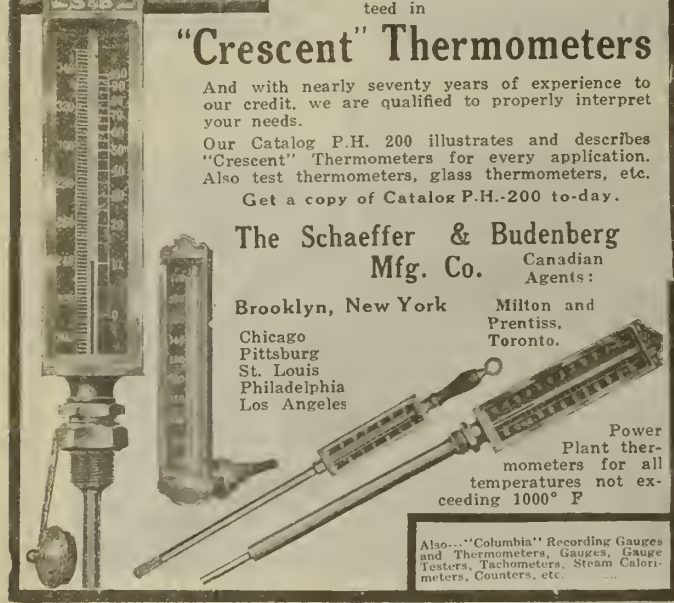

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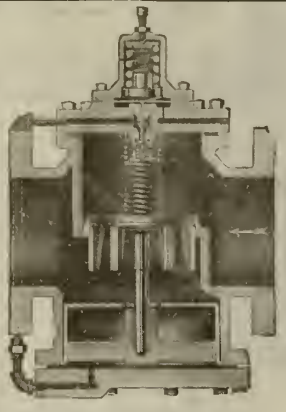

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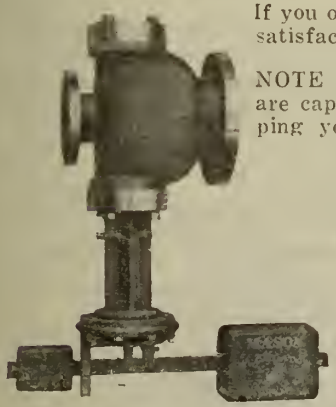

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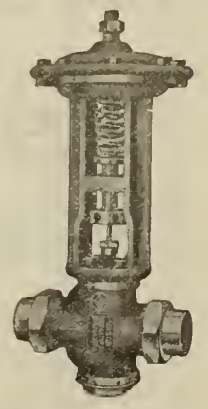

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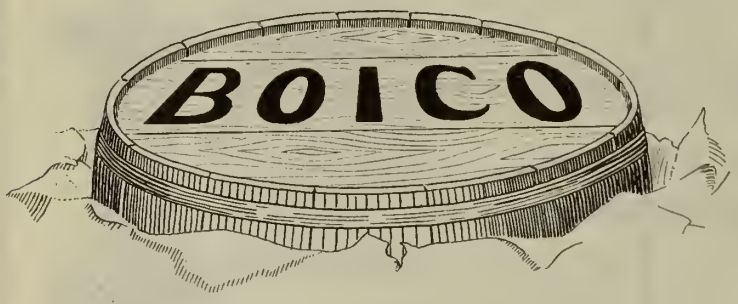

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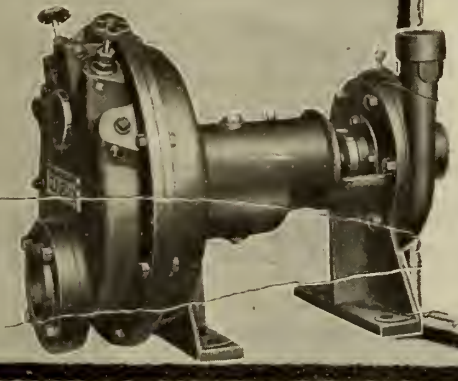

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Because at all times really fine materials are used; and because each and every machine receives a degree of individual attention that is impossible in mass production.

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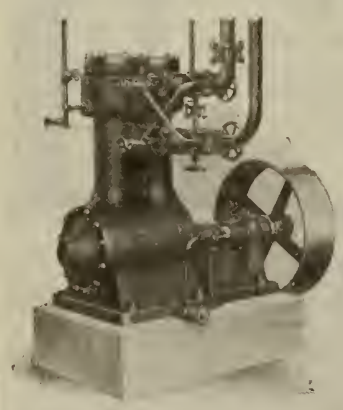

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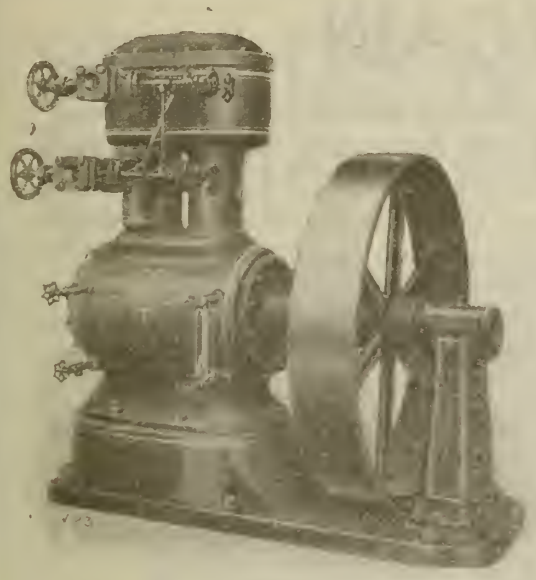

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ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical Horizontal—Absorption.

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Down on Long Island, New York, the Loose-Wiles Biscuit Co., makers of "Sunshine" biscuits and other good things, have a big modern plant. Because it is modern in every respect, it goes almost without saying that the brine and ammonia lines, coolers, tanks, etc., are insulated with

Nonpareil Cork Covering

For Cold Pipes and Tanks

And so it is all over the country. Almost every up-to-date plant, large or small, has its cold pipes and tanks protected against loss of refrigeration with Nonpareil Cork Covering. They find, just as you will find, that money spent for Nonpareil Cork is money well invested. Dividends are paid every day the refrigerating machine runs.

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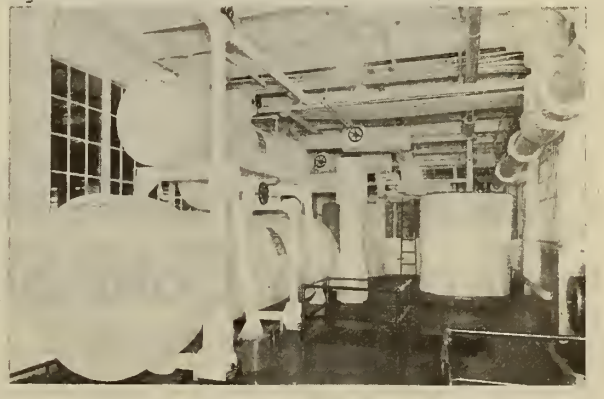

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The Quality and Service Guarantees back of all York Products should lead you to give us a chance at your business. Our interest in every plant after it is erected is a further protection to you and an assurance of our good intentions.

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YORK MANUFACTURING CO.

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Canadian Ice Machine Company

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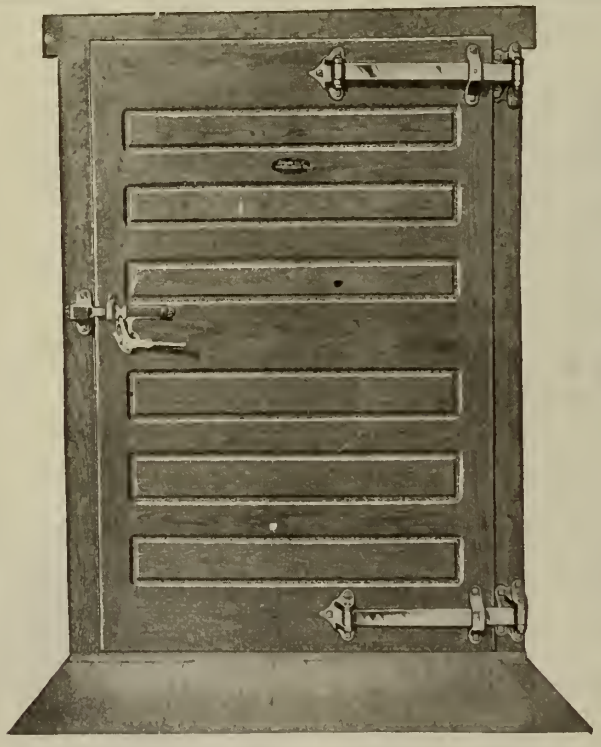

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"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

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Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. **HAGERSTOWN, M.D., U.S.A.**

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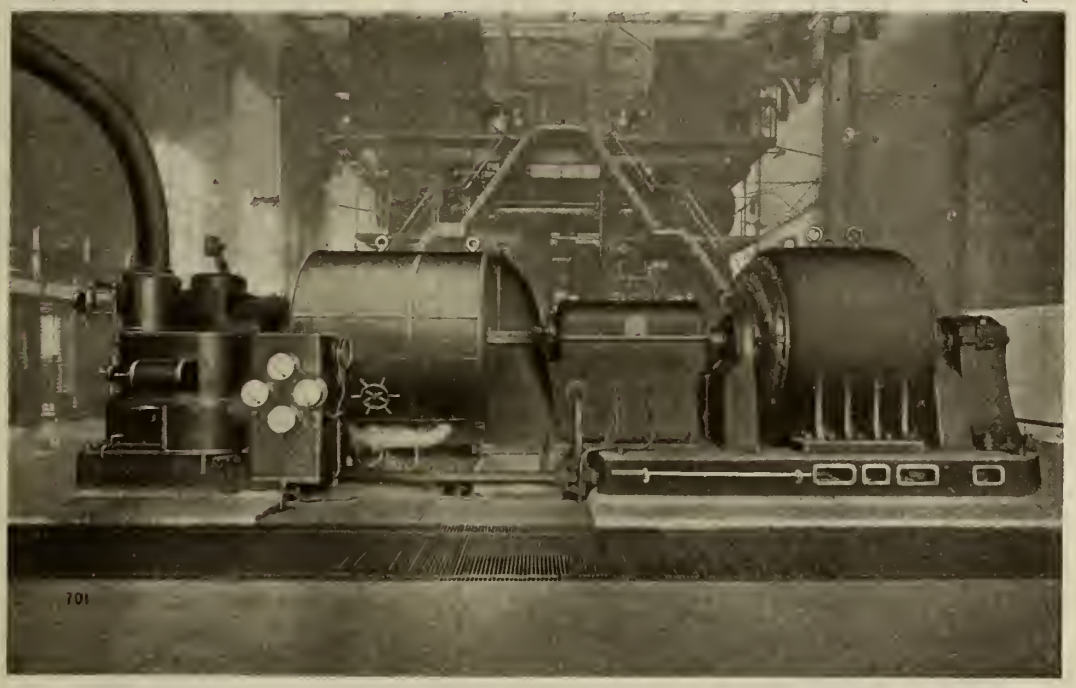

Belliss & Morcom 2000 K.W. Steam Turbine at Montreal Tramways Power Plant

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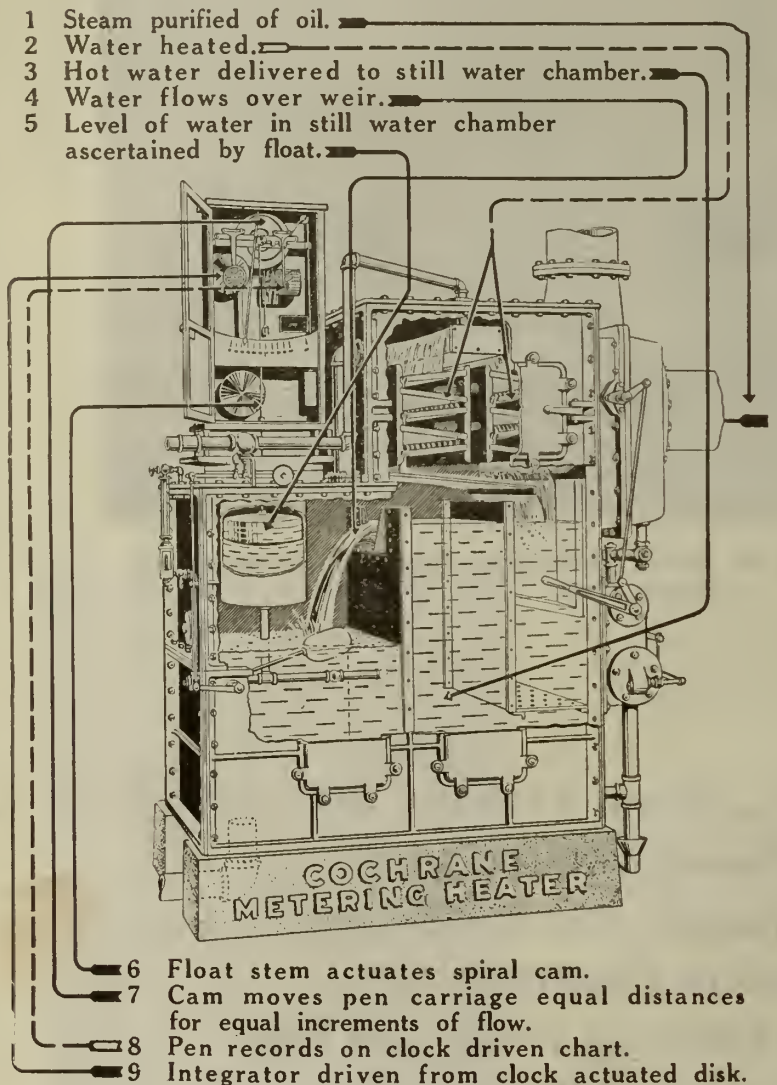
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Send for Catalogue No. 820.

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Power Plant Equipment, Mining, Crushing, Hydraulic and Milling Machinery, Contractors' Plant and Architectural Bronze and Iron Work.

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But Johns-Manville salesmen have never been of the kid-glove variety. They are first of all sales-engineers, and it is a source of just and lasting pride to us that the emergencies of war-time found them ready.

How to save heat and fuel, how to guard against fire—these are the lessons they have carried into countless plants the country over. It is not too much to say that by their man-to-man methods of preaching Asbestos and Conservation, our salesmen have rendered here at home a distinct service to the nation, have made a notable contribution to the efficiency of our war-machine, have helped the country in no small way to weather a national fuel crisis.

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Asbestos and Magnesia Heat Insulations, Packings, Refractory Cements, Steam Traps, and other Power Plant Materials; Asbestos Roofings and Shingles; Electrical Products; Asbestos Brake Lining, Fire Extinguishers, Speedometers.

Through—

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that keeps the heat where it belongs
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that make boiler walls leak-proof
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that cut down fire risks
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that save power waste
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that make brakes safe
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—and so:

JOHNS-MANVILLE
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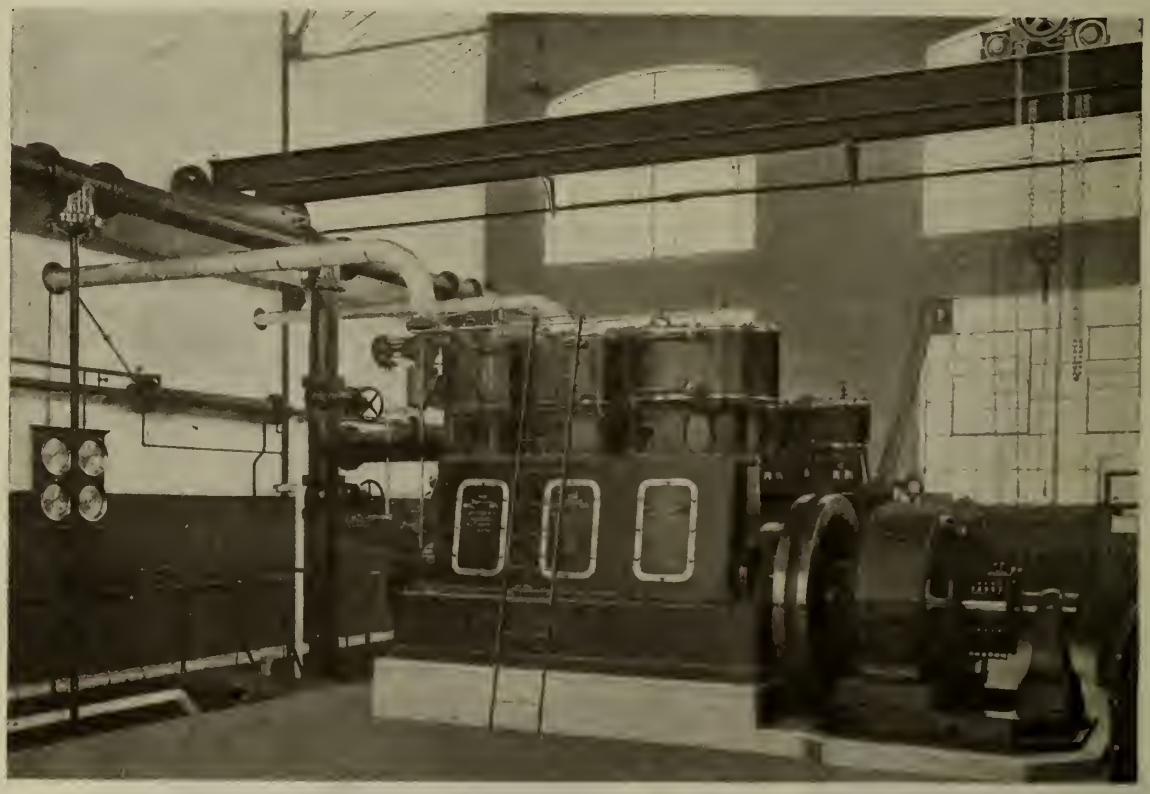

A corner in the Engine Room of our New Power Plant recently erected at our Main South Works. Equipped with G. & McC. Co. Three-Cylinder Compound and Two-Cylinder Compound Vertical Forced Lubrication Steam Engines.

G. & McC. CO. ENGINES and BOILERS

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Canada Controls Nickel Output of the World

Plant of the International Nickel Co. of Canada, Ltd., at Port Colborne, Has Features of Interest to the Power Plant Engineer —This Refinery Assures Canadian Control of Nickel

By W. F. SUTHERLAND

View of refinery, showing main smelter building, machine shop, part of power house and nickel refinery.

FROM the earliest times, when man first emerged from the stone age, down to the present, iron and copper have been essential to his well-being and progress. Other metals, amongst them tin, lead, and zinc, have also been of much value to him throughout the ages, but it is only within the last century that nickel has assumed the importance its properties entitle it to. By itself, its brightness, non-corrosive properties and hardness render it one of the most useful of metals, and alloyed with iron, it was almost indispensable during the war.

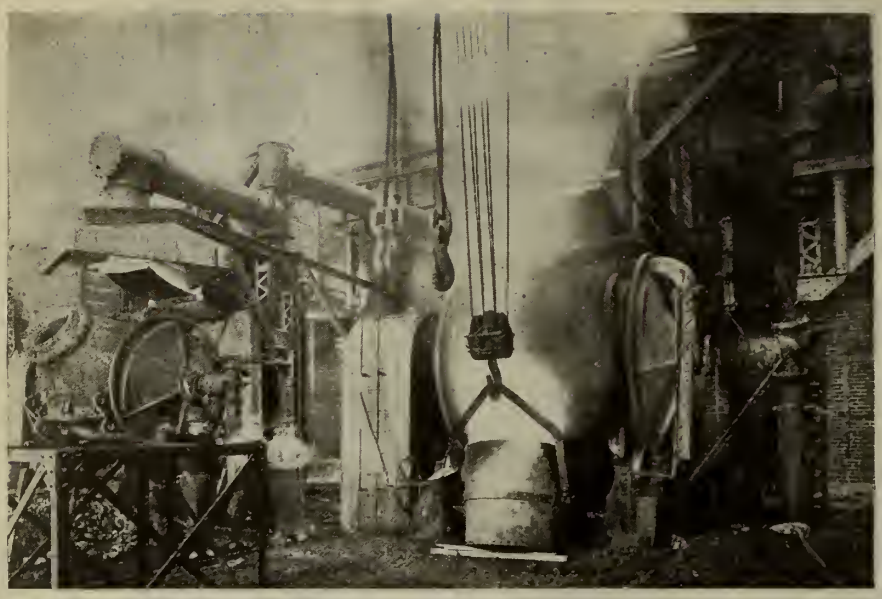
The importance of nickel in the recent war lends particular interest to the refinery of the International Nickel Co. of Canada at Port Colborne, the first refinery to be built on Canadian soil, and its successful establishment marks a new epoch in the industrial development of the Dominion. It has long been recognized that it would be of great advantage to the country and to the Empire at large to have Ontario's nickel industry self-contained within the borders of our own province, and an agitation has been carried on for many years with this object in view. Economic conditions have, however, in the past prevented the attainment of this very desirable object, the long freight haul and tariff on the necessary fluxes and other materials needed in refining have made it out of the question to refine at the mines. War conditions rendered it imperative that Canadian nickel be refined in Canada, and, after considerable study, Port Colborne was selected as a site where freight and other expenses could be reduced to a minimum, the longer haul on the materials imported being, in some measure, counterbalanced by the shorter haul from the smelter on the copper-nickel matte. Full advantage is also obtained from the lower cost of water haulage.

Together with the establishment of the refinery at Port Colborne, the Canadian Copper Company underwent a change in its organization, becoming entirely a subsidiary of the International Nickel Company of Canada then formed. It may be emphasized that this company is not an American organization and that its policy is to employ Canadian engineering talent and labor as far as possible, a feature contemplated for a good many years, ever since the desirability of establishing the refinery in Canada was considered by the personnel of the company.

Nickel as a Mineral

The geology of nickel and the location of the various deposits throughout the world are of considerable interest, and a knowledge of the mining and smelting of the ores is of value and may well precede the description of the refinery proper.

Contrary to popular belief, nickel-bearing ores occur in widely separated countries, Canada and New Caledonia having by far the largest and best deposits. The United States has some workable deposits which were worked for many years until competition from



POURING BLISTER COPPER FROM A CONVERTER INTO THE CASTING LADLE AFTER SEPARATION FROM THE NICKEL.

New Caledonia rendered it unprofitable. These deposits are located in widely separate parts of the country, and some is still being obtained from the blister copper refined at Perth Amboy, near New York.

Nickel Ores of New Caledonia

Next to the Sudbury region the French colony of New Caledonia, 900 miles east of Australia, is the most important source of nickel in the world, the deposits having been first discovered in 1865 by Garnier. Deposits of nickel, cobalt, and chromium are found in large beds on gentle slopes or basins on the flanks of the mountains; the nickel occurring as a hydrated silicate in which the nickel has replaced magnesia to a greater or less extent. The richest silicates, which are green and soft, may contain up to 48.6 per cent. of nickel oxide, but their composition varies greatly.

It is interesting to note that the New Caledonia ores practically never contain sulphur, being silicates accumulated in beds through the weathering of the original rocks, while the nickel deposits at Sudbury are in the form of sulphides associated with those of iron and copper.

The Sudbury Region

Sixty years ago, Northern Ontario, then a part of Upper Canada, was a wilderness, known only to a few Indians, who made a living as best they might by hunting, fishing, and trapping. The timber resources of the country were untouched, the vast mineral resources were unknown, and the fertile farm lands of the clay belt were thought non-existent.

The first intimation that valuable ore deposits might be found in the regions at the head of Lake Huron was made in 1848, in a report by Sir William Logan, then provincial geologist. He mentioned the fact that in one instance copper pyrites was accompanied by compounds of iron and nickel, with a trace of cobalt and stated that it would appear singular if a region extending over a space of between one and two thousand square miles, and giving marked indications of mineralization, did not, in the course of time, yield many valuable results.

From that time onward, various discoveries of copper and nickel-bearing ores were reported by various geologists and surveyors, who traversed the country, nickel being found at several places somewhat remote from what is now known as the Sudbury region. Nickel was first reported from this region by Murray in 1856. The well-known land surveyor Salter first reported indications of iron near the present Creighton mine, the greatest nickel mine in the world, his compass needle being very materially deflected by the iron with which the nickel is associated in the ore, and at his suggestion Murray investigated the deposit, finding copper and nickel.

As is often the case, the opening up of a country by improved transportation leads to its rapid development, and the utilization of its natural resources. The running of the Canadian Pacific in 1883 through the Sudbury district in this particular instance effected the discovery of important nickel deposits, as in the making of a cutting the excavation was carried through the ore body of what was afterwards known as the Murray line.

This exposure on the C. P. R. right of way gave the public some inkling as to the value of the minerals to be found and the country was quickly prospected, most of the important deposits of nickel and copper ores being found in a short time.

Geology of the Sudbury District

The nickel region has sharply-defined boundaries of a geological nature, since all the ore deposits are connected with a great sheet of eruptive rock, roughly boat shaped. Only the upturned edges of the sheet are exposed, since it is basin shaped and has its interior filled with sedimentary rocks. The basin is thirty-six miles long and about sixteen miles wide, and the known ore deposits are all either along the edge of the sheet, or less than four miles away from it on projections or offsets.

The Sudbury ores contain essentially only four ingredients, a magnetic sulphide of iron, which is practically free from nickel and copper, a sulphide of nickel and iron, a sulphide containing equal parts of iron and copper, and a variable amount of rock matter of several kinds. Some of the ores are low in copper and high in iron, and if these could be selected so as to contain only a minimum amount of copper, the large amount of iron present in the ore could be used directly in the production of nickel steel and much expense avoided. Recent researches have demonstrated that under certain conditions copper is not detrimental to steel, and it is possible that some method may be developed which will render possible the saving of the iron content in the form of a steel containing both nickel and copper.

The Canadian Copper Co.

The history of mining and smelting in the Sudbury region is so closely bound up with the Canadian Copper Co., now absorbed by the International Nickel Co. of Canada. that a good idea of the processes connected with the smelting of the ores may be gained by following the various operations as they are conducted at this company's smelter at Copper Cliff.

COPPER CONVERTERS IN REFINERY BUILDING

COTTRELL PRECIPITATION PLANT SEVEN 25 KW., C.G.E. MOTOR GENERATOR SETS SUPPLY ALTERNATING CURRENT TO THE STEP-UP TRANSFORMERS.

The valuable constituents of the ores are nickel and copper, and these two metals must first be separated from the useless materials and then from one another. The first step is the elimination of much of the sulphur found in combination with the nickel copper and iron of the ore, and in the past this has been largely accomplished by heap roasting, although it is anticipated that this process, destructive to vegetation and wasteful of sulphur, will soon become a thing of the past. For heap roasting, a flat, well-drained surface is prepared, and a layer of cordwood or dead pine is laid down to a depth of a foot or eighteen inches. On this bed coarse ores are placed, followed by medium ores, and finally by fines. The heap, when completed, contains up to 2,000 or 3,000 tons. and has a trim, rectangular shape. with flat top and sloping sides. The wood is set fire to and burns out, by which time the sulphur is ignited and burns without further assistance. Larger heaps require three or four months to burn, and at the end of this time all but about 10 per cent. of the sulphur has burned off and the iron is more or less completely oxidized.

After roasting, the ore is smelted in water-jacketed furnaces to standard matte. These copper blast furnaces are rectangular in shape and can handle about 500 tons of ore per day. The ore from the several mines owned by the company, owing to the large proportion of iron and admixture of rock with the sulphides, can be blended to form almost self-fluxing mixtures, but quartz is added as required to produce a further oxidization. The smelting results in two products, matte and slag. The matte contains practically all the nickel and copper. with much of the iron. The matte from the blast furnace is next poured into basic converters, where the remaining iron is oxidized in much the same manner as is the carbon in the familiar Bessemer converter of the steel mill. The iron passes out in the slag resulting from the operation, and a standard matte ready for refining results. This matte contains very nearly all the nickel and copper, very little of the iron, and a high percentage of sulphur. The matte is sent to the refinery at Port Colborne, where the copper and nickel are separated and refined.

The Port Colborne Refinery

On approaching the refinery one is favorably impressed with the excellent architectural features of the administrative and other buildings forming a group at the entrance.

The comfort and health of the large staff have been given considerable care, and the result is shown in the staff house provided for employees, and in the club house for the accommodation of the unmarried department and executive heads. This latter building contains recreative features such as bowling alley and billiard rooms. in addition to the living accommodations provided.

Laboratory

The laboratory is housed in a separate two-storey and basement building, and besides the offices necessary, contains the main laboratory and balance rooms. The laboratory has been fitted throughout with alberine or soapstone tables and a central fume hood with ten compartments has been arranged around a central stack. Each compartment is also constructed of alberine and has wire-inserted plate glass sliding doors with marble trim. The balance room is equipped with the usual precision and assay balances carried on an alberine slab free standing from the building, and supported on brick piers carried to bed rock.

Transportation Facilities

Railway sidings from the Grand Trunk enter the company's property from the north. These sidings serve every portion of the plant, and all handling of materials by hand being eliminated.

The furnace building, known as the No. 1 building, is 746 ft. in length by 125 ft. in width, and at present houses three blast furnaces and three converters. The matte received from the smelter at Copper Cliff undergoes its initial treatment here, and the method of handling the raw materials is of interest. The matte, coke and fluxes are brought in on an elevated trestle of reinforced concrete, and which displays excellent design and workmanship. From the cars the materials are dumped into elevated storage bins, from which it goes to the feeding floor and thence to the furnaces. The standard matte, 55 per cent. nickel and 24 per cent. copper, is smelted with saltcake, the nickel separated and the copper bessemerized in the converters. These converters are of Allis-Chalmers made, and are of 84 in. by 126 in. size. Electric tilting gear controls their movement. Besides these converters this company supplied two sets of crushing rolls and a sample grinder.

Removal of Fumes and Gases

In the various operations conducted in the No. 1 building much sulphur is given off in the form of sulphur dioxide gas, and to remove this and disperse it in such a manner as to prevent damage to vegetation has been a problem of some magnitude. Each converter has a stationary hood and also a movable one for use when pouring, through which all of the deleterious gases are removed and conducted to the stack. For the removal of dust and a valuable metallic content, the gases, before entering the stack, are subject to the familiar Cottrell precipitation process.

The Cottrell Precipitation Process

For many years there was no known process by means of which dust and other objectionable matter in flue gases and in the gaseous products of metallurgical operations could be completely eliminated. The Cottrell precipitation process, a somewhat recent development, has been applied to these uses with such success, however, that it has been well established as a standard means of removing fine particles of material such as dust, fumes, acid, mists, etc., from the gases, resulting from the smelting and refining of copper, lead, zinc, and other metals.

The installation of this system in the refinery at Port Colborne is one of the largest and most successful in North America, and is admirably planned for the work it has to do in the elimination of many of the noxious elements of the gases and in the recovery of valuable metals.

A brief description of the fundamental principles underlying the electrical precipitation process will be of much assistance in understanding the operation

B. & W. BOILERS SUSPENDED BUNKER, AND CHAIN GRATE STOKER.

of the plant. A body highly charged with electricity, if of small enough diameter, or with sharp points, discharges electricity silently through the surrounding air. The corona discharge surrounding high tension lines under certain conditions, and visible as a pale light, is an analogous condition. Some of the electrical energy thus discharged is imparted to any particles of matter in the immediate vicinity, and they in turn are transformed into charged bodies (positive or negative as the case may be). As bodies charged with electricity of the same sign repel each other, all such particles will, if free to move, be violently repelled from the fixed electrode or charged body, and will be attracted to a body of opposite polarity.

The essential elements in a precipitation plant then are a source of high potential direct current and the two electrodes of opposite polarity. One set known as the discharge electrodes, are of such form as will facilitate an electric discharge from their surface. This is accomplished by making them in the form of a wire or light chain or a strip of metal having relatively sharp edges. The other set of electrodes known as the collecting electrodes, are of such shape as to prevent as far as possible any discharge from their surfaces. in this case, in the form of a pipe with a smooth bore.

These electrodes are so arranged in the precipitator that the different types oppose each other, and between them a silent or glow discharge is maintained by supplying to the discharge, electrode energy of a uni-directional character. The collecting electrodes are grounded for safety, the ground being used as the return circuit.

In this refinery the fumes from the copper converters are collected by hoods and carried away in two collecting flues, which unite at the base of the stack. These flues are of concrete and steel construction and are lined with brick. The gases on the way to the stack pass through the precipitating tubes which are arranged in two separate groups, one serving each flue, and all particles of suspended matter are driven to the enclosing walls and drop into suspended bins below, from which they are removed from time to time by means of the company's railroad.

Energy is supplied by means of seven 25 kw. motor generator sets of General Electric make. These motor generator sets take current from the d.c. busses and transform it into lower-tension alternating current at sixty cycles. A step-up transformer for each set serves to step the voltage up to 100,000 volts, at which potential the current is commutated and led to the precipitating tubes. The commutator is a bakelite disc about thirty inches in diameter and is keyed to the end of the motor-generator shaft, thus keeping it in exact synchronism with the alternator frequency; two metallic sectors are attached to the disc and the current is transformed into a uni-directional current by means of fixed sparking contacts, no mechanical connection being necessary.

From the precipitator the flue gases pass into the stack, which is 350 feet high and 12 feet internal diameter at the top. This stack, together with all others at the plant, is built of reinforced concrete and was erected by the General Concrete Construction Co.

Air Supply

The converters and blast furnaces require a large volume of air, and for this purpose three high-pressure turbo-blowers are installed in a separate building. These blowers are made by the Ridgway Dynamo and Engine Co., and

INTERIOR VIEW OF POWER HOUSE, SHOWING WEBSTER-LEA HEATER METER, INGERSOLL-RAND COMPRESSOR, PUMPS FOR PLANT WATER SUPPLY AND TURBO-GENERATOR

EXTERIOR OF POWER HOUSE.

have each a capacity of 7,500 cubic feet of free air per minute, at 30 oz. pressure. The blowers are individually driven by high speed direct-current motors at 3,600 revs. per minute.

Further refining of the nickel is done in the No. 2 building, and one of the most interesting features of this portion of the plant is the comprehensive arrangement of the mono-rail system. The bottom chords of the roof trusses have been designed to take care of the additional load, resulting from the mono-rail system and Shepard crane and hoist mono-rail trolleys serve every portion of the plant. Safety features, suspended walks and runways are provided, and it is impossible for any car to run off an open switch or otherwise do damage to itself or to another.

A stack of the same size and construction as that serving the No. 1 building serves to carry away and dissipate in the upper atmosphere all fumes from the roasting ovens here installed.

Power Plant

In common with the remainder of the refinery, the power plant shows evidence of careful planning and considerable attention to future conditions. The equipment at present installed is capable of taking care of a considerable extension to the plant, and ample space has been provided for future extension both of the boiler house and turbine room.

The building is of the usual brick, steel and reinforced concrete power house design, and the equipment has been arranged in an attractive layout.

The main power house boiler room contain four Babcock and Wilcox standard water-tube boilers, each of 3,419 square ft. heating surface, set in two batteries. These boilers are built for a working pressure of 160 pounds per square inch, each being fitted with B. & W. superheater, which superheats the

bines operating at 8,500 revs. per min. steam about 100 degrees. B. & W. chain grate stokers are also fitted.

Two B. & W. boilers of special design are also installed for utilizing the waste heat from the reverberatory furnaces of the nicked refinery. These boilers are designed for a capacity of approximately 400 boiler horse power each, and are of particular interest as they represent the latest design in waste heat boilers developed from very extensive investigation into this class of work by the Babcock and Wilcox Company.

Coal and Ash Handling

Coal is received from the cars in a track hopper crushed in a Jeffry single-crushing roll, elevated, and conveyed overhead to a ssupended bunker, from which it is fed as required to the stokers.

The ashes are removed from the ash pits by ash cars running in an underground tunnel to the elevator and ash storage bin from which they are dumped into cars for removal.

One 6 ft. by 175 ft. reinforced concrete chimney conveys the products of combustion from the boilers in the power house. The waste heat boilers are served by two 5 ft. x 10 ft. reinforced concrete stacks.

Turbines and Generators

Two Ridgway-Rateau high pressure turbines furnish power for the direct connected d.c. generators, each of 1,000 kw. capacity. These turbines operate under 150 pound initial steam pressure, and 28 in. vacuum, and run at 1,700 revs. per minute.

The power house also contains two other turbo-driven units, these being high pressure blowers supplying air for the converters. Like the turbo-generators, these units are of Ridgway-Rateau make. The turbo-blowers are each of 15,000 cub. ft. capacity, and deliver air at 15 pounds pressure. They are connected to high pressure condensing turbines operating at 8,500 revs. per min.

The superseding of the reciprocating engine by the turbine in the large power plants has provided the means for the elimination of the cumbersome blowing engine. The high rotating velocities obtainable to-day are especially well adaptable to the driving of centrifugal blowers, and the turbo-blowers at this plant are much more economical of space than blowing engines of similar capacity would be.

The impellers are built up around a large diameter shaft with dovetail radial slots milled in it. The impeller blades are tapered in sections, being much thinner at the tip than at the root, and are driven into these slots, distance pieces being inserted between the blades in several stages. All turbines are equipped with Frahm tachometers, supplied by James Biddle, Philadelphia.

Condensing Equipment

Two No. 7 Westinghouse LeBlanc jet condensers, with individual air and circulating water pumps serve the turbo-generators. Each unit is fitted with a 31 h.p. steam turbine and reduction gear for pump drive. These condensers are each capable of handling 17,500 pounds condensate per hour, and maintain a 29 in. vacuum, with 40 degrees cooling water.

For the turbo-blowers two similar No. 5 units are installed. These are fitted with 21 h.p. steam turbines, and are capable of handling 11,000 pounds of condensate per hour, at 29.05 in vacuum with 40 degrees cooling water.

Electrical Features

The main switchboard supplies the plant load with direct current at 250 volts, lighting and other 110-volt services being supplied by means of a three-wire service operated by two 20 kw. motor generator balancing sets. I. T. E. circuit breakers. Weston indicating ammeters, and Sangamo watt-meters are installed on the generator and feeder panels.

Feed Water Equipment

The feed water is heated by exhaust steam from the various plant auxiliaries in Webster-Lea heater meter units. The heaters were supplied by Warren Webster and Company, Camden, N.J., and the Lea meters by the Yarnall-Waring Co., Philadelphia.

Two units were installed, one heater good for 5,000 h.p. equipped with Lea recorder, and having a capacity of 275,000 pounds per hour, and another unit similar in construction to the first and having a capacity of 1,500 h.p., or 100,000 pounds per hour. Both units are of extra heavy construction and were designed to withstand a back pressure of 10 pounds per square inch.

A two-inch venturi meter meters all feed water, and the feed pumps are of Lea-Courtenay make, direct-connected to Terry steam turbines of standard type. Owing to the horizontal parting of the casing, these turbines are very accessible for repair, and the fact that no oil comes in contact with the steam renders the use of an oil separator on the exhaust line to the heaters unnecessary.

MORE THAN 2,000,000 H.P. ELECTRIC ENERGY GENERATED IN CANADA

THAT there is upwards of 2,000,000 horse-power of electrical energy generated in Canada is demonstrated in the report on Electric Generation and Distribution in Canada about to be issued by the Commission of Conservation. The investigation into this subject has extended over a number of years and has been a most comprehensive one. Two of the principal points to bring out are the large part water-power plays in the production of electricity and the fact that over three times as much power is produced by privately-owned plants as by those publicly owned.

Water Power Predominates

There are, according to the report, 565 electric generating plants in Canada, with an aggregate capacity of 2,107,743 h.p. These supply 752 distributing systems, which serve 973 localities. Classified according to the prime-movers used, these plants are divided as follows:

270 hydro-electric, aggregating	1,806,618 h.p.
201 steam plants, aggregating	288,202 h.p.
49 gas plants (nearly all producer-gas), aggregating	8,157 h.p.
45 oil or gasolene engine plants, aggregating ...	4,766 h.p.

These figures give a very fair idea of the power situation, and show the unquestionable predominance of water-power. In the Maritime Provinces, steam and water-power predominate with the former in the ascendancy. In Quebec, Ontario and eastern Manitoba, water-power is the dominating source of power, every large centre and most of the smaller ones being supplied by electricity produced from water-power. In the Middle West, large plants are steam operated, while the smaller ones use internal combustion engines. In British Columbia and western Alberta, water-power again predominates, but the generous coal supply in certain districts also permits considerable steam operation.

In the large hydro-electric installations, the report says, the type of plant is of the most up-to-date and substantial construction, but the same, unfortunately, cannot be said of many of the small plants, particularly the older ones. Old, leaky dams and inefficient types of water-wheels in bad repair are often the real causes of shut-downs attributed to lack of water. Likewise in the large steam plants, efficiency is shown, but this is not generally true of the smaller ones. For the prairie provinces, where fuel and the cost of generation are high in price, the report suggests that it would be more economical to generate electric power in large central steam plants and distribute it over transmission lines.

More Privately-Owned Plants

The report shows that there are 207 municipal or publicly-owned plants of 452,508 h.p. capacity and 358 plants privately owned with a capacity of 1,655,235 h.p. The Niagara system of the Ontario Hydro-Electric Power Commission is the largest under public ownership. It has a load of over 201,000 h.p., supplies 120 municipal distributing systems and serves an area of 210 miles long by 85 wide. The largest privately-owned system is the Shawinigan in Quebec, with a load of 205,000 h.p. supplying 76 distribution systems and serving a triangular area with a base of 140 miles and a height of 75 miles.

The largest hydro-electric development is 488,800 h.p., in the three large power plants at Niagara. The large installations are not all confined to this site, however, as there are, in addition, 5 plants of over 100,000 h.p. and 36 plants of over 10,000 h.p. capacity. The large single plant is the Ontario Power Co., now operated by the Ontario Hydro-Electric Power Commission at Niagara, with a total capacity of 211,300 h.p. The largest single unit thus far installed in Canada is 20,000 h.p., at Grandmere, Que., though the Ontario Hydro-Electric Chippawa plant will contain units of 50,000 h.p., while future plans contemplate the use of 100,000 h.p. units.

The average head of water utilized is not exceedingly high, but many large hydro-electric plants operate under fairly high heads, such as 140 to 180 ft. at Niagara, 145 ft. at Shawinigan, 83 ft. at Grandmere and 400 ft. at the Coquitlam-Buntzen plants near Vancouver. The highest head in eastern Canada is 540 ft., at the 8,000 h.p. plant at Eugenia Falls, Ont., while, in the West, a head of 1,820 ft. is utilized at Britannia Beach, B.C., where the development also provides a total head of 3,530 ft. in two steps of 7,450 ft. and 2,080 ft. for the direct operation of other machinery. On the other hand, one of the largest plants recently installed at Cedars, Que., operates under a head of 30 feet.

The 26,667-horse-power plant at Hamilton, Ont., is the largest steam-power plant in Canada and is used as an auxiliary. The 14,234-h.p. plant at Edmonton, Alta., is the largest steam plant operated continuously.

Storage Reservoirs Increasing

No less than 59 plants report the successful operation of storage facilities to provide for increased flow at low-water periods. Among Government undertakings of this nature may be mentioned the three large reservoirs at lakes Timiskaming, Kipawa and Quinze to regulate the flow of the Ottawa river; La Loutre reservoir on the St. Maurice river; lake St. Francis dam for the St. Francis river, Que.; the extensive system of small conservation reservoirs on the Trent river, Ont.; lake Minnewanka, on the upper waters of Bow river, Alta., and the reservoirs on Jordan river and Goldstream, near Vancouver, B.C. Most satisfactory results have been obtained from storage undertakings, the capacity of plants being frequently doubled or more than doubled.

The utilization of the large peat areas in the north part of Jutland is receiving much attention. The area is said to be as much as 28,000 acres, which, according to "Ingenioren," could be completely drained by gravitation, and the total contents might be equivalent to 23 million tons of coal. It is suggested that the peat could be utilized (1) as air-dried briquettes used for heating the boilers of adjacent electrical supply works; (2) as machine made briquettes sold for general consumption as far away as the cost of transport will allow; (3) as peat litter to be sold to neighboring farmers; (4) the lower parts of the bogs should be reclaimed and used for agriculture. The heating value of the peat is assumed to be half that of coal. The works required should be executed by private enterprise, aided by the State, and the cost of reclamation would amount to £50,000. The first 9,000 acres could be dealt with in twenty years, and the rest of the land occupied in course of time as the peat is cleared away.

ELECTRIC PLANTS IN CANADA, SHOWING CAPACITY, OWNERSHIP AND PRIME MOVERS

Province.	Plants.		Ownership. Private.		Public		Kind of Prime Mover. Hydraulic.		Steam.		Int. Combustion.	
	Number	Capacity h. p.	No. of Plants	Total Capacity h. p.	No. of Plants	Total Capacity h. p.	No. of Plants	Total Capacity h. p.	No. of Plants	Total Capacity h. p.	No. of Plants	Total Capacity h. p.
Nova Scotia	38	27,177	24	23,064	14	4,113	12	3,474	23	23,478	3	225
Prince Edward Island	9	1,314	9	.....	...	.....	5	207	2	475	2	632
New Brunswick	23	18,607	16	16,212	7	2,395	8	7,463	12	10,014	3	1,130
Quebec	119	625,061	99	604,903	20	20,158	92	585,911	20	38,791	7	359
Ontario	173	899,856	105	609,658	68	290,198	113	831,004	50	66,519	10	2,333
Manitoba	23	103,015	8	53,706	15	49,309	4	78,550	13	23,841	6	624
Saskatchewan	62	30,593	26	2,682	36	27,911	...	.....	15	26,585	47	4,008
Alberta	52	85,117	27	43,235	25	41,882	4	31,980	42	51,805	6	1,332
British Columbia	63	306,776	41	290,234	22	16,542	1	10,000	2	227	...	2,280
Yukon	3	10,227	3	10,227	...	.....	31	258,029	22	46,467	10	.....
Canada	565	2,107,743	358	1,655,235	207	452,508	270	1,806,618	201	288,202	94	12,923

Historical Development of the Steam Turbine--IV

The Last of a Series Dealing With Development of the Turbine—Coupling Design Has Improved Since the First Turbine Was Built, and Lubricating Systems Are Now a Most Important Feature

Couplings

In the earliest machines, the turbine and generator shaft were each provided with a square formed in the end of the shafts over which fitted a loosely fitting sleeve. This was subsequently replaced with a claw-type coupling, Fig. 34. This coupling is of the so-called flexible type which, however, does not permit of successful operation with material misalignment of the turbine and generator shafts. With misalignment there is a slight variation of angular velocity which, on account of the inertia of the revolving parts, causes a heavy intermittent stress on the driving horns, each horn in turn having to accelerate the masses slightly at each revolution. There were a few cases where breakage occurred, although the stresses due to normal operation were quite low. Of course, the greater the length of the coupling between the sets of driving horns the more truly flexible it becomes.

In the latter type couplings shown in Fig. 35, circular driving pins having considerable overhand are employed, thus permitting a slight flexibility of the pin itself, that is, they may deflect slightly without strain. No breakage has occurred with this design.

Lubricating Systems

All turbines have been provided with lubricating systems, operated by pumps directly driven by the turbine. In all but the smallest sizes, this is relayed by a separate steam-driven pump, which is for use only in starting and stopping. With time, however, the lubricating

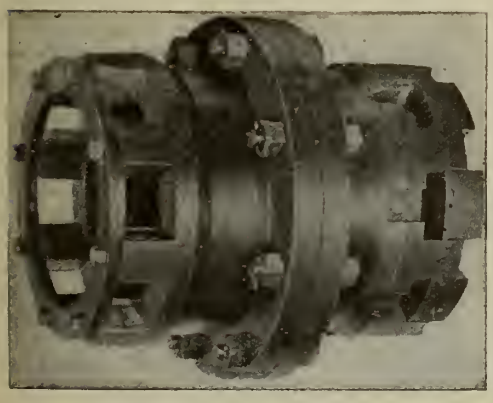


FIG. 34—CLAW TYPE COUPLING.

system has become more elaborate. It is generally recognized that the life of the oil is much increased by an ample reservoir. The longer the rest the oil has between the times of actual use in a bearing, the better; hence the capacities of reservoirs have been materially increased, a 20,000 kilowatt turbine having a 20 barrel oil tank. Later machines are provided with elaborate strainer systems which may be cleaned while the turbine is operating.

A system of fractional filtration is coming into general use, there being provided in the power house a first-class filter system of moderate size, capable

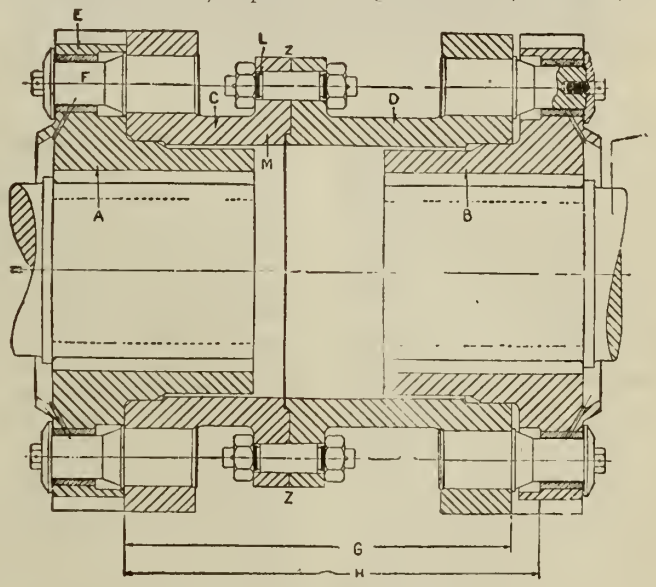


FIG. 35—DETAIL OF MODERN COUPLING.

of filtering continuously a few per cent. of the oil actually being used. The oiling system is provided with an overflow arranged to drain out from the bottom of the reservoir the dirtiest oil. A supply of clean, pure oil, commensurate with the capacity of the filter system, is then delivered into the turbine system; the same amount of dirty oil overflowing to be refiltered.

Oil coolers or their equivalent are always necessary. It has been the custom of the Westinghouse Company always to employ a separate cooler. The practice of water cooling the bearing itself, or of embedding cooling coils in the babbitt, while highly efficient from the standpoint of heat transfer per unit of surface, has never been resorted to because of the impracticability of cleaning. A modern cooler is shown in Fig. 36, the water making many passes at high velocity through the tubes, the oil circulating outside the tubes. The cooling surface merely lays in a cast-iron box, the water connections being more or less flexible. Proper provision for expansion is evident as it is the means by which the whole element may be lifted out for cleaning.

Oil is used at a temperature conducive to any chemical action; it therefore must have no tendency to turn acid, which generally precludes the admission of any animal or vegetable oils. It is found that some higher viscosity oils, while they may contain nothing but pure mineral stock, have a tendency to emulsify. This is particularly true in cases where the reservoir system is not large and the oil gets insufficient rest. A viscosity as low as 150 secs. Saybolt at 100 degrees Fahr., is satisfactory for turbines. In the case of geared units, however, a viscosity of 250 to 350 secs. Saybolt at 100 degrees is recommended; the turbine itself operating equally well with this higher viscosity, the only difference being a slightly higher bearing temperature and a little more cooling required. The ideal lubricant is the fluid having the greatest adhesion and the least cohesion. The requirement of the bearing is that the relatively moving surfaces be adhered to by the fluid, the fluid itself being sheared between the surfaces, a definite film adhering to each surface. The work of the bearing, due to the bearing losses, depends on the resistance to this shear, which is a function of the viscosity. Inasmuch as the vicosity becomes less with increasing temperatures, bearing losses may be maintained at a minimum by operating with high oil temperatures. Decreases of viscosity with the increase of temperatures reduces the losses, so unless there is something the matter a bearing will reach a definite temperature and stay there. It is self-regulating in that respect. While turbines operate well with oil temperatures as high as 160 degrees Fahr., no attempt is made to state what may be regarded as limiting temperature, or in what respect the life of the oil is reduced by continued operation at high temperatures. Inasmuch as the oil consumption of a turbine, after the system has once been charged, is practically nothing, the question of price at the expense of quality

and suitability should not receive consideration.

Exhaust Passages

More attention is being given to the exhaust passages of turbines, that the steam may leave the turbine without eddies in the exhaust chamber. In older designs it was not uncommon to find hot and cold spots with the turbine operating under light loads, and particularly on a change of vacuum, doubtless inducing considerable temperature strains. Some later large machines are projected with what may be termed "stream line exhausts," the steam being divided up as it leaves the last row of blades into a number of easy curved passages leading to the exhaust opening.

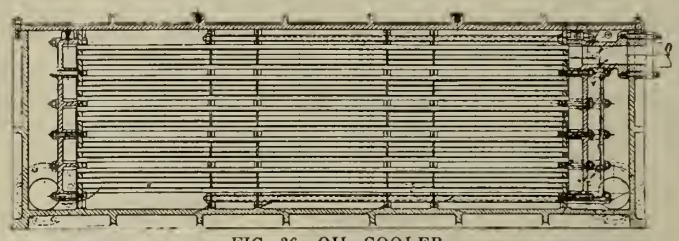


FIG. 36—OIL COOLER.

With high-speed machines the exhaust passages have greater physical dimensions than anything else about the machine, the turbine almost appearing to be all exhaust chamber, so any further reduction in diameter in the inherent turbine parts will not materially affect the dimensions of the whole turbine.

Progress and Future Possibilities

Discussion of the general progress of turbine development in the past is not complete without reference to the possibilities of the future. It is plain that with turbines of large size, which deliver to the switchboard 76 to 80 per cent. of the theoretical energy available from the steam expanding between the limits specified, further improvements in the turbine itself will not materially raise this efficiency, and that further improvement in central station economies must be looked to from causes other than the steam turbine. This is a subject of the greatest importance in view of the rapidly increasing cost of fuel, and justifies considerably more capital expenditure for economizers and other plant apparatus which will reduce fuel cost.

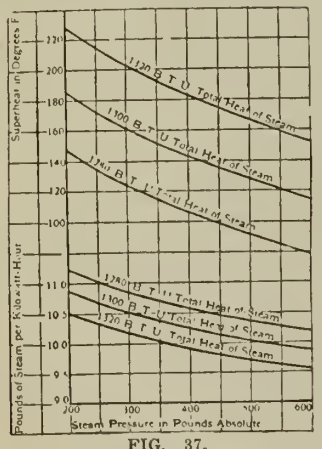

Superheat in Degrees F
Pounds of Steam per Kilowatt-Hour
Steam Pressure in Pounds Absolute
1120 B.T.U. Total Heat of Steam
1300 B.T.U. Total Heat of Steam
1240 B.T.U. Total Heat of Steam
1280 B.T.U. Total Heat of Steam
1100 B.T.U. Total Heat of Steam
1150 B.T.U. Total Heat of Steam

FIG. 37.

Attention at the present time is being directed to employing higher boiler pressures, viz., pressures as high as 600 pounds. To-day 200 pounds pressure, 200 degrees Fahr., superheat is regarded as a more or less every day operating condition for large plants. Steam is generated at 600 pounds pressure, having exactly the same heat content as that contained in 200 pounds pressure and 200 degrees Fahr. superheat will have a superheat of approximately 128 degrees Fahr. This expanded to 29 inches of vacuum is theoretically capable of giving 13 per cent. more energy than when generated at 200 pounds. Doubtless, when operating under these conditions, the turbine will be of lower efficiency. The high pressure element will be less efficient on account of the great density and the small volume of steam, and on the other hand the low-pressure elements will be less efficient because of the great amount of water precipitated by the steam expansion from the high pressure, introducing a brake in the turbine. However, it is reasonable to suppose that the turbine will avail itself of at least 50 per cent. of this 13 per cent. possibility, producing a net saving of 6 or 7 per cent. What may be expected to be derived from higher pressures is exhibited in Fig. 37, plotted for various pressures.

Another source of improvement of performance in large multiple-cylinder machines may be obtained by intermediate reheating, the steam expanding from a high pressure and superheat through a high-pressure element to a pressure of say 40 pounds absolute, where nearly all the superheat has disappeared, the steam then being passed through a separately-fired superheater and raised to approximately its original temperature, thus giving a nearly dry cycle to the whole steam expansion. The addition of an intermediate reheater to such an installation would be expected to secure an improvement in total b.t.u. supplied, of 5 per cent. Until lately, however, the capital expense involved would hardly have been warranted.

Much more than formerly, attention is being given to the subject of feed water heating, and means are available for providing a heat balance between the feed water heating system and the main turbine unit, valves being provided which will take steam from the turbine whenever there is a deficiency of auxiliary exhaust steam for heating feed water and take steam from the heating system when the feed water heater is incapable of condensing all of the exhaust steam from the auxiliaries. Valves are also available which, when the conditions demand, will take steam from a higher pressure stage of the turbine in one case and admit steam to a lower stage in the other.

A heat balance system has been proposed, employing electric motors for driving the auxiliary machines, and these in turn operated by a special generating unit, the generator being driven both by a non-condensing steam turbine, an electric motor operated from the main busbars, the flow of steam to the turbine being controlled by the pressure in the exhaust and hence by the needs of the feed water heater. At times of excessive demands for feed water heating the motor may give energy to the system and conversely when there is a small demand for steam for heating feed water, the energy for driving the auxiliaries will, in part, come from the main units. The auxiliaries, being motor driven, have the advantage of reducing the general dirtiness, heat, and overcrowding to be found in the basements of many power plants on account of the steam and exhaust piping of the many small turbines. The general prejudice against electric motors and other auxiliaries would seem to be giving way in view of greater ruggedness of electric motors and the safety of their circuits. The heat energy actually required to operate the auxiliaries with such a system would be far less on account of the better performance of the large turbine unit as compared with the number of small non-condensing auxiliary turbines in spite of the electrical losses involved.

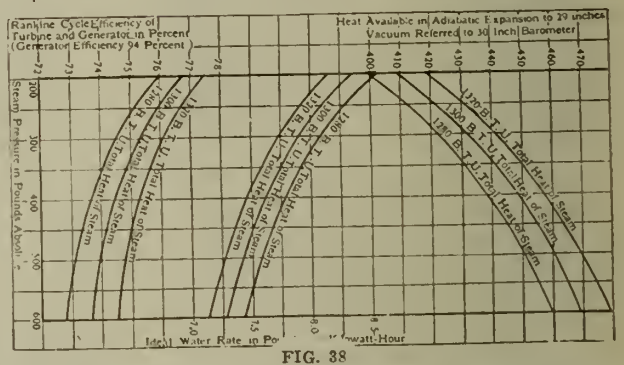

Rankine Cycle Efficiency of Turbine and Generator in Percent (Generator Efficiency 94 Percent)
Heat Available in Adiabatic Expansion to 29 inches Vacuum Referred to 30 Inch Barometer
Steam Pressure in Pounds Absolute
Ideal Water Rate in Pounds per Kilowatt-Hour
1100 B.T.U. Total Heat of Steam
1200 B.T.U. Total Heat of Steam
1300 B.T.U. Total Heat of Steam

FIG. 38

Further economy may be expected by making more extended use of the economizer. Until lately it has been considered difficult to operate economizers successfully if the feed water is admitted to them at a temperature much below 200 degrees, because of corrosion of the surfaces and the condensation of tarry compounds from the fuel. It is probable that in the future economizers will operate well with the water entering them at 120 degrees or thereabouts, the water being heated to this temperature by a fewer number of steam-driven auxiliaries or by the employment of electrically-driven auxiliaries entirely, and bleeding the main turbine at a stage where the pressure is commensurate with that temperature.

The present time is a very important period in the development of the steam turbine. A large number of big units have been built ranging in size from 25,000 to 60,000 kilowatts. Those built by the General Electric Company are of the impulse type, those by the Westinghouse Company entirely of the reaction type, and sometimes a combination of both types, where the complete expansion is carried out in a single cylinder. Of the Westinghouse machines, the increased reliability obtained by dividing the steam expansion in separate cylinder structures is recognized. Some have been arranged with the high and low-pressure cylinders arranged tandem fashion, driving a single generator. Others are arranged "cross compound," each turbine element driving a separate generator. The very largest sizes are of the three element design, comprising one high-pressure turbine with a low pressure on either side, each of the three elements having its separate generator.

Some of these units are now in operation, and within another year a great many will be in service. Some of them will be tested for steam efficiency. All of them will give evidence as to their reliability of operation and accessibility for inspection and repairs. The multi-cylinder turbine certainly seems to have much to commend it if there is anything in the thought that with increase in the capacity of the prime mover there should be a corresponding increase in reliability. These very large units, if built in a single cylinder structure, impose grave problems of design, for as the structure becomes larger, the more likely it is to change shape under the varying temperatures within its walls. Also, the hazard is introduced of using higher grade materials to deal with higher stresses, with all the uncertainty which that question involves in the actual securing and testing of such materials, with absolute knowledge that the quality of the test specimen will be secured approximately in the finished piece.

We then have the increasingly imminent question of dealing with higher steam temperatures, which does not make the design of turbines any easier as is well proven in several recent instances, so if we take advantage of the fact that in size alone resides an ability to achieve higher efficiency, then it would seem that the uncertainties of design and construction as regards heat stresses, as well as centrifugal stresses, can best be removed by introducing no new questions. Let us have the high efficiency that comes with large size as bringing us within well-tried practice, dealing with no special materials, avoiding widely differing temperatures within the same structure, keeping the high temperatures within the relatively small high-pressure element, and be ready also for the still higher temperatures of the future. The multi-cylinder arrangement occupies more room, measured in the width of the unit, but less in length; however, the turbine room space in this respect is not a problem in most stations. They have the advantage, previously pointed out, that the turbine elements are sensible of being operated separately in the event of derangement of either one of them. Automatic apparatus is provided, when demanded, for any two of the three turbine elements continuing to carry load, should the one be taken out of service, either by the opening of the circuit-breaker or by tripping the emergency stop. The compound unit costs more money, but not prohibitively more, if the construction behind its adoption is justified by experience. In view of the present power house costs there would seem to be no economic need of reducing the cost of the turbine units below the amount required to make them as nearly perfect as possible. It is hoped that the time is not far distant when the turbine designer will not have to initiate quite so much as he has in the past, that on the operating side the engineers will test their turbines more generally and will know precisely what results they give in steam consumption, and will take a stronger position respecting the mechanical features of design, details of operating convenience, etc., much as they used to when they dealt with the subject of Corliss engines, and recognize and give consideration to better detail design of not only the turbine itself, but its appurtenances.

From all that has been said it is plain that the progress in the construction of turbines has not been to reduce intrinsic cost. The increased reliability, while sometimes secured by more skilful design, and at even a reduction of cost, generally however involves a greater cost. The higher operating conditions, pressure, superheat and vacuum, each involves greater expense. The higher vacuum calls for larger low-pressure blade arrears, as well as an increased number of turbine elements. The higher pressures and superheat both involve more turbine elements, and also preclude the use of cast iron for the high pressure portions, adding materially to the cost of gears, etc. Competition calling for the highest performance, has brought about the employment of higher design coefficients which introduce still another element of increased cost. The increase in rotational speed for a given size machine is about the only item besides improved manufacturing processes that have enabled manufacturing costs to be reduced.

In spite of this, the price (under pre-war conditions) of large turbine generating units has been reduced to approximately 40 per cent. of the cost of the earlier large turbines of 5 000 kilowatts or thereabouts. The efficiency ratio has been increased in this size approximately 8 per cent. Considering the larger sizes that now obtain, the cost per kilowatt is further reduced and efficiency ratios have been improved 12 per cent. Actual heat consumption of b.t.u. supplied at the throttle has shown a reduction of 24 per cent. between the 7.500-kilowatt turbine of 1905 and the Interborough turbine of 1914.

Comparison of steam engine performances are, however, incomplete without consideration of capitalization, depreciation, etc. Assuming the cost of steam at 15 cents per thousand pounds, a load factor of 75, and 15 per cent. for fixed charges, a saving of 33 per cent. is produced by the latter of the above two machines.

To make similar comparison between a modern large turbine installation and the best performance of reciprocating engines, assume:

	Turbines	Engine
Initial cost per kw. of the generating units	$8.00	$40.00
Fixed charges, per cent. .	.15	.15
Pounds steam per kw.-hr.	.11	.17
Cost of steam per thousand pounds at 220 pounds, 150 degrees supht., 175 pounds dry sat.	.15	.14
Load factor	.75	.75
Cost of foundations per kw.	.50	2.50
Cost of condensers per kw.	3.50	2.50
Cost of engine room personnel, not including executive administration, per kw. per year .	0.61	1.57
Oil and engine room supplies per kw. year	.10	1.34
Total cost per kw. per year	$13.34	$25.29

The modern large turbines have therefore accomplished a saving over the best reciprocating engine installation of approximately 47 per cent. The cost of energy has been no doubt reduced to one-half if consideration is given to reduced size of buildings, etc.

In the early days of the oil-immersed transformer, attempts were made to use some of the fixed oils, such as resin oil, linseed oil, cotton-seed oil; because it was found that these oils had a higher dielectric strength than the straight oils at that time on the market. It was soon found, however, says Mr. W. S. Flight, in the "Electrician," that the fixed oils gave trouble in the transformers due to the formation of carbonaceous deposits, and about the same time it was found that straight oils, free from impurities and all traces of moisture, had as high dielectric strength as the fixed oils. As the latter are not so liable to form deposits and are cheaper, their use has continued ever since. It has been found that the voltage at which a definite thickness of oil will break down depends more upon the amount of moisture and other impurities in the oil than upon the type or nature of the oil. When tests are carried out on clean moisture-free oils it is found that those having a low viscosity have a higher dielectric strength than those of higher viscosity.

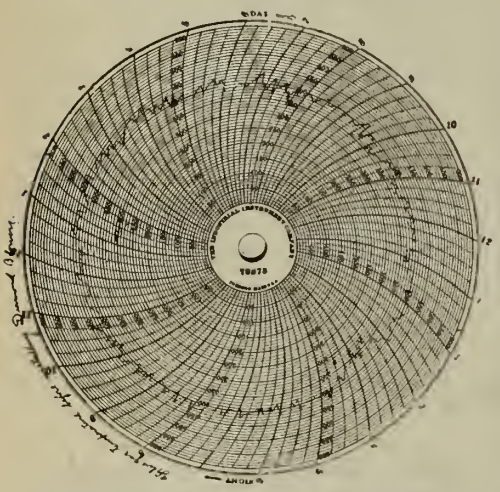
Power Plant Management; Heat Absorption

How Heat is Transmitted—Effect of Scale Influence on Heat Transmission—Soot—What it Is—How it Acts—Hand Cleaning Not Effective—Tests on Soot Blowers

By ROBERT JUNE

THE war has been won, and the tension under which the power plants of Canada have been operated is somewhat relaxed—that is, theoretically. Actually, the reduction, to date, in demands upon our industrial power plants is merely relative; that is, instead of being called upon to deliver steam to 200 per cent. of their normal rating they are now permitted to dawdle along at 180 per cent.

Incredible as it seems, the war has nearly doubled Canada's economic resources. It has added 200,000 trained workers, a number of new blast furnaces, steel mills, and many general manufacturing plants. As a result of its demands, very large extensions have been made to our textile, paper machinery, brick and clay, ice and refrigerating plants, and so on all the way down the line of industry. In



FLUE GAS TEMPERATURES BEFORE INSTALLATION OF MECHANICAL SOOT BLOWERS, PLANT OF AMERICAN HOIST & DERRICK CO.

addition to keeping these plants busy, we have the varied wants of an immense new shipping industry to care for. Unfortunately, proportionate extensions have not been made—perhaps have not been possible—to our boiler plants, whether isolated or central station.

Inasmuch as it is a foregone conclusion that we will capitalize our new war-given resources, we are confronted by the following conditions:

First.—The coal shortage will continue. Although the coal situation may not attract so much attention this year as last because the shortage will be less pronounced, there is no possibility of our mining or securing as much coal in 1919 as we can, or will want to, use.

Second.—If many needed power plant extensions are authorized, and boiler manufacturers work to the limit of their productive capacity in 1919, there will still be a boiler shortage, which, of course, means the existing plants must continue to be driven at high ratings.

I have gone into the existing situation at some length because I am in close touch with it and have some reason for believing that it is not thoroughly understood, and also because it places an obligation upon every power plant operator to conserve coal in the utmost practicable degree by running his boilers on the most efficient basis.

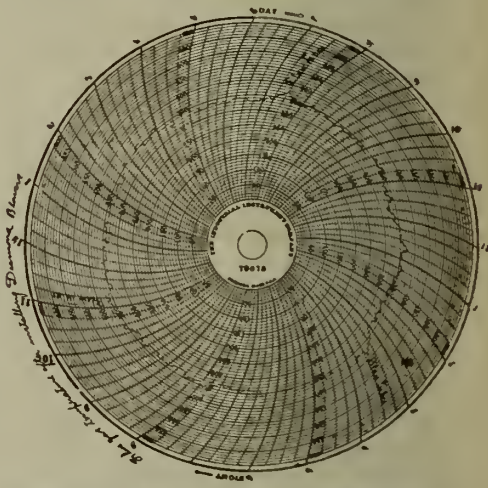
"Cleanliness is next to Godliness," says the age-old proverb. Certainly, we moderns know that it is also next to efficiency—is indeed part and parcel of the latter quality. Nowhere is this truer than in the operation of a steam boiler. How clearly the United States Fuel Administration recognized the fact is shown by its assignment of a value of twelve points out of a possible one hundred, to clean boiler-heating surfaces, in determining the rating of power plants.

How Heat is Transmitted

Heat is transmitted to the water within the boiler by three processes—radiation, convection and conduction. The generally accepted theory of the part each of these processes plays is illustrated in Fig. 1. It will be seen that radiation originates in the fuel bed and hot furnace walls, convection in the hot travelling gases, and that conduction is a function of the metal of the boiler. It is furthermore shown that the heat has to penetrate five layers of interfering substances; namely, a film of dry stagnant gas, a layer of soot, the metal of the tube, a layer of scale, and a film of dry steam.

With the exact or relative values of radiation and convection we are not here concerned, except to observe that on account of the limitations of refractory materials there is no great hope of increasing furnace temperatures in the immediate future, and that if we are to increase boiler capacity it will have to be through other agencies than convection. Inasmuch as we can greatly increase the amount of boiler surface exposed to radiation, this is the principal line along which we are to look for improvement in boiler and furnace design.

Hardly less important, however, is the necessity for devising means of dispersing the dry gas and steam films on either side of the tube. These films are extremely poor conductors of heat. It has been found, as the result of experiments by Professor Nicholson and the U.S. Geological Survey, that by establishing a powerful scrubbing action between the gases and the boiler plate, the non-conducting film of gas can be torn off as rapidly as it is formed, thus bringing new portions of the hot gases in contact with the tube, and thereby



FLUE GAS TEMPERATURES AFTER INSTALLATION OF SOOT BLOWERS, PLANT OF AMERICAN HOIST & DERRICK CO.

greatly increasing the rate of transmission. Similarly, the faster the circulation of the water the greater will be the scrubbing action tending to remove the bubbles of steam from the wet surface, and the more rapid will be the transfer of heat from the tube to the water. By filling up the tube of a Cornish boiler with an internal water vessel, leaving an annular space of only one inch around the latter, Professor Nicholson found that it was possible to drive the boiler to 800 per cent. of normal rating, with a flow of gases of 330 feet per second. This flow, which is 8 to 10 times the average, was maintained by a fan, utilizing about 4½ per cent. of the total power generated.

I have mentioned these factors in heat transmission because they presage certain important improvements sure to come in boiler and furnace design, and it is the duty of prospective boiler purchasers to be informed of them, to discuss them with boiler manufacturers, and to lend every encouragement to the latter in their work of devising cheaper means of steam production.

Scale

Coming now to practical questions of every day operation, we find that the formation of scale is only in a limited

Editor's Note.—This article, one in a series on "Power Plant Management," by Mr. June, deals with the all-important problem of maintaining clean heating surfaces in the boiler. The need of stringent economies in boiler operation makes the question of scale and soot removal of direct interest to every power plant operator.

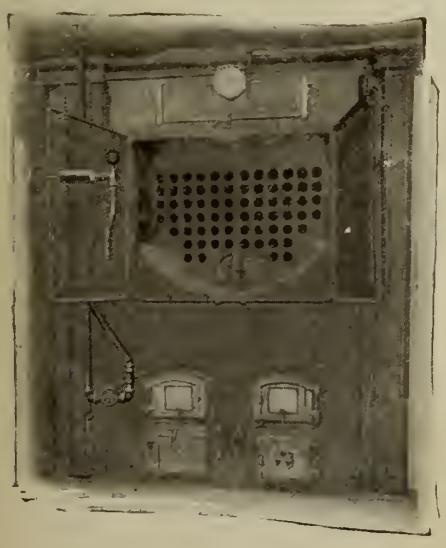
degree a factor of design, being chiefly dependent upon the rate of driving and the nature of the scale-forming ingredients in the feed water.

That the formation of scale should be absolutely prevented by purifying the feed water, or that it should be removed as rapidly as it forms by scale cutters, or "tube cleaners" as they are called, is one of the most elemental facts in efficient boiler-room operation. The loss in conductivity, due to the presence of scale, has never been reduced to a rule or formula, depending upon the thickness, or the degree of hardness and thickness, or the chemical composition of the scale. The percentage of loss can only be determined in each individual case by actual tests.

Table I gives the results of a number of tests of loss due to scale, made at the University of Illinois. It will be seen that the results are so varied as to prevent any detached conclusions—but that they do point unmistakably to the very great loss, running from 2 per cent. to 19 per cent. caused by scale—and that they also point to the previously stated very great necessity of absolutely preventing scale formation, or failing this, its removal as soon as formed.

TABLE I.
INFLUENCE OF SCALE ON HEAT TRANSMISSION.

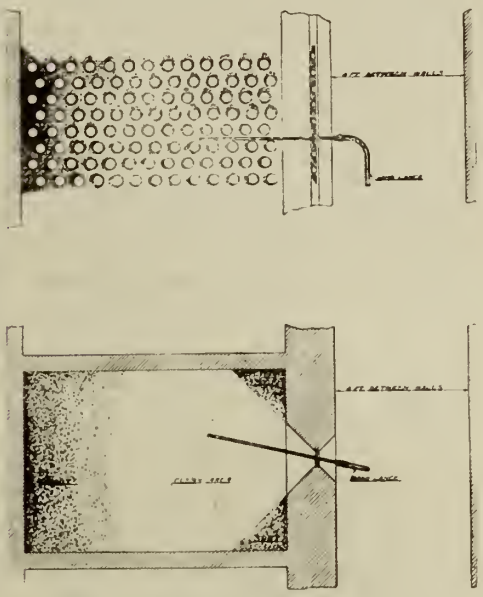
No.	Character of Scale.	Thickness of Scale.	Decrease in Conductivity due to Scale. Per cent.
1		.02	Hard, dense 9.1
2		.02	Hard 2.02
3		.033	Soft 4.83
4		.033	Very hard 3.5
5		.038	Medium 4.03
6		.04	Soft, porous 6.82
7		.04	Hard, dense 3.07
8		.042	Very soft 9.54
9		.047	Hard 2.75
10		.065	Medium 2.39
11		.07	Soft 2.38
12		.07	Hard 4.43
13		.085	Soft, porous 19.0
14		.089	Very soft 4.95
15		.11	Hard, porous 16.73
16		.13	Hard, dense 6.75



DIAMOND SOOT BLOWERS ON RETURN TUBULAR BOILER.

Soot

Of all sources of preventable waste, that of the formation of soot on the fire surfaces of the boiler is the most troublesome. Air leaks in the setting may be found and be hermetically sealed. Losses due to radiation may be largely eliminated by proper insulation of the pipes, and losses caused by excess air drawn through the grates may be done away with in a large degree by the installation of stokers and draft gauges. The formation of soot, however, cannot be stopped by any permanent means. It is an ever-present source of trouble. Its deposit on the fire surfaces of the boiler is an ever



WHY THE HAND LANCE DOES NOT CLEAN THE BOILER

continuous process.

Soot is all but the best insulator known. In non-conducting properties it has been proved to be more than five times as effective as fine asbestos. More heat would be transmitted to boiler tubes through a full one-inch wrapping of asbestos than through one-fifth inch coating of soot. The table following is from Kent's pocket book.

TABLE II.
WATER HEATED THROUGH VARIOUS SUBSTANCES.

Thickness of each substance .....1 inch
Temperature applied to each.....310 deg. Fahr.
Temperature increase of water in each case ..... 10 deg. Fahr.

	Substances	No. lbs. of water heated.
1.	Loose wool	8.1
2.	Loose lampblack (soot))	9.8
3.	Hair felt	10.3
4.	Carded cotton wool	10.4
5.	Fine asbestos	49.0

A perfectly clean boiler tube, one-eighth inch thick, will transmit forty times as much heat as will a tube covered with one-inch thickness of soot.

The loss in heat conductivity of boiler plate, due to soot deposit, may be noted in the following table:

TABLE III.

Thickness of soot.	Per cent. of loss.
Clean pipe	0.0
1-32"	9.5
1-16"	26.2
1-8"	45.3
3-16"	69.0

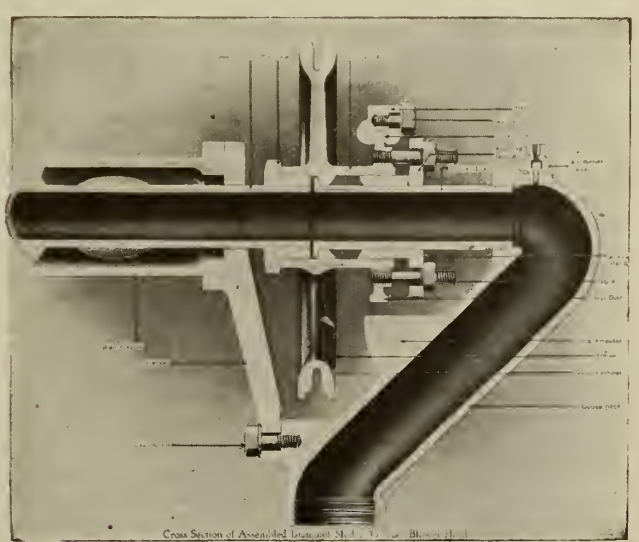
Fortunately soot does not collect on all surfaces of a boiler in the same proportion. Some portions may be fairly clean while others are thickly coated. This does not lessen the fact that there is a wasteful expenditure of fuel and heat wherever a portion of the tubes are coated.

What Soot Is

The principal constituent of "pure soot," or lamp black, is carbon. Mixed and associated with this carbon are various tar products and acids.

Soot, as found in steam boilers, varies considerably in appearance and composition, depending upon the grade of coal burned, conditions of combustion, and the part of the furnace from which the sample is taken. Nearest the fire the deposits formed consist largely of ash. Analysis of samples of soot taken from the first pass of a boiler shows in addition to the "pure soot" the presence of silica, alumina, iron oxide, various alkalis and sulphur dioxide.

In color, soot varies from black to grey, greyish white, greyish green, greyish blue, brown, and reddish brown.



CROSS-SECTION OF DIAMOND MODEL G SOOT BLOWER HEAD.

In all but the coolest portion of the setting soot is usually gritty in texture. The grains may be as large as medium sand, or as fine as cigar ash. These particles are in a plastic state when they leave the furnace, and striking the lower portion of the boiler they adhere to the tubes.

If this deposit is not removed frequently it quickly increases in amount and changes in character. The carbon burns out in part and the mass cements together. The repeated reduction in heat-absorbing surface increases the temperature of the flue gases, so that the process of cementation is continuous and constantly increasing in intensity. An extremely hard, clinker-like formation results. In a short time the space between the tubes in some portions of the boiler is entirely blocked, thus materially reducing its capacity. In this condition mining operations alone will remove the deposits.

A bad feature of these deposits is that if they are allowed to remain, the corrosive action of the various constituents of the soot is exceedingly apt to cause leaky tubes. Under the influence of heat, a ferrous carbonate is formed. The excess of air that is always present brings free oxygen in contact with the ferrous carbonate and the reaction produces ferric oxide and carbonic acid. Carbonic acid, particularly in the presence of free oxygen, acts very rapidly on the metal of the boiler. Another source of corrosion is the sulphur dioxide in the soot which changes first to sulphurous acid and then to sulphuric.

Only the boiler-insurance companies know how many boilers are condemned annually as unfit for operation, years before their natural period of service would terminate. That the number is very high we know, for cases are constantly coming to light.

Hand Cleaning Not Effective.

It is a mistake to think that soot can be removed by the hand-hose method (using steam, through rubber hose and nozzle). The use of this system arose in the sheer necessity for removing some of the deposits from the tubes. It is admittedly an inefficient and expensive process as well as being an extremely disagreeable and, to a certain extent, dangerous task.

Two men are required, one close up to the boiler setting, frequently on a ladder (a delightful position on a hot summer day) and the other at the steam valve. The time employed is usually from 20 to 30 minutes. The nozzle is inserted, the spray of steam goes into the boiler, but whether it reaches all of the soot-covered parts of that section the fireman doesn't know. There is a large section near the cleaning door which he cannot reach at all. He is using a large supply of steam and he is letting an immense amount of cold air into the furnace. When he moves to the next location he will blow some of the soot back.

Says the author of "Furnace Efficiency":

"I was talking one time with the manager of a very modern power plant in the very modern city of Minneapolis. We got around to the subject of soot and the engineer said: 'I will show you that we keep our boiler tubes clean.' He raised the slide from one of the blow holes at the first pass in the boiler. There was a good light from the furnace just below the tubes and we had a fair view of them. They were reasonably clean. We then went to the back pass of the boiler but there was no light from the furnace there and we could see nothing. While the engineer was in search of a light I found a piece of gas pipe about six feet in length, and thrust this through one of the blow holes in the last pass and across the tubes of the boiler. I could tell by the feeling of the pipe that there was a surprise in store for my engineer friend. The flashlight showed furrows an inch deep where I had plowed with the gas pipe across the top of the tubes.

"Now, it is evident that the man who had charge of cleaning these tubes had not finished his job. He had blown soot from the first pass back into the second and from there to the third. Then he had stopped. Now, if things like that can happen in a well-regulated plant, what can we expect to find in plants that are not regulated?"

To clean off soot properly all of it should be blown off from the tubes. To blow it from one locality to another does not help much. It is no uncommon thing to find soot so thickly packed into the corners, along the side walls of a water boiler that you could use a hoe and shovel in removing it.

You want your boiler tubes to conduct heat as rapidly as possible to the water within the tubes. If you want to keep up steam when the soot piles up you will have to pile in more coal.

The Five Essentials in Preventing Soot Waste

The five essentials in preventing waste are:

1.—Frequency in cleaning in order to minimize the cumulative effects of increasing deposits. Tubes should be cleaned three to six times a day.

2.—Thoroughness in cleaning, in order to maintain high furnace and boiler efficiency, and prevent the destructive corrosive effects of soot accumulation.

3.—Availability of system; the soot-cleaner system should be instantly available, automatic in action, capable of rapid operation

4.—Durability of system; the blower units should be so designed and constructed that they will withstand the stress of hard service when placed in the hottest portions of the boiler without necessity for frequent repair or replacement.

5.—Economy of operation: The soot-removing system should require less steam and labor than hand blowing; it should be so installed as to prevent the entrance of cold air into the furnace during its operation; it should pay for itself from an investment standpoint.

Soot Blower Tests

The following extract is an excerpt from a report by J. A. Moyer, member A.S.M.E., professor of mechanical engineering, Pennsylvania College, covering a comparative test on a B. & W. boiler at the college power house, equipped with the Diamond soot-blower system.

The comparison was made, as regards operation, by making two tests with the usual method of hand cleaning the tubes with a steam nozzle, blowing them off every twelve hours. A second test was made when the Diamond soot blower was used for cleaning the tubes every three hours. Clearfield coal, having a heating value of approximately 13,650 pounds B.t.u. per pound of dry coal, was used in all of these tests. The actual heating value was determined with an oxygen bomb calorimeter for each test and the efficiency then calculated on this basis. Duration of tests one and two, was approximately eight hours, while tests three and four were run for 24 hours.

Load Conditions Good.	Test No. 1 Without soot Cleaner	Test No. 2 With soot Cleaner
Water evaporated per lb. of coal as fired, lbs.....	8.06	8.72
Equivalent water evaporated from and at 212 deg. per lb. of coal as fired, lbs...	9.50	9.97
Equivalent evaporated from and at 212 deg. per lb. of dry coal, lbs.	9.61	10.06
Efficiency, including grate, per cent.	68.3	71.5

Saving of coal $\frac{71.5 - 6.83}{.683} = 4.7\%$

That the power plant operators of Canada recognize the value of mechanical soot blowers is evident from their large volume of purchases of this equipment.

COMBUSTION CHAMBER

The space back of the bridge wall in the ordinary horizontal tubular boiler, and any space that may be equivalent to it in boilers of other types, is known as the "combustion chamber." The gases from the fuel-bed, and any supplementary air that may have been admitted at the fire doors or elsewhere, should have become thoroughly mixed by the time they have passed the bridge wall; but the chemical combinations that begin at the fuel-bed are still incomplete, as a rule. The combustion chamber is in effect a local enlargement of the general channel followed by the hot gases, and it serves to temporarily check their velocity and afford time for the completion of the oxidation. To accomplish this end properly, the combustion chamber should be ample in size, and it should be kept well cleaned out. Otherwise the fine particles of coal and ash that lodge in it will collect until the entire space becomes nearly choked up. A combustion chamber thus neglected fails to fulfil its mission, because it does not prevent the gases from passing swiftly onward to the tubes, and becoming thereby chilled, by intimate contact with the relatively cool surfaces of the boiler, so that further combination does not occur.

Transformer Connections for Power Transmission

The Various Types of Transformer Connections in Common Use Are Described and the Electrical Characteristics of the Resulting Circuits Are Gone Into Fully—A Number of Connections Are Described Which Are Not in General Use

By GORDON KRIBS

THE development of the modern alternating current transformer dates from twenty-five years ago, when it was just emerging from the experimental stage. It was the invention of the alternating current transformer which made possible the use of the alternating current system of long distance power transmission. True, a few long-distance direct-current systems have been installed under the Thury patents, but they have not been a practical success. Previous to the invention and application of transformers to alternating current work, all electrical distribution was direct current. The main advantage of alternating as compared with direct current transmission and distribution is due to the ease with which electrical power can be transformed from one voltage to another, which alone makes long distance transmission of electric power economically possible.

The purpose of this article is to describe a few of the more common methods of connecting up single-phase transformers to the various systems of electrical distribution to produce the desired results under definite given conditions.

In order to fully understand such matters it is necessary to review the properties of single, two and three-phase currents.

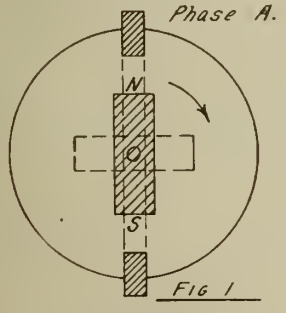


FIG. 1—ELEMENTARY SINGLE PHASE MACHINE

Fig. 1 represents a single-phase machine with a single armature coil. The field consists of a permanent magnet with a north and south pole. The current generated in such an elementary machine is alternating, the frequency depending on the speed. It is apparent that to generate one complete cycle the field has to turn through a complete circle, which is equivalent to 360 degrees. The maximum voltage in the armature coil occurs when the field is in the position shown full. When the field is in the dotted position the voltage wave is passing through zero, and when the field is again in the full position with the poles reversed the voltage wave is again maximum in the negative direction.

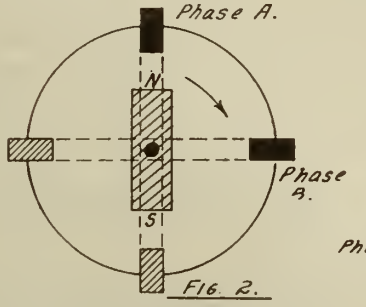


FIG. 2—ELEMENTARY TWO PHASE MACHINE.

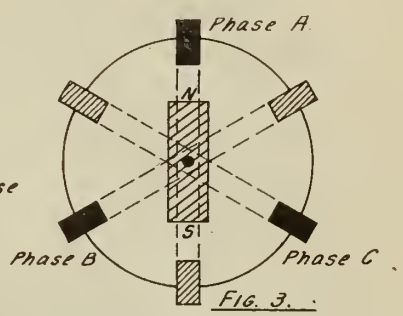


FIG. 3—ELEMENTARY THREE PHASE MACHINE.

Fig. 2 represents an elementary two-phase alternator with one coil only in each phase, the revolving field consisting of a permanent magnet with a north and south pole. The current generated in each of the coils is alternating, the frequency depending on the speed. To generate a complete cycle in each of the coils or phases, the field must revolve through 360 degrees or a complete circle. The maximum voltage occurs in phase A when the field is in the position shown. In order that the voltage in phase B may reach a maximum the field has to turn through ¼ circle or 90 degrees. It is thus apparent that in a two-phase circuit the one-voltage wave is 90 electrical degrees ahead of the other and hence a two-phase circuit is sometimes called quarter phase.

Fig. 3 represents an elementary three-phase machine with one coil only in each phase and a single permanent magnet field as before. It will be seen that the field must travel 120 degrees, or one-third of a circle from position of positive maximum voltage in phase A to position of positive maximum voltage in phase B and similarly for phase C, so that it is readily seen that the voltage waves in a three-phase circuit are 120 electrical degrees apart.

Description of Transformer

The constant potential transformer consists essentially of one or more primary coils and one or more secondary coils wound on an iron core and carefully insulated from each other and the core. It is usually assembled in some form of outer protecting case and the intervening space filled with insulating fluid such as oil, which acts not only as an insulator but also as a means of carrying the heat generated within the transformer to the casing and thence to the outer air. If the primary winding of a transformer were connected to a direct current source of power of the proper voltage it would constitute a short circuit. On account, however, of the systematically changing value of alternating currents, the magnetic flux produced in the iron core generates a voltage in the primary winding which is opposed to the incoming or line voltage. This counter voltage holds the current down to normal value which, neglecting losses, is just sufficient to produce a voltage in the primary coil equal and opposite to the incoming voltage. If a current flows in the secondary it is opposite in direction at any instant to that in the primary coil and tends to neutralize the flux generated by the primary and hence lowers the counter voltage and this automatically allows more current to flow in the primary as the load in the secondary increases.

Since, ignoring leakage, the same magnetic flux passes through both primary and secondary coils it is apparent that the ratio of the primary to the secondary voltage of the transformer is the same as the ratio of the number of turns in the primary to the number of turns in the secondary. Thus, if the primary has 2,000 turns and the secondary 200, the ratio of turns is 10 to 1 and the ratio of primary to secondary voltage will be 10 to 1, viz., if the primary voltage is 2,200 volts, the secondary voltage would be 220 volts.

Vector Diagrams

Many problems involving relations resulting from various transformer connections can be readily solved by means of vector diagrams. Take the case of the single-phase transformer, Fig. 4.

The primary coil is connected across the mains, having a voltage of 2,000 volts, and the voltage across the secondary A to C is 200 volts, i.e., the ratio with the two secondary coils in series

is ten to one. It should be noted that at any particular instant the currents in the primary and secondary coils flow in opposite directions and that the volt-

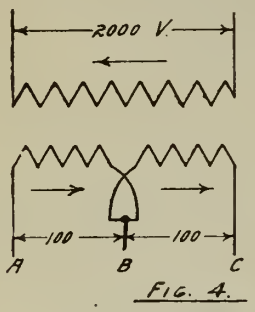


FIG. 4—SINGLE PHASE TRANSFORMER.

ages in all coils of the transformer are in phase, i.e., reach maximum and minimum values at the same instant.

Any voltage may be represented by a straight line of a certain length according to the scale used. Thus, in the above example a line 1 in. long may represent the voltage A B=100 volts. If we wish to add the voltage B C, which is in phase with A B, it is merely necessary to draw another line 1 in. long from the end of the first one and in line with it, the total length being 2 in., and on the basis of our assumed scale representing 200 volts.

In the case of a two-phase transformer combination as shown in accompanying sketch, Fig. 5, we have two transformers

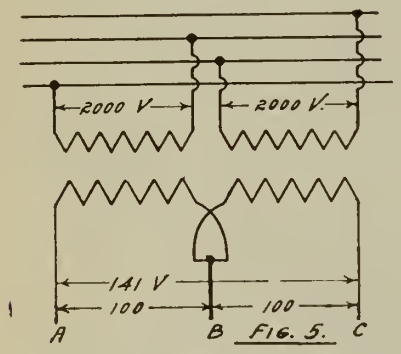


FIG. 5—TWO PHASE TRANSFORMER CONNECTION.

connected to a four-wire two-phase system with their secondaries connected for three-wire, two-phase, wire B acting as a common return for both phases.

As pointed out previously the voltage waves are 90 degrees out of phase with each other. To represent the voltage relations by means of vectors,

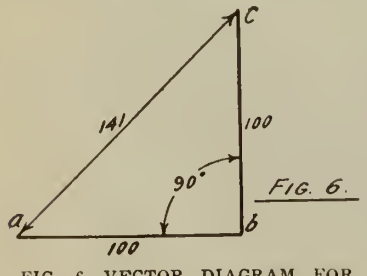


FIG. 6—VECTOR DIAGRAM FOR TWO PHASE CONNECTION.

draw line a b, Fig. 6, of such length as to represent 100 volts, and from 6, draw b c, at 90 degrees to a b, to represent 100 volts at 90 degrees phase relation with a b. Now the distance a c to the same scale represents the voltage between the two outer wires, which, when scaled off, is found to be 141 volts in-

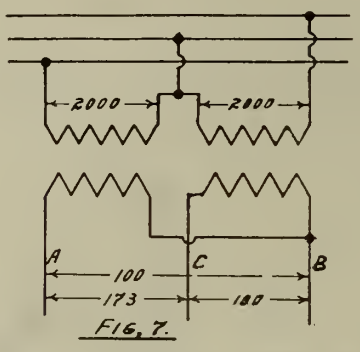


FIG. 7—THREE PHASE TRANSFORMER CONNECTION.

stead of 200 as in previous example. It should be noted that 141 volts is the equivalent of 100 volts $\times \sqrt{2}$, in other words the sum of the two equal voltages in a two-phase circuit equals either voltage multiplied by $\sqrt{2}$, to 1.41.

In the case of a three-phase transformer combination we will assume that we have a transformer connection similar to that shown in Fig. 7.

As pointed out previously the voltage waves of a three-phase alternating circuit are 120 degrees out of phase with each other. If we draw a line a b (Fig. 8) one inch long to represent the voltage

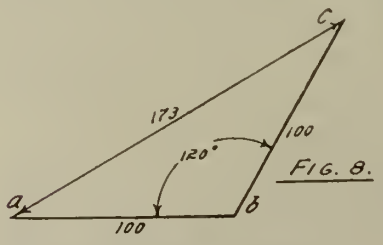


FIG. 8—VECTOR DIAGRAM FOR THREE-PHASE CONNECTION

A B = 100 volts, then the voltage B C may be represented by the line b c, which is one inch long and makes an angle of 120 degrees with a b. The distance a c will represent the difference in voltage between the lines A and C, which in this case is 173 volts. It should be noted that 173 volts is the equivalent of 100 volts $\times \sqrt{3}$.

SYSTEMS OF TRANSFORMER CONNECTIONS

For the purpose of making a preliminary study of transformer connections, the various systems may be divided into the following groups:

(A) Single-phase connections.
(B) Two-phase connections.
(C) Three-phase connections.
(D) Two-phase—three-phase connections.

We will consider them in the order named.

(A) Single-Phase Connections

The ordinary single-phase transformer such as is used on distributing systems consists of two circular primary coils and two similar secondary coils.

The primary coils are ordinarily connected in series for 2,200 volts, while the secondary coils have all their terminals brought out and can be arranged either in series or parallel. Sometimes the high-tension coils are arranged with reduced voltage taps so as to take care of poor line regulation.

In Fig. 9 we have a standard lighting transformer with its secondaries connected in parallel for a 110-volt 2-wire light-

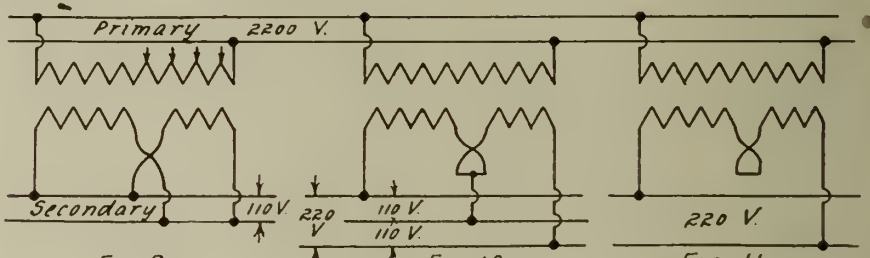


FIG. 9 110 VOLT, 2 WIRE CONNECTION.

FIG. 10—THREE WIRE, 220 110 VOLT CONNECTION

FIG. 11—220 VOLT CONNECTION

ing main. The two secondary leads in the centre are ordinarily crossed before bringing them out of the case as shown in the diagram. Reduced voltage taps are shown on the high-tension winding.

In Fig. 10 we have a standard lighting transformer with secondaries connected in series with a tap taken off the middle or neutral point for 110-volt-220-volt, 3-wire lighting mains.

In Fig. 11 the secondaries are shown connected in series for 220 volt power service.

Transformers may also be connected in parallel with their secondaries supplying the same set of secondary mains. Care should be taken in connecting transformers in parallel to see that the polarity of the transformers is the same. One transformer might have either its secondary or primary winding wound in the opposite direction with respect to the other, in which case corresponding leads of the secondary would be opposite polarity, and if connected in this manner would produce a short circuit. Interchanging leads on one side or reversing the order of bringing the leads out of

the case will also reverse the polarity. In connecting a transformer in parallel with another already in circuit, one side of the secondary should be fused lightly before the primary plugs are inserted in order to protect the transformer from damage in case the potential is reversed.

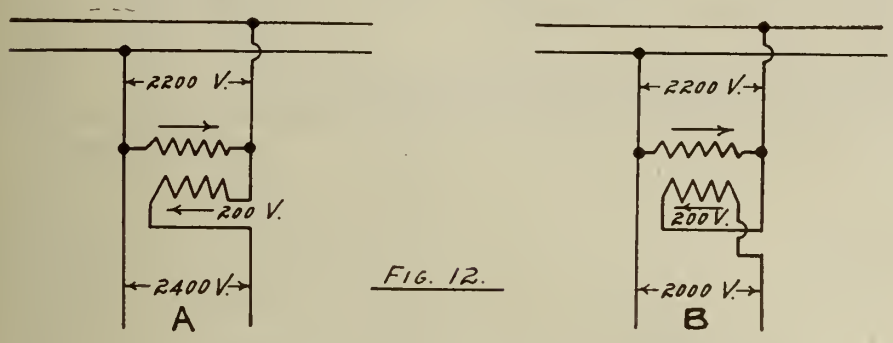


FIG. 12—METHOD OF RAISING OR LOWERING VOLTAGE.

If the fuse does not blow, the secondary may be connected in permanently. Some companies make it a practice of fusing the secondary of all transformers in parallel. Transformers in parallel are particularly subject to burn-out, since if one transformer during a period of heavy load becomes damaged and the fuses blow from this or any other cause, it throws an additional load on the other transformers in circuit with it and they will probably burn out one after another.

Sometimes it is found that the primary voltage on a certain line is too low, and that it is advisable to increase it, or possibly it is too high and it is desirable to lower it. This may be done by means of a boosting transformer, which is merely an ordinary lighting transformer connected in as shown in the following diagrams:

In Fig. 12A, an ordinary lighting transformer is connected in circuit so as to increase the voltage in this branch main from 2.200 to 2,400 volts.

In Fig. 12B the transformer is connected to buck the primary voltage and the voltage in the branch main is thereby reduced from 2,200 to 2,000 volts. Transformers arranged for either bucking or boosting should be connected in solid and without fuses—otherwise abnormal voltages will be produced in the transformer in case a fuse blows. Care should be taken to select a transformer for this purpose whose secondary has sufficient current-carrying capacity to carry all the current flowing in the main. Thus, in either of the above examples if 100 amperes is flowing in the main, a 20 kw. transformer would be needed for a booster.

(B) Two-Phase Connections

As pointed out previously a two-phase circuit is simply two single-phase circuits in which there is a fixed phase relation between both the voltage waves and current waves of 90 electrical degrees. Ordinarily two-phase power is transmitted over four wires—there being no electrical connection between phases either primary or secondary.

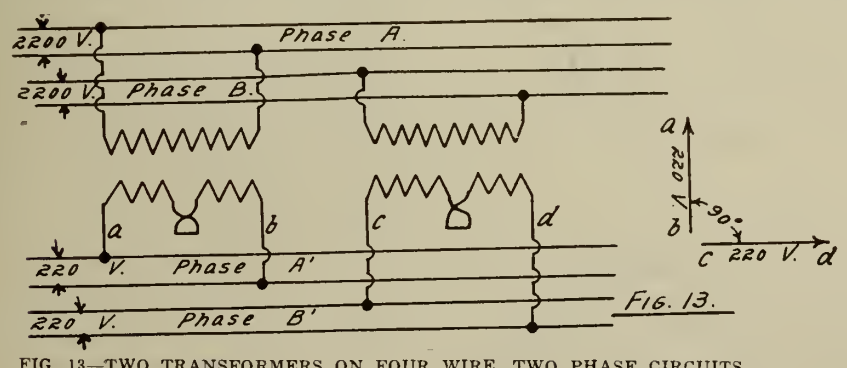


FIG. 13—TWO TRANSFORMERS ON FOUR WIRE, TWO PHASE CIRCUITS.

In the diagram, Fig. 13, we have the ordinary method of connecting two transformers on to two-phase circuit.

Sometimes, however, the two central wires of a two-phase system are combined into one which is common for both phases and carries 141 per cent. as much current as the other two wires. In this case the transformer connections are as shown in Fig. 14.

It should be noted that the voltage between the two outer wires of the primary is in this case 3,120 volts instead of 2,200, also that the voltage across the two outer wires of the secondary is 312 volts. This is readily seen by reference to the vector diagram. By taking a tap off the middle point of either transformer 110 volts for lighting purposes can be obtained between this tap and either of the other leads of the transformer. The voltage difference between X and Y is 156 volts. Thus four different voltages may be secured from this combination viz., 110, 156, 220, 312 volts. It would be necessary, however, to have a 5-wire secondary to make these various voltages available.

(C) Three-Phase Transformer Connections

A three-phase power circuit is a combination of three single-phase circuits so arranged that the voltage and current waves in each circuit have a definite phase relation of 120 electrical degrees with either of the other two. Ordinarily three wires are used to conduct these three single-phase currents, each wire acting in turn as a return circuit for the other two. Sometimes, however, a fourth or neutral wire is used under circumstances such as will be explained later.

The most common methods of connecting transformers in three-phase systems may be enumerated as follows:

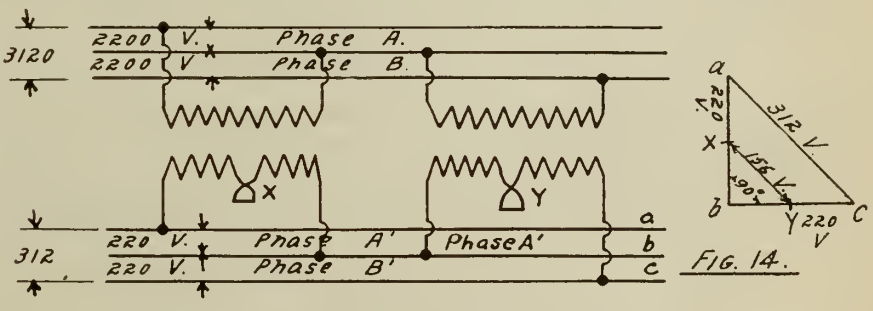


FIG. 14—TWO PHASE, THREE WIRE CONNECTION.

1. Delta to Delta.
2. Delta—Star (Y to Y).
3. Delta to Star.
4. Star to Delta.
5. Open Delta.
6. T connection.
7. Open Y—Open Delta.
8. Three-phase Booster connections.

1. Delta to Delta Connection

In the Delta-Delta connection three transformers are used and the system is so called from its supposed resemblance to the Greek letter D, or Delta.

All three transformers are connected in series, the end of one coil is connected to the beginning of the next, making the circuit complete with three junction points, one live wire being attached to each of these points, as in the accompanying diagram, Fig. 15.

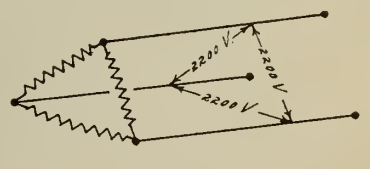


FIG. 15—DELTA CONNECTION.

In the Delta-Delta connection, both primary and secondary are connected in this manner.

An example of a three-phase Delta-Delta connection is given in Fig. 16. In this case we have a three-phase, 2,200-volt line, and desire to secure a three-phase 220-volt power circuit and one 110-volt lighting circuit.

It should be noted that the three transformer coils connected in the Delta form a closed circuit by themselves and that the line wires are attached to these points.

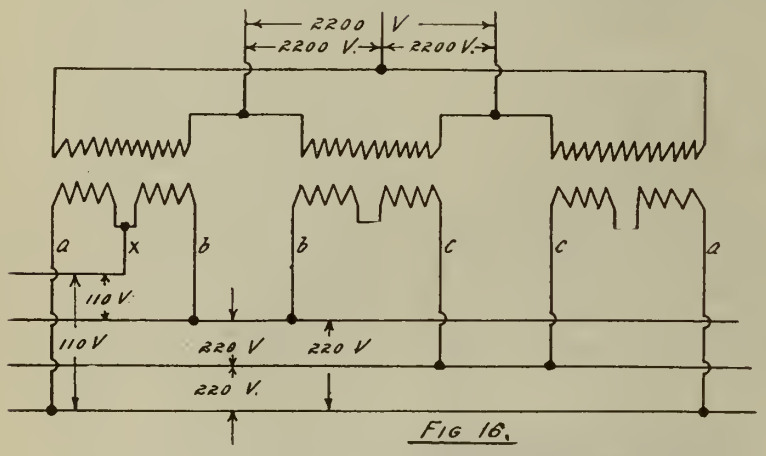


FIG. 16—THREE-PHASE DELTA-DELTA CONNECTION.

In order to fully understand the conditions existing in the secondary of a bank of transformers connected as in the above diagram, it is well to draw a vector diagram. Proceed as follows:

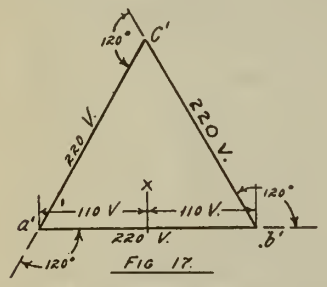


FIG. 17—VECTOR DIAGRAM FOR DELTA CONNECTION.

Draw a' b', Fig. 17, to such a scale that it represents 220 volts, i.e., the voltage across the transformer terminals a-b. The voltage b' c', is also 220 volts and can be represented by the same length of line, but there is 120 degrees phase difference between 'a b' and b' c'. Hence mark off an angle at b' equal to 120 degrees, and draw b' c' equal to 220 volts. Similarly c' a' represents the voltage across the terminals c-a. The completed diagram represents the line voltages in magnitude and phase—the line voltage and the transformer voltage being identical in the Delta connection and hence the primary voltage of the transformers must be the same as that of the incoming line. The current-carrying capacity of the transformers however, need be only 58 per cent. of that of the incoming line, or in other words the current in the line is 1.73 times that in the windings of any one of the transformers in a Delta group. This may be explained as follows:

In a Delta-connected bank of transformers we have two transformers in parallel, taking current from or giving current out over one line. These currents, like the voltages, are not in phase with one another, but are 120 degrees out of phase, hence they cannot be added numerically, but must be added vectorally as in Fig. 18. It is thus seen that if we have two transformers of a delta group each supplying 100 amperes to the same line, the line current will not be 200 amperes, but only 173 amperes, or 1.73 times the current in each transformer, and the current in each transformer winding will be 100 amperes, so that the current in each transformer will

$$\frac{100}{173}$$

be ——, or 58 per cent. that of the line current.

It should also be noted that at unity power factor the line current is out of phase with the transformer current by 30 degrees. The transformer current and transformer voltage, however, are in phase at unity power factor.

In the case of Delta-connected transformers, if one transformer is burned out or otherwise disabled, it is quite possible to continue to supply three-phase service after the disabled transformer is cut out, although the capacity of the bank will have been reduced to 58 per cent. of its capacity with three transformers. This will be further explained under the V or Open-Delta connections.

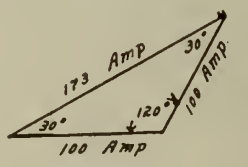


FIG. 18—CURRENT VECTOR DIAGRAM FOR DELTA CONNECTION.

(To be Continued)

BANKING FIRES

When the boilers are to be put out of service for a short time, but are nevertheless to be kept hot and ready to be restored to use within a few hours, it is customary to "bank" the fires instead of drawing them or allowing them to burn out. The operation of "banking" consists in disposing of the fires so that they will cease to burn actively, the combustion being reduced to the lowest limit that is compatible with the maintenance of the ignition. In this way unnecessary and wasteful loss of fuel is avoided, while at the same time a large body of intensely hot coal is maintained in a condition that makes it possible to start up the fire again very easily, and with little loss of time or material.

Fires that are to be banked should first be well cleaned, and a supply of fresh coal should be thrown upon the grates and allowed to become well ignited. The dampers should next be nearly closed, and the fires pushed back against the bridge wall so as to leave the front part of the grates bare. The fires should then be entirely covered with a considerable supply of fresh coal, the front part of the grates being still left bare, however, so that any air that enters the ash-pit may pass up into the furnace freely, and over the deadened fire instead of through it. Some firemen haul the fire forward, and bank it in a windrow across the front of the furnace. It will keep best if covered with fine, damp coal, well tamped down; for a crust then forms over it which excludes the air so effectively that the fire will often remain alive for two or three days.

Coal-gas is slowly distilled off from a banked fire, and to guard against accident from the ignition of explosive mixtures of gas and air in the furnace and the passages connected with it, care should be taken to ensure sufficient ventilation of the furnace and its connections by permitting a small quantity of air to stream continuously up through these spaces and out into the stack. The ash-pit doors should be closed tightly, and the damper in the uptake of the boiler should be as nearly closed as is compatible with the maintenance of the ventilation to which we have just referred. To guard against the accumulation of explosive gas mixtures, dampers are usually perforated so that they will pass a small amount of air even when they are set squarely across the uptake, and when such a perforation exists it will usually afford sufficient protection against gas explosions, provided a circulation through the furnace is made possible by admitting a slight amount of air above the grates. The fire doors should be opened by a mere crack, if the furnace is of the usual type; but if it is built with a hollow bridge wall as previously explained the air needed for ventilating the setting may be admitted by way of the bridge wall openings.

Our Question Box

What is Heat? Heat is a form of energy. By touching a body we can tell whether it is warmer or colder than the hand and by touching two such bodies in quick succession we can form a rough opinion as to their difference in hotness or coldness over a limited range, the colder body, if of the same material and of the same size, will contain less heat than the hot body or less energy is stored up in it in the form of heat. From physical reasoning it is possible to conceive of a body which has no heat at all and this body will have a temperature of absolute zero. This point has never been reached by experimental methods but has been approached to within a few degrees.

What is Cold? Cold is merely the absence of heat and in the usual sense it is used in comparing one body with a hotter one.

How is Heat Measured? By means of a thermometer which measures the temperature of the body and by means of its specific heat or the amount of heat which it contains. The amount of heat in a body depends upon its temperature and upon the material of which it is composed as well as upon its mass. Some materials require a greater amount of heat to raise them through one degree of temperature than others, for instance water requires about eight times as much heat to raise it through one degree as cast iron for equal weights.

How Was the Thermometer Discovered? The thermometer was discovered by Galileo, who first developed a thermometer having a tube with a bulb at the top. The tube dipped into a colored liquid. Temperatures were indicated by the expansion or contraction of the air in the tube and bulb, which caused the liquid to be drawn up or forced out the tube. While sensitive this thermometer wasn't very satisfactory for it was subject to fluctuations according to barometric pressure. The more modern form of thermometer with a bulb, a sealed tube and a contained liquid is also attributed to Galileo, about 1612.

Alcohol was the first liquid used and the graduations employed on the Fahrenheit thermometer were proposed by Gabriel Daniel Fahrenheit in 1714. He proposed to take as zero the lowest temperature obtainable by a mixture of ice and salt and to divide the space between this point and that of the temperature of the human body into 96 degrees. The fixed points were afterwards chosen at that of melting ice and that of boiling water at standard atmospheric pressure. This with the old divisions retained gave 32 deg. for melting ice and 212 deg. for boiling water.

For general scientific purposes the centigrade system is usually adopted. This has the zero freezing point marked zero, and the boiling point 100 deg., giving 100 degrees in between. The absolute zero spoken of above is 273 deg. Centigrade below the Centigrade zero.

How are the Fahrenheit and Centigrade Scales Converted from the One to the Other? Nine Fahrenheit degrees equal five centigrade degrees and this gives us a means of converting from one to the other. One other thing must be remembered and that is the difference in the marking of the freezing points, Centigrade, 0 deg., and Fahrenheit, 32 deg. To transform Centigrade to Fahrenheit then multiply by nine, divide by five and add 32 deg. To transform Fahrenheit to Centigrade, first subtract 32 deg., then mutiply by five and divide by nine.

If a Fahrenheit Thermometer Gives the Temperature of a Bearing as 62 deg., What Temperature would be a Centigrade Thermometer Read? Subtract 32 deg., multiply by five and divide by nine. The result will be 17 deg. (nearly).

What is Meant by a British Thermal Unit (B.T.U.)? A British Thermal Unit is the amount required to raise the temperature of one pound of water through one degree Fahrenheit from a temperature of 60 deg. Fah. The temperature from which the water is to be raised is specified because the amount of heat necessary to raise the water through one degree varies slightly with different temperatures. What is it a measure of? It is a measure of the quantity of heat.

How Many B.T.U.'S are there in a Pound of Good Coal? Good coal runs from 13,000 up to 14,500 B.T.U. per lb. These figures are of course only approximate and coal varies greatly in its calorific value.

What is the Mechanical Equivalent of Heat? The mechanical equivalent of heat is the number of foot-pounds of mechanical energy equivalent to one British Thermal Unit. The most probable value is probably 778 foot-pounds to one B.T.U.

If all the Heat in One Pound of Coal Could be Turned into Horsepower, How Many Horsepower Hours Would be Produced? One heat unit or one B.T.U. equals 778 ft. lbs. Assuming a value of 14,000 B.T.U. for one pound of coal the number of foot lbs. of work stored in it will be $14{,}000 \times 778$. One horsepower hour equals $33{,}000 \times 60$ foot lbs. Therefore the number of horsepower hours will be $14{,}000 \times 778 \div 33{,}000 \div 60 =$ 5.4 h.p. hours.

DAMPERS

The damper in the flue leading to the chimney or stack is intended for regulating the fire, and thereby controlling the steam pressure also. It is much better to check the draft by closing the damper partly or wholly, rather than by opening the fire doors so as to admit cold air into the furnace. The damper should be nearly closed when firing or cleaning fires, to prevent chilling the boiler by the large quantity of cold air that would otherwise be drawn into the furnace. Just enough draft should be left on, at these times, to prevent flames or hot gases from rushing out through the fire doors when they are opened. Automatic regulators are now common, for closing the dampers when the steam pressure exceeds some predetermined value. They are actuated by the pressure of the steam against a piston or a flexible metallic diaphragm. In heating residences by steam, automatic damper regulators (usually of the diaphragm type in this case) are almost a necessity; because if they were not employed it would be necessary to have an attendant nearby during the entire day.

LEAKAGE THROUGH BRICKWORK

Care should be taken to keep the joints of all the brickwork about the boiler tight, so that air cannot leak in through any part of the setting, and mingle with the products of combustion. Leakage of this kind chills the furnace gases so that the heat is not absorbed from them with the same readiness, and it also injures the draft. The action of the air that leaks in through the setting is similar, in these respects, to that of the air that enters through the fire doors when they are left open too far. It is not necessary that the openings admitting the air through the setting should be individually large, in order to experience undesirable effects, for the multitude of small chinks that exist in a loosely-built brick wall can unitedly pass a very considerable quantity of air. Leakage directly through the brickwork of boiler settings is much more common than might be supposed, and in many cases there is a serious loss of economy from this cause, which is not detected because its existence is not realized. These considerations show the importance of keeping the brickwork of the setting in good repair at all times.

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Canada's Power Developments

A PRELIMINARY announcement issued by the Commission of Conservation appears on another page of this issue and furnishes interesting information concerning the state of Canada's power development. This report is preliminary to a complete report shortly to be issued by the Commission and shows the importance of water powers in our industrial life.

As might be expected, steam power is used to a greater extent where supplies of native coal are available, as in the Maritime and the Prairie Provinces, while in British Columbia water and coal are both abundant. The most interesting suggestion brought forth is that for the Prairie Provinces, where it is suggested that it would be most economical to generate electric power in large central steam plants and to distribute it over transmission lines.

This suggestion is almost identical with the power centralization scheme now being worked out for England and the economies which will be effected in England could be duplicated here with little effort in some parts of the country where conditions are especially favorable. This use of the Western lignites would make the high tension transmission line as familiar in the West as it is in the Niagara district. The figures, Province by Province, are especially interesting and show how greatly power development is influenced by manufacturing industries. Ontario is well in the lead with a total plant capacity of 899,856 h.p., with Quebec coming next with 625,061 h.p.

The highest head in Eastern Canada is 540 feet at the 8,000 h.p. plant at Eugenia Falls, Ont., while in the West, a head of 1,820 feet is utilized at Britannia Beach, B.C. The total horsepower developed in Canada is shown to be well over 2,000,000.

An Oliver Message of Optimism

THERE'S something in the attitude of the Oliver Machinery Co. of Grand Rapids, Mich., that is well worth noting just now. They state that business has been good with them and they are not afraid to stand up and say so.

Why not others? We have had a regular procession of reports about cancellations of contracts and the subsequent difficulty of readjustment. We have been getting yards of material about firms "waiting" to see if there is going to be any change in the price of raw material. But there are few—mighty few—who are coming right out into the open and owning up to the fact that business is good enough to earn them three meals a day.

Here is what the Oliver people have to say about it:

"The month of January, 1919, showed the biggest shipment the Oliver Machinery Company has made in their history. Part of this is due, without question, to the fact that our export business has replaced some of the domestic business of previous months. Old export orders were allowed to be filled because of shipping conditions improving.

"Orders received during the month of January were also very gratifying, being within 10 per cent. of our average monthly business for the past year, while a part of our business, and we might say a substantial part, is export. At the same time, every time we receive an order for a carload of machinery for export we must bear in mind that we have to purchase a certain amount of steel, which purchase is domestic business. We have to purchase almost a carload of cast iron, which is indeed domestic business, etc., until all of the parts that go into our machinery are ordered. We hope that other people who are actually enjoying a good volume of business will publish the fact in the hope that those who are putting off purchases unnecessarily will see the error of their ways."

That message ought to be passed on. There's nothing so bad for the dumps as to find out that some person else has 'em. There's nothing that will help along a feeling of doubt and pessimism like a sermon from a man who is a regular honest-to-goodness pessimist himself. And there's nothing that will cure this thing so effectually as a good dose of "business is good" talk from men who are honest enough to say so.

All You Could Have Done Was Kill Us

Meester Editor:—

Some time ago I tol you about dat inspector not letting me run ze power machines because I could not answer some question. Well, I go back and tell ze Boss I better tak ze job cleaning everything and ze boilers, and for hem to get some ozzer feller with a cer-tif-i-cat. Ze Boss say "sure"—your pay will now drop to eight bucks ze week. Sack-ree, zat only pay for my board. Well, I mak up my mind I read and learn. One day ze Boss come along when I am sit and read and learn about not waste exhaust steam, and ozzer zings. He say, Batistee, what ze blazes you do for a living? I say, nozzong Boss. Ha he say, by gar I zink so to. Better do something if you want to stay around here. Just den, bang, roar, goes ze steam from ze safety valve. I say, Boss, I just am reading about dat exhaust steam, every clowd wasted is a big dollar bill los, why not hitch ze feed water heater to ze safety valve. He say, by gar, if dat new feller got cer-tif-i-cat it must be to waste steam. Just den, zip, plunk, plunk, ziss, ziss, go ze blow down, dat cer-tif-i-cat feller had let ze water get to high in ze boiler. I say Boss, I just been reading about wasting hot water, every few gallons trew away means more dollar bills gone, better hitch dat blow down pipe to ze baths. Sacre-dam, said he, what dat certif-i-cat feller means anyhow. Just den, fizz, fizz, fizz, goes de blow down pipe on one of ze boiler skimmers. De Boss jump in ze air and say a lot of cuss words. Be hevins, said he, is the devil trying to blow ze insides all out of ze boilers. I zink ze Boss is Irish. I say Boss, I just been reading about dose skimmer zings, every time dey is blown down when zey should not, dere is a waste of steam. He yell, the Lord help me to kill dat cer-tif-i-cat feller. Just den ze whistle start to shriek for ze quit at noon. I say, Boss, I just been reading zat during dese times ze whistle she should be only blow about half as long as before. Zen ze Boss yell, blast you Batistee, you and your reading, why did you not have dat cer-tif-i-cat. All you could have done was kill us, ze other feller will ruin us, which is a lot worse. Boss, I say, I just been reading zat ze Boss should never get mad before his men, he loze his dignity and zay laugh at him. He yell, Batistee, if you tell me any more about what you have just been reading, I will poke your eyes out wit a crowbar. Where do you get all dat reading anyhow. I say in ze Power House. I soon be able to got dat cer-tif-i-cat my own self. He say, lend me dat book I will show it to ze feller what knows all about wasting steam and water and coal. I gess zat feller got his cer-tif-i-cat when ze law came in force, he sure never was examined. I say, sure, dat is right, but next year some fellers will drop hard if zey are not lak me and start to read and learn. I was only joke when I say to hitch doze safety valve to ze heater and ze other pipe to ze baths. Ze book say it mighty bad to let water get too high in ze boilers, when ze engine run she might go bang on zee cylinder head, and it be better to flow down at ze lowest pressure carried and when ze load is smallest. It say ze skimmers should be blow according to ze dirt in de water used and lots of oder tings lik dat, I tell you Boss, I get zat job back pretty soon when I am a real engineer wid a real engineer's cer-tif-i-cat.

—Batistee Sefor

A LESSON IN THRIFT

A colored gentleman went into a down-town store to buy a suit of clothes. He wanted to pay about $20. In fact he had that much set aside for the purpose.

The clerk, well schooled in the art of making people buy what they couldn't afford to pay for, got the customer prancing around in a $35 outfit, and was telling him that that was the sort of togs he should wear.

The colored man simply smiled, stuck out for a $20 outfit, and remarked: "I never hang my hat no higher than I can reach."

And there's quite a heap of common sense and wisdom in the saying.

Is there anything more painful than witnessing a man with a $2,000 income trying to make a splash that looks like that of his neighbor who reaches through the cashier's wicket for $5,000 per annum?

And yet it's being done all the time. Two dollars can't go as far as five, and two thousand can't do what five thousand can. That looks simple enough, but the people who fail to realize that fact would make quite a heap were they all pitchforked up together.

That colored man preached a pretty fair sermon on "thrift" when he announced his text as "I never hang my hat no higher than I can reach."

Association and Personal

ALBERTA C.A.S.E.

EDITOR, POWER HOUSE: If I can beg sufficient space I wish to show readers of this valuable magazine what The Canadian Association of Stationary Engineers are doing in Alberta.

Several of the most progressive engineers in this district realized the need of a more co-operative feeling among the engineers, so we got together last June and applied for a charter. We have had a hard fight but we have all pulled together and we now have as good an organization as there is to be found in the West.

Our first benefit to the engineer is the indicator. With this we are able to find our engine and piping faults and thus greatly increase the efficiency of the plant and smooth out its operation to the benefit of our employers and ourselves, thus increasing the value of our services. We own an indicator of the best make with a cylinder and piston for ammonia and high and low pressure. Each member has it one week at a time and is instructed in its benefits.

Our service cards are of great value to the employer and the engineer. Each member's experience, education and qualifications are listed and a complete record of him is kept. When he applies for a position our secretary mails this record and references, which we are back of, to the prospective employer. Also, when employers enquire for engineers, these records prove their worth. Since our whole object is to raise the standard of engineers, this is a great incentive to the engineer to try and raise his own standard.

The grading of engineers according to their experience and qualifications is another of our strong points. Since Alberta has a high standard in this line for steam engineers, our efforts are not needed, so we turn our attention to the electrical worker, and steam engineers wishing recognition along this line. We have an examining board, and grant certificates in four grades to those having the required experience and satisfactorily passing the examinations for the respective grades. The requirements are such that any engineer holding our certificates will be able to prove to the public his worth, so that when employers become acquainted with us they will know the value of a member of our organization.

We have received hearty support from the employers here and leading engineers, and the Alberta Government have shown themselves on our side, so we feel that our work is not in vain. It is our ambition, now that the war is over, to keep the engineers up to the high efficiency they tried so hard to maintain during the war. We wish every engineer to wake up and co-operate with us and try to raise his standard of thinking and working and thus help to raise the standard of all.

We are not a union, nor in any way connected with them in the general term union goes. However, we recognize the necessity of such, and know that union is strength, but we also know that strength is not of much value without the guiding hand of intelligence. Trade unionism progresses by strikes and intimidation. The C.A.S.E. never countenances coercive measures to secure justice for engineers. The trade union adopts standard wages regardless of a man's efficiency, but this policy can never be in harmony with the principle of engineering, where individuality and individual ability must always be recognized.

In order to obtain its objects, the C.A.S.E. believes in individual salesmanship of personal services more than collective bargaining, in demonstration of worth rather than demands with threats, in pay according to economic value rather than a pyramiding scale of standard wages, in publicity regarding working conditions that are unsatisfactory rather than methods of force.

We do not mean by this that we are against unionism. We know that with intelligent guidance it has its place and value to the laboring classes, and is often the only means of getting justice for the under man. We are not against the union engineer, we are here to help him and wish him to help us, to come in with us and let us all stand for safety, reliability, economy, and intelligence, and a square and honest deal to employer as well as engineer.

H. E. WIGHT.

TORONTO SECTION A.I.E.E. HOLD INTERESTING MEETING

The manufacture of electrical porcelain was dealt with in a paper read before the Toronto section of the American Institute of Electrical Engineers on Jan. 7, by Hugo J. Lundgren, of Peterborough. Both the wet and dry processes of manufacturing porcelain were described and the various operations were shown by means of slides.

Elements for suspension insulators and similar parts required in quantity are molded in steel dies in a press with special precautions to prevent the clay sticking to the mold. A few years ago a record was achieved by an insulator which took a puncture test of 15,000 volts, the insulator being one of the same size and shape as that used on telegraph lines. To-day, twenty-five years later, with the same raw materials a porcelain is made which will stand a test of 15,000 volts per millimetre. Above seven mm. the dielectric strength becomes less. A greater proportion of feldspar will increase the dielectric stress, but usually at the expense of the physical properties. Under ideal loading conditions the compressive strength might be taken at 8,000 lbs. per sq. in. and the tensile strength 24,000 lbs. per sq. in. in practice.

Canada's raw materials for the manufacture of porcelain are not abundant, and at the present time the kaolin and other materials are imported with the exception of feldspar, of which unlimited quantities are available.

GET THE RIGHT QUANTITY OF AIR

To obtain ideal results, the total quantity of air admitted to the furnace, including that which passes up through the fuel and that which enters at the fire doors or through other openings, should be exactly adjusted to the needs of the fire. The admission of an excess of cold air is wasteful, because this excess serves no useful purpose, and yet it becomes heated in passing through the furnace. The heat that is required to raise this excess air up to the temperature that prevails in the uptake, where the gases leave the boiler to pass to the stack, is entirely wasted. This source of loss is real, and it should be remembered and considered; but as it is practically impossible to admit exactly the right amount of air to the furnace, and to admit it in precisely the right manner, it is exceedingly important to note that it is far better to admit too much air than too little. This is because the loss of heat by the distillation of unburned substances from the coal, and by the escape of the carbon monoxide gas that is usually present in large quantities when the air supply is deficient, is far greater than any loss that is likely to arise from the admission of an excess of air, when the fireman is careful and intelligent.

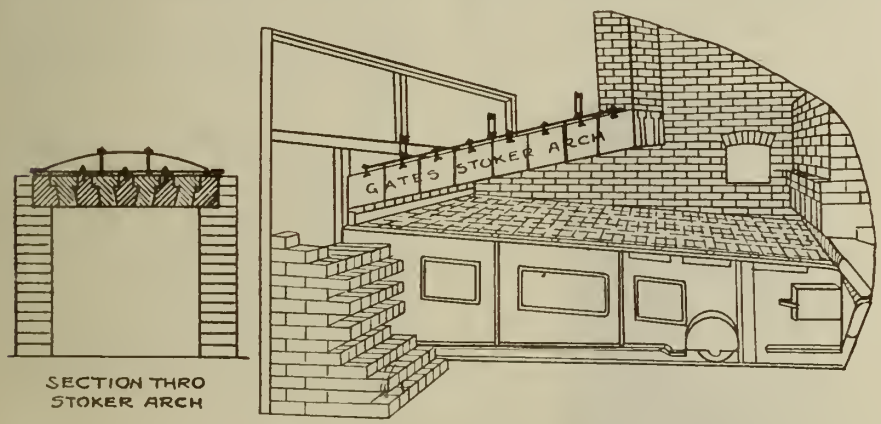
Progress in New Equipment

NEW SUSPENDED AND SELF-SUPPORTING ARCH

THE greatest source of expense in connection with the operation of furnaces, is the destruction of the brick lining in the fire chamber. In many instances it is necessary to dismantle the entire brick work in order to make the necessary repairs. In addition to the cost involved, this method frequently requires the shutting down of the furnace for several days. This objectional feature has often resulted in a furnace being operated much longer than it otherwise would, the consequence being the complete destruction of the brick lining.

To minimize these disadvantages and at the same time effect a saving in the cost of maintenance, several designs of furnace blocks have been constructed by C. W. Gates, Ltd., of Montreal, which have given excellent results. The most recent departure in this respect is the new type of arch block adapted to stoker arches, Dutch oven type of boiler setting, or H. R. T. boiler back arches, and large fire door arches, reverbatory and smelting furnaces. As illustrated in the sketch these arches are constructed on the unit principle, where any single block can be replaced without disturbing the rest of the brickwork. This is made possible by means of the self-supporting and suspended feature of interlocking and keying the various blocks composing the arch. The blocks are so designed that any one in the set can be removed and a new one inserted without destroying or dismantling the adjoining blocks.

In addition to the arch being self-supporting, an increased factor of safety—but one that is not absolutely essential except when repairs are being carried out—is the suspension framework provided. These are fabricated pieces of bar iron and built in truss form to insure lightness with strength, and yet permit of ample expansion and contraction without destroying the dovetail supports in the upper surface of the bricks. These truss cross bars are provided in numbers to suit the length of the arch, with longitudinal bars running at right angles to carry the bolts that support the arch blocks. The interlocking feature of the block has the added advantage of preventing the leakage of the gases through the intervening space. This particular type of arch can be applied separately or in conjunction with the side furnace blocks, also manufactured by this company.



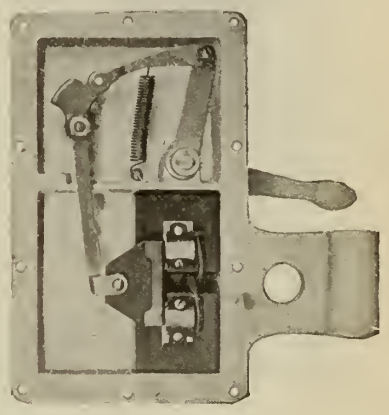
SUSPENDED ARCH FOR BOILER FURNACES.

ENCLOSED TANK SWITCH

THIS enclosed tank switch is of the single-pole double-break type, is instantaneous in action and suitable for use in tanks, etc., where regulation of liquid level between high and low limits is required. The construction avoids opening of the switch before the proper time and is free from the sticking and burning of blades that make trouble with a knife switch. No part of the casing or mechanism can become charged.

The regulation is obtained by a float operating the switch, which in turn actuates a solenoid controlling mechanical or other electrical devices.

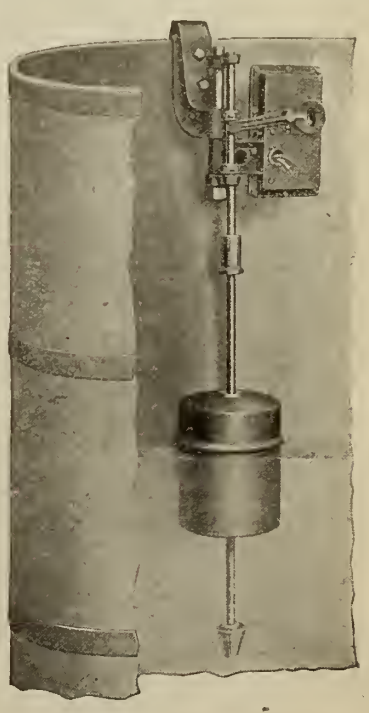
The case consists of a cast iron body and cover with corresponding flanged edges that permit the use of a gasket for damp proofing. The gasket makes it as nearly waterproof as any switch for



INTERIOR VIEW OF SWITCH.

its purpose can be. A substantial lug at one side of the back provides a means for standing to a supporting post.

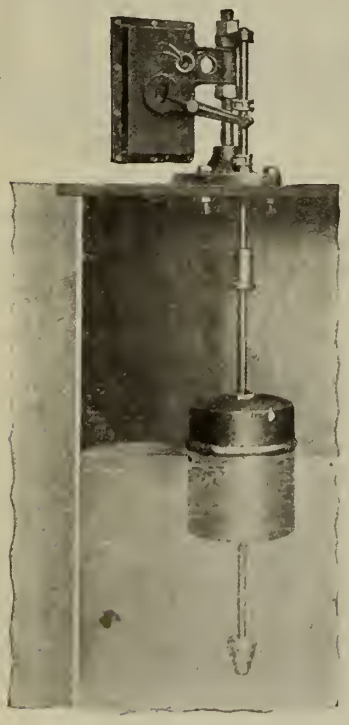
The internal electrical and mechanical parts are separated by an inside dividing partition which forms two separate compartments. A block of transite ebony asbestos bolted into the electrical compartment of the case supports the fixed contracts and also acts as an



INSTALLATION IN TANK.

insulating bushing for the incoming wires, which are brought through a boss in the back of the case. This boss is threaded to receive a ¾ in. conduit.

The fixed contacts are short cylinders of carbon held by set screws in ma-



chined brass terminals bolted to and insulated by the transite block.

The bolts which hold terminals and transite block together are countersunk and sealed at the back, and the wires are held by flanged binding screws on the sides of the terminal blocks.

The moving contact is a folded copper strip bolted to a piece of transite, which is loosely pivoted in the forked end of the cam lever. A flat spring within this fork keeps the contact piece always in correct position.

A float riding up and down on a guide rod hits a limiting stop on the rod. As it does so, the rod is carried up or down, and through collars upon its upper end imparts a corresponding movement to the switch lever. The length of travel of this lever is limited by a stop acting in a slot on the opposite side of the lever.

Movement of the lever oscillates a shaft and "grasshopper" lever, which in turn move a roller across a cam on the end of the electrical contact lever. The roller is held closely to the cam by a coil spring fastened to the dividing partition in the case. The tension of this spring throws the contact lever with a quick positive motion the instant the roller passes over the centre of the cam.

All internal levers are made of cast brass and are of substantial size and strength.

This device is manufactured by the Blackburn Smith Corporation, 105 W. 40th St., New York.

IMPROVED INSTRUMENT PANEL FOR THOMAS GAS METER

In order to place the total and graphic records of the gas flow furnished by the Thomas Meter in the superintendent's office or near the attendant interested in them, the Cutler-Hammer Mfg. Co., of Milwaukee, has recently developed a new design of instrument panel which requires but very little floor space. The earlier panels carried both the recording and regulating apparatus, but in the new arrangement the instruments are mounted on a separate small panel and the regulator may be located in some other part of the plant convenient for inspection by maintenance men. The meter housing is, of course, located at a point in the pipe line where a measure of the gas flow is desirable. In accordance with the modern trend of safety first ideas, further refinements have also been made in the design of the instrument panel to make it practically fool proof and shock proof. The new design follows the dead front principle of switchboard construction, as the accompanying illustration shows. The top section contains the galvanometer, which differs from the usual form of laboratory instrument in that the number of sensitive parts has been reduced to a minimum, and those sensitive parts that are neces-

sary are made easily replaceable, while all other parts are made very strong and durable. The mechanism and connections are placed in an aluminum case and are arranged so that the sensitive parts are well protected, but accessible. It is constructed jointly by the Leeds & Northrup Co., and the Cutler-Hammer Company. Most forms of galvanometers are placed in wooden cases and are so constructed that they do not give good service when used by unskilled mechanics.

The middle section contains the Easterline graphic watt meter, which records in standard units the flow of gas through the meter housing. Below the Easterline instrument is a Westinghouse single-phase watt meter, with scale calibrated for thousands of cubic feet of gas, which shows the total gas flow Mounted on the back of the centre section is a square D quick knife switch, operated by a lever on the front of the section, which serves as a main line switch for the heater circuit and all control circuits. At the left of this switch is mounted a push button control switch, which operates a C-H single pole remote control switch. This switch is magnetically opened and closed and mechanically locked and is used to open the heater circuit in the meter housing to permit the operator to balance the meter. The instrument panel also contains a current transformer, for all except the small sizes of meters, and fuses for the recording circuits and test connections for electrically testing the two watt meters. These watt meters are standard 5 ampere, 110 or 320 volt instruments, hence they may be tested for accuracy in the same manner as any other standard indicating or integrating electrical instrument, that is, by connecting them in series with similar meters of known accuracy. Test constants are stamped on each meter and it is not necessary to shut off the gas or interrupt the gas measurement to test the recording and integrating instruments. All live parts are enclosed in the enclosing case upon which the sections of the panel are mounted and the complete panel is furnished with a cast iron sub-base necessitating no other work in installation than the mere lagging of the base to the floor.

BAFFLE PLATES

In most forms of water-tube boilers, baffle plates are placed among the tubes at different points, to regulate the flow of the furnace gases and direct them so as to secure the greatest possible amount of heat absorption. These baffle plates undoubtedly add to the efficiency of the boiler when they are correctly placed, and it is therefore important, each time the boiler is cooled down sufficiently for a man to examine them, to see that they have not become displaced. Some of the tiles of which they consist may have fallen out or become broken, or the baffles may become otherwise displaced, as a whole or in part. In any case of displacement a passageway is likely to be opened for the flue gases, which will be shorter and easier than the one they are supposed to follow, so that a considerable fraction of the gases from the furnace will pass to the chimney or stack by a short cut, and without giving up as much of their heat as they are supposed to yield when the baffling is in good order; and of course this means a loss of efficiency.

The Operators' Point of View

The Power Plant is a Good Field for Ingenuity

Makeshift Gaskets and Packings Can Often be Extemporized From Most Unpromising Material—Ingenuity Helps, Even in the Washing of Hands

By J. E. NOBLE

A GREAT many power plants are located in small towns and villages, a large percentage of these plants keeping little or no supply of manhole gaskets, etc., on hand for emergencies. The engineer should persist in bringing such a condition to the attention of the owner or manager, putting such a notice in writing at least once, keeping a duplicate of the notice in his own possession in case of trouble along this line.

In most cases there is no store in such villages and towns handling power supplies, and it becomes necessary to send to the nearest city for the goods required. Altogether likely the telegraph will be used, with the possible result that the wrong goods will be sent on account of insufficient data, which means a further delay. In such a case, where a manhole gasket gives out, a substitute of some kind will be used; this may take the shape in a piece of hose, a red leaded gasket of twisted hemp, or some other makeshift. If it is possible to secure a piece of composition lead pipe, such as is used in gas work, a good substitute gasket can be had by drawing a piece of asbestos rope, or a piece of oil-soaked cotton rope, through the pipe to act as an equalizing cushion.

Sometimes you run across pointers in the small plants which the big fellows never hear about. One such came under my notice some time ago. Very often, even in big plants, hand cleaning soap is not supplied by the owners, and unless the engineer buys the soap himself he is apt to use the strong lye soap and caustic soda supplied by the owners for rough scrubbing and cleaning, with the consequent result of chapped hands for the engineer in cold weather. If the engineer will buy a bar of ordinary castile soap (25 cents) and get a box of fine sand, he will be fixed up for about six weeks. First soap the hands, then take a little of the sand, and a few rubs will take off every bit of dirt with absolutely no harm to the hands. This works better even than using coal oil and soap.

We often see it printed in the technical journals that it is a mistake to use paint, red lead, or pipe joint compound inside pipe fittings, that these things should be placed on the pipe thread only, thus doing away with the danger of getting some of the "dope" under valve seats in steam traps, etc. Under certain conditions I am against this advice; personally I believe that all new work should receive a good coating of lubricant, which is the principal use for any mixture used, much more so than as a filler) both inside the fitting and on the pipe thread, in this case the threads have every chance of screwing up into a tight position with the minimum amount of twisting strain. Under these conditions one thing must be done, whatever the pipes are to be used for they must be properly blown out before the main or finishing connection is made. Not for a minute or two but for a few hours. I remember reading an article once by the manager of a large concern who installed power plants. His advice was to blow steam through all new work for 48 hours to remove every particle of dirt, grease, red lead, white lead, iron filings scale, turnings and dirt generally. His statement concluded by the following: "Of course this wastes a lot of steam, but it is paid for a hundred times over in the avoidance of subsequent trouble."

INTERNAL COMBUSTION

By R. M. Murray

I often wonder why it is that woman is nearly always the medium chosen by the poet for his romance while empire-building romances are left unsung.

But perhaps the word poet is only a name that should in reality be applied to many other types of people.

The engineer, for example, is a mighty dreamer, but unlike the poet, he dreams about the force of machinery instead of the force of love.

Let us take as a comparative picture the Eastern dream of the magic carpet and I think you will agree that the result in practice is a wonderful achievement.

The dream in effect you will remember was that an individual might travel long distances easily and faster than the most speedy horse of Arabian legend. Stevenson's engine was an attempt to achieve this wish for speed, but it has developed into too heavy a vehicle to hold a true place in romance. Too many people are required for the management of a railroad train.

The internal combustion engine, however, as used on a motor car, motor cycle, or aeroplane is a vastly different proposition. It can be maintained by a single person, and it realizes the Eastern dream by enabling one to travel vast distances at great speed.

Consider also the simplicity of the engineer's dream in this particular instance. The engine in question is just a metal cylinder into which gas is drawn from a carburettor and ignited by electricity produced by the magneto. The downward stroke of the piston draws in the gas. The upward stroke compresses it, and the electricity fires the charge, producing what is called the working or driving stroke, after which the return stroke of the piston forces the exhaust gases out of the cylinder.

This cycle of operations is continually repeated, which fact gives the engine its name—the four-stroke internal combustion engine.

The four stroke internal combustion engine—it is indeed a true king in the world of romance. It has opened up for the future the possibility of learning the secrets of the unknown spaces. In the years to come everyone will have the opportunity of becoming a knight of the air.

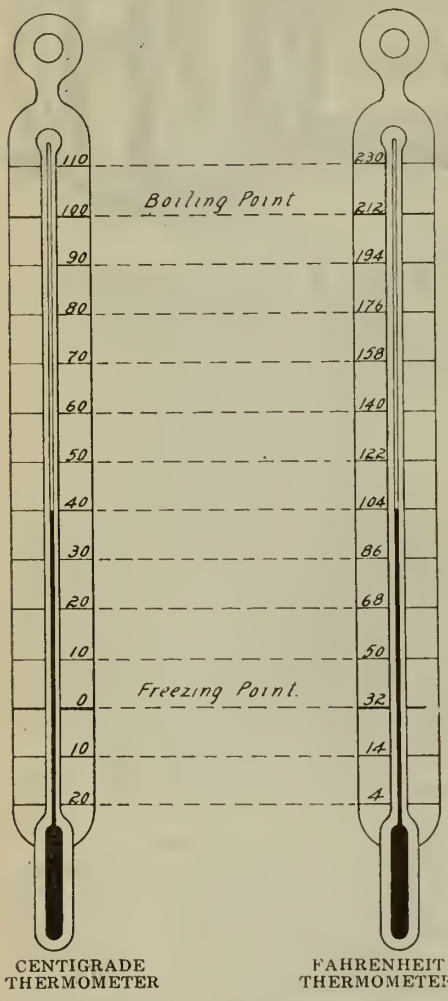
Think it over and judge for yourself whether the poet and engineer are not equally great dreamers and whether engineering is not truly one of the world's romances.

THERMOMETER SCALES

By T. L. Smith

When the term 40 degrees C. is used how does this correspond to the heat in Fahr.? The diagram shown in Fig. 1

answers this question graphically. To the right are shown the Fahr. temperatures, and to the left the corresponding



C. temperatures. From this picture it is evident that a temperature of 40 deg. C. corresponds to a temperature of 104 deg. Fahr.

ROPE AND TACKLE

Ropes are so frequently used that everyone should be thoroughly acquainted with their proper selection, care and employment. In using a single and double block or two double blocks taking a ¾ inch rope, the rope should be of good length, especially if the blocks are double and triple. Such a tackle may be used to lift timber to place or in putting up timber frames and trusses and in hauling up rafters. In hauling a heavy object on the ground the tackle should be so fitted up that the rope which is pulled runs from the object to be moved and not towards it. Ropes which have a woolly appearance, or where the ends of the fibre protrude, should not be used for important work. All ropes should be protected from dampness. Ropes are frequently allowed to unravel at the ends and thus become shorter. If a piece of twine is wrapped round it this might easily be avoided. When a rope runs over a pulley it is constantly bending and straightening, causing the fibres to chafe at the centres. The smaller the pulleys the worse it is. A pulley should not be less than eight times as large in diameter as the rope, and a larger one would be better. Ropes used in tackles or pulleys will give more service if they are reversed occasionally. For such important work as hoisting tackles it is better to use a four-strand woven around a cord. This costs more than the three-strand, but is worth more.

Knots weaken a rope; the more bends there are, and the shorter they are, the worse.

One principle of a knot is that no two parts that would move in the same direction if the ropes were to slip should lie alongside each other. Another is that a knot must be so devised that the tight part of the rope will bear on the free end in such a manner as to pinch and hold it.

To untie a hard knot in a rope or strap, hammer it on all sides with a piece of wood, then dip it in boiling water for a moment or two. A little soap will help. With a sharp-pointed instrument the knot may then be picked loose.

To remove a snarl in a rope, draw out one end as far as possible, then open the centre of the snarl so it can form a hole round this free end, and seize the entire bundle, forcing it through this hole, putting the outside first; this will add to the free ropes, and if continued will unravel any tangle.

PROPER HEATING OF BUILDINGS PROMOTES HEALTH

By J. E. McCormick

I HAVE just received from a nerve specialist in New York a booklet entitled "The Prevention of Colds, Influenza, Grippe, Pneumonia, and Tuberculosis." Incidentally, the author thereof passes a few remarks on the subject of "Heating" and of "Humidity." I have been wondering whether or not some of his remarks might not be of sufficient economic importance to be worthy of consideration by engineers in charge of heating plants. I have never given much attention to the heating and ventilation of buildings. My chief concern along such lines has been to prevent long lines of pipe from bursting during temporary shutdowns in cold weather, therefore I am not competent to judge of the above matter, neither am I at present in a position to give it a proper try-out. I shall quote from the booklet chiefly such parts as might concern engineers in heating plants. In some instances the booklet contains several paragraphs between the parts I have selected. I quote:—

"(a) When a fluid or moisture evaporates, a chill is produced. As an example: Moisten your finger and blow against it, you will observe that the side you blow against will feel cold."

"(b) The degree of chill produced through evaporation depends directly upon the rapidity of evaporation. The more rapid the evaporation, the greater the chill."

"(c) The rapidity of evaporation depends mainly upon the degree of dryness of the air coming in contact with the fluid or moisture. Free air always contains a varying amount of moisture. The less moisture it contains the more readily it will absorb moisture, and vice versa."

"From the foregoing it should not be deduced that moist air always feels warmer to the body than dry air. This applies only when the temperature is above 60 degrees or thereabouts. At lower temperatures the reverse is the case, that is, cold moist air feels colder than cold dry air, for the same reason that cold water feels colder to the skin than air at the same temperature."

"Perhaps the most common cause of colds is the disregard for the degree of humidity in heating and ventilating our living rooms."

"As an example of the influence of low humidity, I shall cite a condition that existed at the U. S. capitol at Washington, D.C., during the winter of 1913-1914. In the hall of the House of Representatives there was a mysterious "chill." Frequent complaints were made and many illnesses resulted. The engineers forced the temperature up to 77 degrees, but still the chill remained. In the Senate hall, on the other side of the building, there was perfect comfort with a temperature of 68 degrees. Finally, after a thorough investigation, it was found that the chill in the House chamber had been due to low humidity. Tests showed that the humidity at times dropped to 20 per cent. In the Senate chamber it was nearly 40 per cent."

"Not one room in a thousand is properly humidified. It is only in our large public buildings that the state of humidity is given any attention."

"The question arises: 'What is the proper humidity for a living room?' It is agreed that from 50 per cent. to 60 per cent. is not too high. High humidity combined with high temperature is extremely depressing, but if the temperature is kept below 70 degrees, the humidity may be 70 per cent. or even 80 per cent. without causing discomfort."

"For the bodily comfort, therefore, it is necessary that our rooms be kept reasonably moist. Since we feel far more comfortable in a room heated to 65 degrees and with a humidity of 50 per cent., than in a room heated to 75 degrees and with low humidity, we could save at least 33 1-3 per cent. in heating expenses by keeping the air in our homes and buildings moist."

"To humidify a room of average size it requires that about a quart of water be evaporated daily. This produces a humidity of about 50 to 60 per cent."

"Health lies in the mean, and not in

the extreme. This applies especially to heat, cold and humidity. It should be our aim to keep the body comfortably warm, cool, moist and dry, which means a humidity of about 50 per cent. and a temperature of about 64 degrees. Of course, it is impossible to meet these conditions at all times, but we can at least endeavor to do so."

The "saving in heating expenses" paragraph took my eye. It must be remembered, however, that the maintaining of a few extra degrees of heat throughout a building in New York City means a greater proportional expense than would the same few degrees in a similar building located in our colder Canadian climate. Nevertheless, if any such saving can be made in that place an appreciable saving might perhaps be obtained in Canada by the same means.

The author of the booklet mentions methods of humidifying air. Among other things he says: "There is sold in most house furnishing stores a special tank, which may be suspended from the back of the radiator. The heat from the radiator evaporates the water in the tank and thus moistens the air." The question in my mind is: "If thermo hydroscopes, or else hygroscopes, were installed in addition to thermometers and means were provided whereby the engineer could control both the humidity and the temperature, would this result in an appreciable lowering of the heating expense and at the same time provide a more healthy atmosphere for the residents to live in? Will someone who has studied heating and ventilation and has been in charge of house heating plants, please give us his experiences on this subject?

ASHES AND ASH-PITS

The ash-pits should be kept as clean as practicable, because if ashes are allowed to accumulate there, they not only interfere with the combustion by checking the draft, but also lessen the downward radiation of heat from the grate bars, which are then likely to become overheated, warped, and burned.

In plants of considerable size, in which large quantities of coal are burned, it is usually profitable to handle the ashes by a mechanical conveyor of some kind Convevors are most commonly employed for this purpose when the coal is handled in like manner, and the boilers are fired by mechanical means.

The ash-pit openings in boiler fronts are often left unprovided with doors. We strongly advise that doors be fitted to them in all cases, because the additional control over the draft that these doors afford is often of extreme value and importance. Under ordinary running conditions, however, the ash-pit doors should be left open and the draft should be controlled by the damper, because this procedure tends to keep the ash-pits cooler, and to prolong the life of the grate bars.

Do You Know That

At the end of 1917 there were about 140 electric furnaces installed in Great Britain, and the number has been considerably increased since then.

* * *

That a leading British trade journal contemplates the sending of its overseas circulation to the British Dominions and Colonies and the great trade centres of the world by air as soon as it is possible.

* * *

The extremely minute globules of oil, which are often present in feed water from condensers, are only about 1-1000 millimeter in diameter, and pass through the finest filtering medium. Their removal has been accomplished by means of the action of electric current, which causes these globules to coalesce and to combine into larger droplets, which can be successfully filtered out. The same inventor has also devised an apparatus for removing dissolved air.

* * *

The oxy-acetylene process has been successfully applied to the burning of holes in the mass of solidified iron called a salamander, which accumulates in the bottom of a blast furnace. Instead of drilling holes for dynamite, with the aid of a diamond bit, the hole is sunk by means of oxy-acetylene. As the cutting action of the gases continues, the pressure blows the molten material from the hole. It is found that one tank of oxygen is sufficient to sink a hole four feet deep.

* * *

Germany, during the war, made transmission belting out of steel and paper. Steel belts have been in more or less common use for a number of years, but the use of paper for transmitting power is at first sight somewhat of a startling innovation. The belts are made by several different processes. Some are made of plaited or knitted paper yarn, and thus have no transverse threads, making the edges very strong and eliminating fraying. Other belts are woven or knitted in tube form, and afterwards flattened out and stitched together.

* * *

In a hand-fired furnace about one-half the combustion takes place in the fuel bed, and one-half in the combustion space. The fuel bed acts as a gas producer and a gas retort; in it the solid fuel is gasified by the combustion of the fixed carbon and the distillation of the volatile matter. The gases rising from the fuel bed contain, at times, as much as 32 per cent. combustible, and no free oxygen to burn it. Hence, to burn these gases, air must be admitted over the fuel bed and mixed with the combustible gases, and the mixture burned in the combustion space. The oxygen flowing through the grate is all used up as it passes through the first three or four inches of the fuel bed.

Coal low in volatile matter is the best for hand-fired power plants in the prevention of smoke.

* * *

Although the form of the U. S. standard thread on paper looks very much unlike the Whitworth form in practice there is very little difference. The square top and bottom of the U. S. Standard are hardly ever found in ordinary commercial screws made by taps and dies or rolled. The crests of the threads in a tap or in a cutting or rolling die soon become rounded by the corners overheating and wearing away—and thus a radius is arrived at which closely approaches that of the Whitworth thread.

* * *

Helium, only slightly heavier than hydrogen, has been successfully used for filling arships and balloons. Its scarcity formerly kept the price up to $1,700 per cu. ft., and its only known source was from radium bearing ores. Since the war started however it was found that helium was present in large amounts in the natural gas of Texas and by liquefying this gas it could be recovered in a very pure state. Its main advantage over hydrogen was in its non-inflammability and it thus removed the greatest objection to the airship.

* * *

While the onion is the last thing one would imagine to have a practical use in the machine shop, it has been successfully used as a tempering medium replacing oil. The smell, as may well be imagined, is rather pronounced, but the results secured are very good. The method employed is to place the article to be tempered in a metal basin filled with chopped onions until it is quite cold. The onions can be used repeatedly. Small articles may be inserted in onions large enough to hold them. Garlic might do in a pinch, eh? The Germans are responsible for this latest atrocity.

* * *

Since the outbreak of war many new uses have been found for the metal magnesium. In combination with aluminium and other metals, it produces an alloy with a specific gravity about half that of aluminium, which is largely used for aeroplane work. On the other hand, if the weight has only to approach that of aluminium, a considerable admixture of heavy metals is possible; an alloy containing only 10.30 per cent. of magnesium is stated to have great strength. The formulae of some compositions containing magnesium and aluminium recommended for use in automobile and aeroplane construction, are given in Metallurgical and Chemical Engineering. Reference is made to a recent patent claiming that 92 per cent. of magnesium and 8 per cent. of aluminium gives an alloy of specific gravity 1.75, with a strength equal to that of gunmetal.

Take Agency.—The Yeates Machinery and Supply Co. have taken over the Canadian agency for the McCrosky Reamer Co., of Meadville, Pa.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$32 00	$.....
1¼ in.	36 00	.....
1½ in.	39 00	32 00
1¾ in.	39 00	32 00
2 in.	45 00	32 00
2¼ in.	48 00	34 00
2½ in.	50 00	40 50
3 in.	58 00	45 00
3¼ in.	.....	52 00
3½ in.	70 00	54 00
4 in.	80 00	67 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$5 50	$6 00
Tank plates, 3-16 in..	6 50	6 25

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 60%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 75
Steel bars, base, Toronto ...	5 00
Steel bars, 2" to 4" base...	**6 00**
Iron bars, base, Montreal ..	4 55
Steel bars, base, Montreal..	5 05
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 7 00	$ 7 00
Sheets, Black, No. 10.	6 50	6 90
Canada plates, dull, 52 sheets	8 50	8 10
Canada plates, all bright	8 50	9 50
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	8 20
Premier, 10¾ oz. ...	....	8 50

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

¼ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ In.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Dlamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1....	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws.....	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less...	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly 0	35
Solder, guaranteed 0	40
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums 5	20
White lead, pure, cwt. 16	20
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D." per lb..... 0	03
Rosin "G." per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whitlng, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ¼ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned. 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets. 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd..$0	43
Sheets 24 oz. and heavier base 0	49
Brass tubing, seamless..... 0	55
Tubing, I.P.S., 1" base 0	55

POLISHED DRILL ROD.

Discount off list. Montreal and Toronto ..... Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	20
Peerless	21
Grand	19¾
Superior	19¾
X L C R	18½
Atlas	18½
X Empire	17¼
Ideal	17¼
X press	16
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	20
Fin. and semi-fin. nuts, over 1½ In., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add	40, 10
Cold pressed nuts to 1½ In. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper .. ....$	23 00	$24 00
Electro copper	22 00	23 00
Castings, copper	22 00	21 00
Tin	65 00	65 00
Spelter	9 00	8 50
Lead	7 25	7 00
Antimony	9 00	10 00
Aluminum	40 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided ...$0	38
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.. 0	43
Drilling cables, Manila 0	38

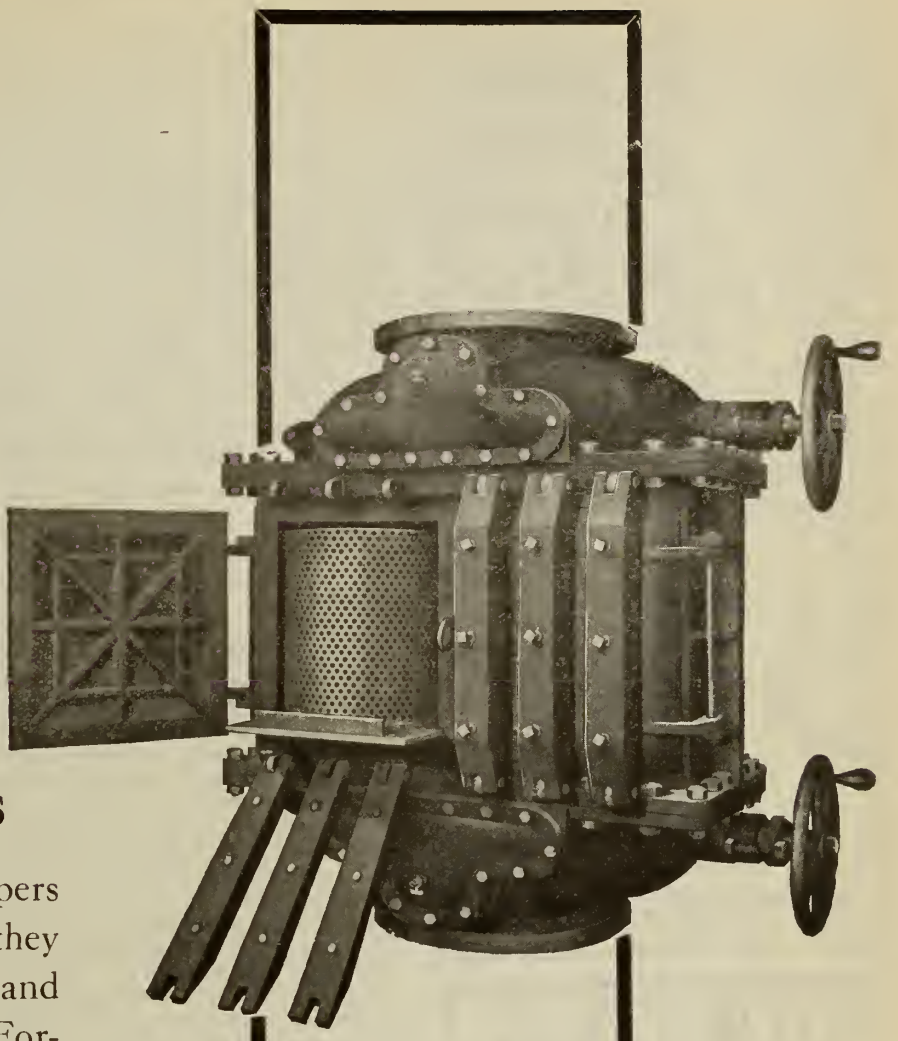
LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

A True Fish Story

Yes sir, it's true that thousands of fish were caught in a few days time out of the water supply to a certain well known city by



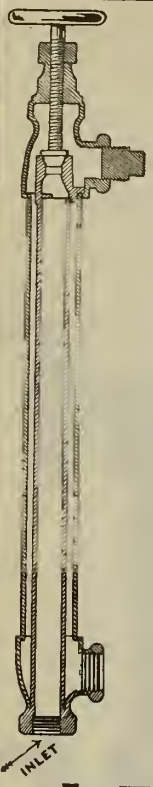
Twin Strainers

"Screens" is what the newspapers called them and in few days they trapped several large perch and several thousand minnows. Formerly these fishes went through the pump and were ground up into the domestic water supply. Ugh! It makes us quail—but it was true.

Minnows are fine for bait but poor as a component part of water used for drinking or steaming purposes. Twin Strainers kept them out and Twin Strainers will keep all of your water clean for they work *continuously*—two baskets, when one fills up you turn a valve and throw the other in without letting any water slip by unstrained.

Twin Strainers will handle water, oil or any other liquid. Everything about them is clearly explained in our complete Bulletin A. Glad to send you a complimentary copy if you'll send your name and address.

ELLIOTT COMPANY
443 Diamond Street, Pittsburg, Pa.



The LONG Patent Steam Trap

Automatically drains jacket kettles, separators and steam mains. Nine hundred to 1,500 feet of one-inch pipe isn't beyond its ability. Also used with splendid success in drying room systems.

Only One Movable Part

Works against 1 and 200 pounds of pressure—no possibility of freezing. Has two outlets so it can be installed in any position.

Circular gives full particulars.

Write to-day.

J. T. LONG
84 Adam Street
MONTREAL, CANADA
If your dealer does not sell it, write direct

R.D. Wood & Co.
Philadelphia, Pa., U.S.A.

Water and Gas Work Supplies,
Cast Iron Pipe and Castings,
Mathews Hydrants and Valves,
Hydraulic Presses and Accumulators,
Operating Valves,
Mechanically Operated Gas Producers.

ENGINEERING

London.—The formation here of one of the greatest electrical combines in the world, to be known as the English Electric Company, with a capital of $25,000,000, and employing 25,000 persons, is viewed as a British effort to obtain ascendency in a market in which the Germans, as well as the Americans, have hitherto offered the most serious competition. One of the largest manufacturing concerns in this country, which has been one of the greatest producers of war materials, contemplates the manufacture of typewriters on a scale sufficient to be a serious competitor in the world market, where American manufacturers have had the monopoly.

Ottawa.—The annual general meeting of the Engineering Institute of Canada opened at Ottawa on February 10th, attended by engineers from all parts of the Dominion. The professional meeting followed the general, at which a number of engineering and national topics were discussed. A number of the leading engineering bodies of the United States were represented, and addresses were delivered by these representatives: Comfort A. Adams, president of the American Institute of Electrical Engineers; A. D. Flynn, secretary of the United Engineering Council of New York; and Doctor Ira Hollis, past president of the American Society of Mechanical Engineers.

HISTORICAL REVIEW OF STEAM TURBINE PROGRESS

The Westinghouse Electric and Manufacturing Company have just issued their Circular 1591, subjected, "An Historical Review of Steam Progress." This publication was written by Mr. Francis Hodgkinson, whose commercial and engineering knowledge of the steam turbine is perhaps as broad as that of any man in America. The circular is a reprint of an article which appeared serially and is now gathered together in one publication with the intention of becoming a handbook on steam turbine progress. The early history of steam turbine engineering is gone into and the earlier machines installed in America are illustrated. From 1899 until 1917 each year's development is probably recorded as it occurred and the improvements noted. The booklet is profusely illustrated with views of all the different types of impulse and reaction turbines and the construction of blading, valve chamber, governor, throttle valve, coupling, and oil cooler are shown in detail. This publication should be a valuable addition to designing and consulting engineers and is being used extensively in the Government training classes for junior engineers on steam engineering work.

BOOK REVIEWS

Graphical and Mechanical Computation. by Joseph Lipka, Ph.D., John Wiley and Sons, Inc., New York; the Renouf Publishing Co., Montreal. Price $4.00. A book written as an aid in the solution of a large number of problems which the engineer, as well as the student of engineering, meets in his work. In the opening chapter the construction of scales is developed and leads to a discussion of the principles upon which the construction of various slide rules is based. The second chapter develops the principles of a network of scales, showing their application to the use of various kinds of co-ordinate paper and to the charting of equations in three variables. Engineers have recognized for a long time the value of graphical charts in the lessening of the labor of computation. Among the charts devised none are so rapidly constructed, nor so easily read as the charts of the alignment type. Chapters III, IV and V give a systematic development of the construction of alignment charts; the methods are illustrated by charts for a large number of formulae. It is the writer's hope, as expressed in his preface, which we quote, that the simple mathematical treatment employed in these chapters will serve to make the engineering profession more widely acquainted with this time and labor saving device. Many formulae in the engineering sciences are emperical, and the value of many investigations is enhanced by the discovery of laws connecting the results. Chapter VI is concerned with the fitting of equations to emperical data. Chapter VII considers the case where the data are periodic, as in alternating currents, sound waves, etc. Where emperical formulae cannot be fitted to experimental data, further computation can be made by interpolation differentiation, and integration by the methods developed in the last two chapters. Numerous illustrative examples are worked throughout the text and exercises are given at the end of each chapter. While a preliminary knowledge of mathematics is essential to the complete understanding of the subject matter of this book, it places in the hands of the designing engineer a powerful means of simplifying the calculation of problems arising every day in structural, hydraulic, power plant, mechanical and electrical engineering. The treatment adopted throughout is concise and well arranged.

Classified Advertising

WANTED—TWO 100 H.P. RETURN TUBULAR Boilers, 16 or 18 feet long, 80 to 100 pounds pressure. State price and where can be seen. Box 152, Power House.

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Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

BOOK REVIEW

"Mechanical Drawing," by Ervin Kenison and Edward D. Waite, the American Technical Society, Chicago

The work of the accomplished engineer or designing draftsman is something which demands broad acquaintance with engineering and necessitates considerable ability and inventive skill. The same men who show such skill have had to acquire it through careful and painstaking study and practice of the rudiments of mechanical drawing. They had first to lay their foundation for the more advanced work along this line of equipment necessary for drawing of various kinds and how to use it. All of these important features are carefully treated of in this work. The studies are illustrated by diagrams and plates, and describe for students the simplest drawing problems to those which in difficulty approach more on the architectural and engineering fields. A portion of the book is given over to the description of necessary tools and their proper use. The method of the actual making of mechanical drawings is taken up in detail. In this part of the book much attention is given to geometrical definitions and constructions, as it is recognized that they are the foundation for much engineering work which finds its way to the drafting board. Altogether this book should prove to be a welcome aid to those who are beginning the study of engineering or architectural drafting.

CATALOGUES

The Howard Iron Works, Buffalo, N.Y., has issued a catalogue on their Howard expansion joint. The catalogue is descriptive of the various types of expansion joints made by this firm, and illustrations show the features of each type.

The H. Mueller Mfg. Co., Sarnia, Ont., have in the course of preparation a 300-page catalogue on water, gas and steam brass plumbing goods. This catalogue is at present in the printer's hands and will be ready for distribution within a few weeks.

The Ohio Blower Co., Cleveland, Ohio, have issued a small pamphlet on their Swartwout vacuum traps, which gives considerable detail regarding the operation of its mechanism. The trap is described and the method by which a number of loose parts are eliminated is shown very clearly by means of a cross section. The principle on which the trap works is also very clearly explained.

The Tallman Brass and Metal Company, Limited, Hamilton, Ontario, have issued their new stock list, dated February 1st, of brass and copper rod, tobin bronze rod, phosphor bronze rod, bass and copper sheet, tubing, etc. This stock-list is unusually complete and lists a great variety of sizes in the articles mentioned above and a number of other products of the Tallman Brass and Metal Company such as sheet copper, finished brass goods, automobile trunks, and electric fixtures.

The Goldie & McCulloch Co., Galt, Ont., have recently issued a catalogue on rotary jet condensers and vacuum pumps. This firm have obtained the rights to the Rees-Roturbo pumps and condensing equipment and this catalogue deals with the various types of condensing equipment which they are prepared to supply. Condensers in general are treated of. Condenser plant economies and the economy of high vacuum are shown. The Rees-Roturbo jet condenser is treated of in detail, its design being gone into thoroughly, and features of installation being dealt with in very thorough manner.

The Goldie and McCulloch Co., Galt, Ontario, have issued a very attractive catalogue on the Rees Roturbo pump, for which they have secured the manufacturing rights for Canada. The Rees-Roturbo pump has proven highly efficient and is widely used in Great Britain, Canada, and the United States. the high efficiency and self-regulating features proving particularly attractive. The literature, which has recently been published by the above mentioned firm, goes into the design of this pump very fully, and makes very interesting reading, the fundamental principle of the pump itself is very clearly explained and the manner in which the problems connected with variation of head in either the suction or delivery are dealt with is clearly shown. The various types of single and multi-stage pumps are featured and dimensions and other information given concerning their design.

The Harvey Hubbell Co., Toronto, have issued a new catalogue on their electrical specialties. This catalogue features the many electrical specialties manufactured by the firm, and the many possible combinations of interchangeable sockets, pull switches, attachment plugs and plug receptacles are illustrated in chart form, and in such a manner that it is an easy matter to make up any particular combination which might be desired.

Across the top of the chart pages appear illustrations of various socket caps, wall and ceiling bases, and down the first column on the first page of each set is a series of socket and pull switch bodies. The rest of the page bears complete views of numerous combinations made up of these interchangeable parts. In addition to the above, the catalogue illustrates the other specialties manufactured by the firm, such as special sockets, both brass and porcelain, and particularly Hubbell reflectors for industrial illumination. These reflectors are shown in such a manner that it is a very simple manner to pick out the proper reflector for any particular work.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
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NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
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An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

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New York, U.S.A.

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WRITE FOR PRICES.

STEAM TRAP

WHY WASTE STEAM?

Wasting steam wastes coal, labor and money; inadequate, complicated, inefficient steam traps waste steam and labor.

Steam Trap SARCO is so simple, so efficient, so inexpensive that it saves money investment when it is purchased, saves labor and money on installing, then keeps right on saving steam for years and years.

Steam Trap SARCO is the cheapest trap sold; also the most compact, lasting and efficient. Adequate to any service from 0 to 200 lbs.; can't freeze or get out of order because steam closes it and condensate opens it; drains itself when steam is off, closes automatically when steam comes on.

Don't hesitate, don't even stop to investigate—simply send for one on 30 days' free trial—the trap will convince you. Write TO-DAY for Bulletin J-6.

SARCO COMPANY, Inc.

Woolworth Building, New York City

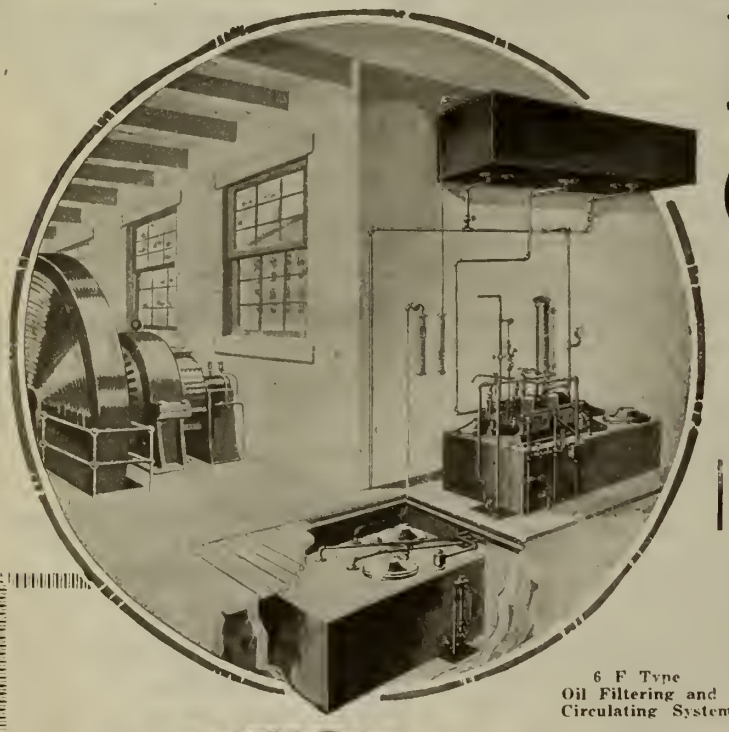
Ellicott Square, Buffalo — Drexel Bldg., Philadelphia — Williamson Bldg., Cleveland
New Telegraph Bldg., Detroit — Monadnock Block, Chicago — Healy Bldg., Atlanta
and representatives in all principal cities. *Canada:* Peacock Brothers, Montreal

BOILER LOGIC

The Heine Safety Boiler Co., St. Louis, Mo., have just completed the printing of the latest edition of their "Boiler Logic," an 86-page treatise on steam boilers.

This treatise covers the following topics:—

1. Some fundamental considerations of boiler design.
   - (a) Furnace design requirements: mixing, time, temperature.
   - (b) Heat transmission from fire by radiation.
   - (c) Heat transmission by convection.
   - (d) Heat transmission through tubes and to water.
2. Practical baffling of water tube boilers.
   - (a) Flexibility of design.
   - (b) Leakage and cost of repairs and renewals.
   - (c) Active and inactive surface.
   - (d) Ease of cleaning soot and ash deposits.
3. Heine boilers for different fuels.
   Hand firing with Bituminous coal
   Hand firing with Anthracite coal.
   Chain grate stokers.
   Underfeed stokers.
   Oil fired.
   Firing and services.
   Shavings and refuse.
   Bagasse.
   Gas fired.
   Waste heat boilers.
   Dredge boat boilers.



6 F Type Oil Filtering and Circulating System

Results that Count

Wherever it is installed there is more uniform lubrication of machines, without loss of oil; less depreciation of equipment; fewer repair bills; a better spirit among employees, and—increased profits, all of which are good, strong reasons why the Bowser should be in your plant.

The Bowser stores and supplies new oil—collects dirty oil — purifies it, makes it good as new—returns the proper supply to points of use wherever located. Its simplicity, durability, and ease of operation are reasons for its popularity in all well regulated plants.

"Results that Count" always follow its use —we'll be glad to tell you more about it if you drop us a line.

BOWSER ESTABLISHED 1885

Oil Circulating and Filtering Systems

The Bowser System makes good results a sure thing.

S. F. Bowser & Co., Inc.

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Sales Offices in All Centres

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BOWSER SERVICE

Don't buy that New Electrical Apparatus Just Yet

WE can supply you with high-grade apparatus that has been slightly used and discarded through no fault of its own, at an **immense saving in cost.** For instance, in many cases we take over entire plants simply because of changed conditions such as increased capacity, change of system, etc.

EVERYTHING IS OVERHAULED AND REFINISHED BY US AND **GUARANTEED** AS GOOD AS NEW, BOTH ELECTRICALLY AND MECHANICALLY.

Our catalogs of offerings should be in the hands of every power plant superintendent each time they are gotten out, and it will be worth while for anyone interested in this class of power plant equipment to be on our mailing list to receive all offerings.

Nearly all of the principal power, lighting and street railway plants in the United States are our customers.

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CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

CO2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

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from Babcock, Stirling and other Water-tube Boilers and Evaporators, also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'

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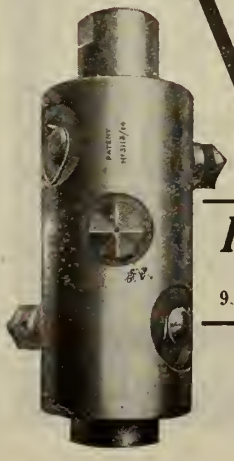
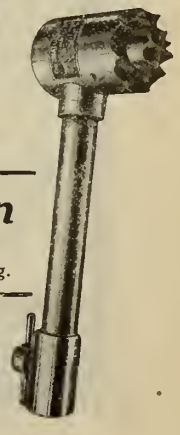


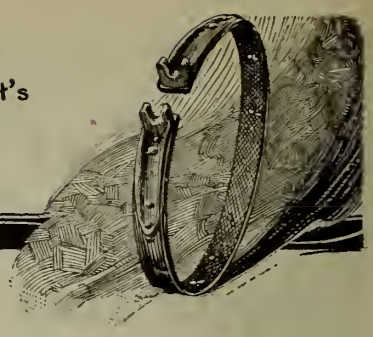


Frank Gilman

(SOLE MAKER)

9. Westfield Road, Birmingham, Eng.

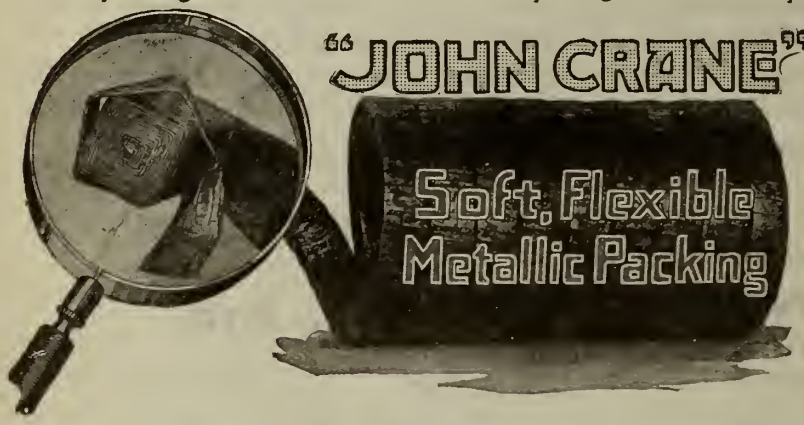
What is used for break lining?
Fabric (Asbestos) etc. Why? Because it grips!
Do you want packing to grip your rods and plungers? Of course not. That's what scores them, necessitating costly machining and replacements.
Then why, by all that's logical, do you use Fabric Packing? Think it over—



Here's An All Metallic Packing— Soft, Flexible and Compressible

"JOHN CRANE" is made of babbitt and therefore is as frictionless as your babbitted bearings. But by a patented process it is made flexible; compressible and so soft you can cut it from a coil with a knife. Thin babbitt foil, wound layer upon layer, with lubricant in between, that's the secret. With "John Crane" in your stuffing boxes and a small stock of "John Crane" in your stock room, your packing troubles are over.

This packing never hardens. Instead of pulling it out and replacing it, you simply add a ring when needed. You run no risks of shutdowns due to packing "blowouts" for no ordinary pressure can penetrate the multiple layers of babbitt foil.



Engineers who know "John Crane" use it for all services. It serves equally well on water, steam, or air, ammonia, oils, or even sulphuric acid. It will pay you to get acquainted with "John Crane" right now.

Order a few coils TODAY.

CRANE PACKING CO.
WINDSOR, CANADA

New York Office: 1044 Park Row Bldg,
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Saves Coal

By stopping up costly leaks in old boiler furnace linings or by making a complete new *jointless* gas tight lining.

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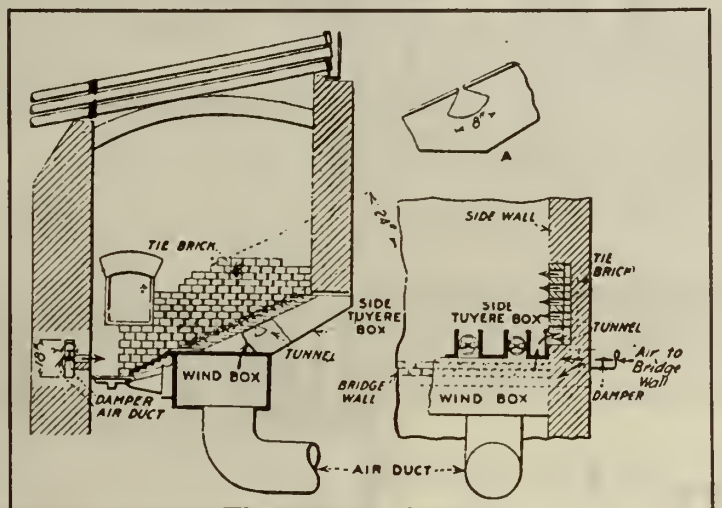
The best advertising is the kind that leaves an indelible, ineffaceable impression of the goods advertised on the minds of the greatest possible number of probable buyers, present and future.

Add Power To Your Furnace

by eliminating the fuel-waste resulting from the "freezing" of clinkers to the side walls. The Bernitz Method of constructing side walls with interior air passages through which cooling air currents are passed to keep the bricks below the fusing point will

Positively Prevent the Accumulation of Clinker Mass



The Bernitz System as applied in a Taylor Stoker Installation

The Bernitz Method

1. Saves coal by insuring more perfect combustion of the fuel used.
2. Increases boiler efficiency by shortening time spent in cleaning walls.
3. Increases efficiency by burning coal which formerly clinkered.
4. By shortening time spent in cleaning walls reduces influx of air through doors.
5. Saves B.t.u.'s usually lost by radiation through side walls.
6. Permits increased forcing of fires by eliminating danger of clinker "freezing."
7. Makes it possible to remove such clinkers as are formed without dumping fire.
8. By reducing manual labor in boiler room keeps laborers more contented.
9. By keeping fires clean insures greater uniformity in heat applied.
10. Is equally applicable to old or new constructions.

The Bernitz Method is licensed, not sold. It has received full patent protection in Canada and the United States and in foreign countries, and licenses under these patents are being granted on the basis of the H.P. rating of the boilers under which the Method is to be installed.

Several Installations in Canada

Write for full particulars to

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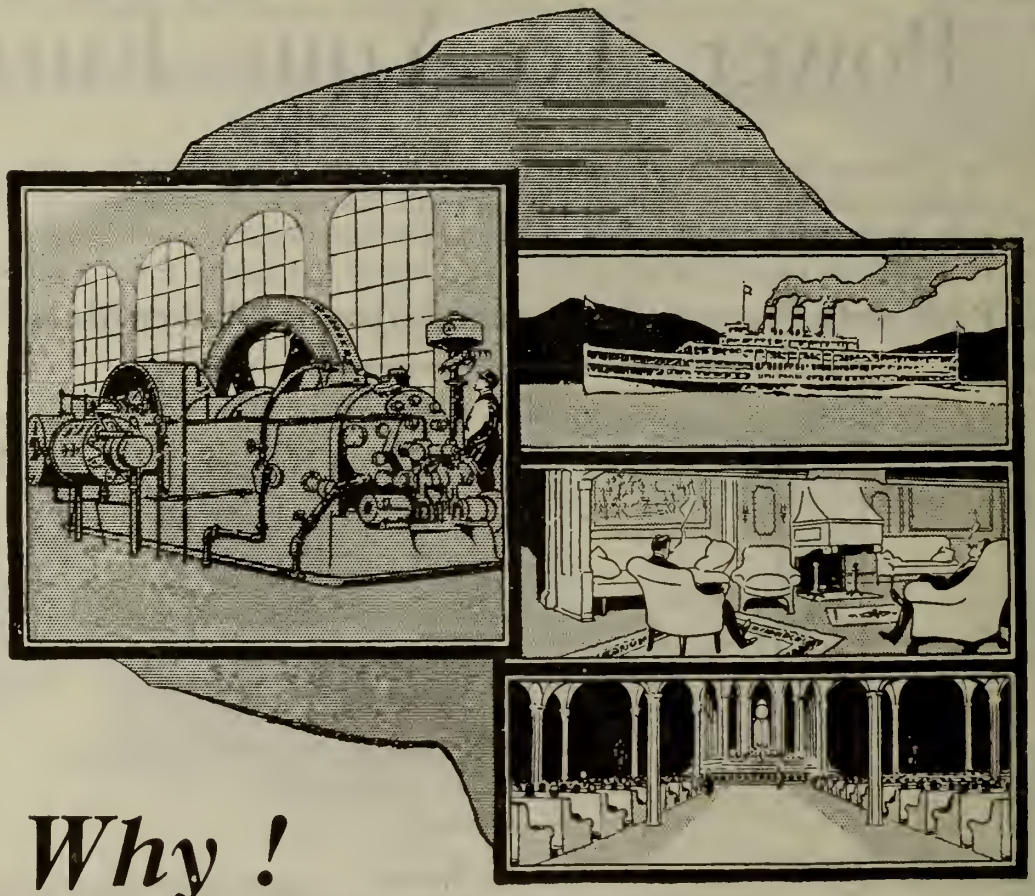

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OIL IS MORE ECONOMICAL

IMPERIAL FUEL OIL is absolutely uniform. Every pound or ton will give the same heating efficiency. It provides more stable and steadier sustained heat, which greatly increases the power-capacity of boilers under which it is used.

Imperial Fuel Oil is highly concentrated. It is easy to handle and saves 40% of storage space. Coal is bulky and is never uniform. In storage, coal deteriorates rapidly and sometimes develops spontaneous combustion.

Imperial Fuel Oil does not deteriorate no matter how long you store it. With Imperial Fuel Oil grates and grate implements are eliminated, and all up-keep expenses are reduced. Considered from a standpoint of efficiency, convenience or economy, Imperial Fuel Oil is not approached by any other type of fuel for use in generating steam.

The fact that Imperial Fuel Oil is so highly concentrated, and that it is absolutely uniform, makes it the ideal fuel for steamships. It makes a big reduction in the boiler-room force possible and will increase the steaming radius and the available cargo space. Then, too, it means cleaner decks and cleaner equipment—pleasanter as well as more profitable voyages for all concerned.

For the heating of hotels, public buildings, schools and churches, Imperial Fuel Oil also offers many advantages.

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Power · Heat · Light · Lubrication

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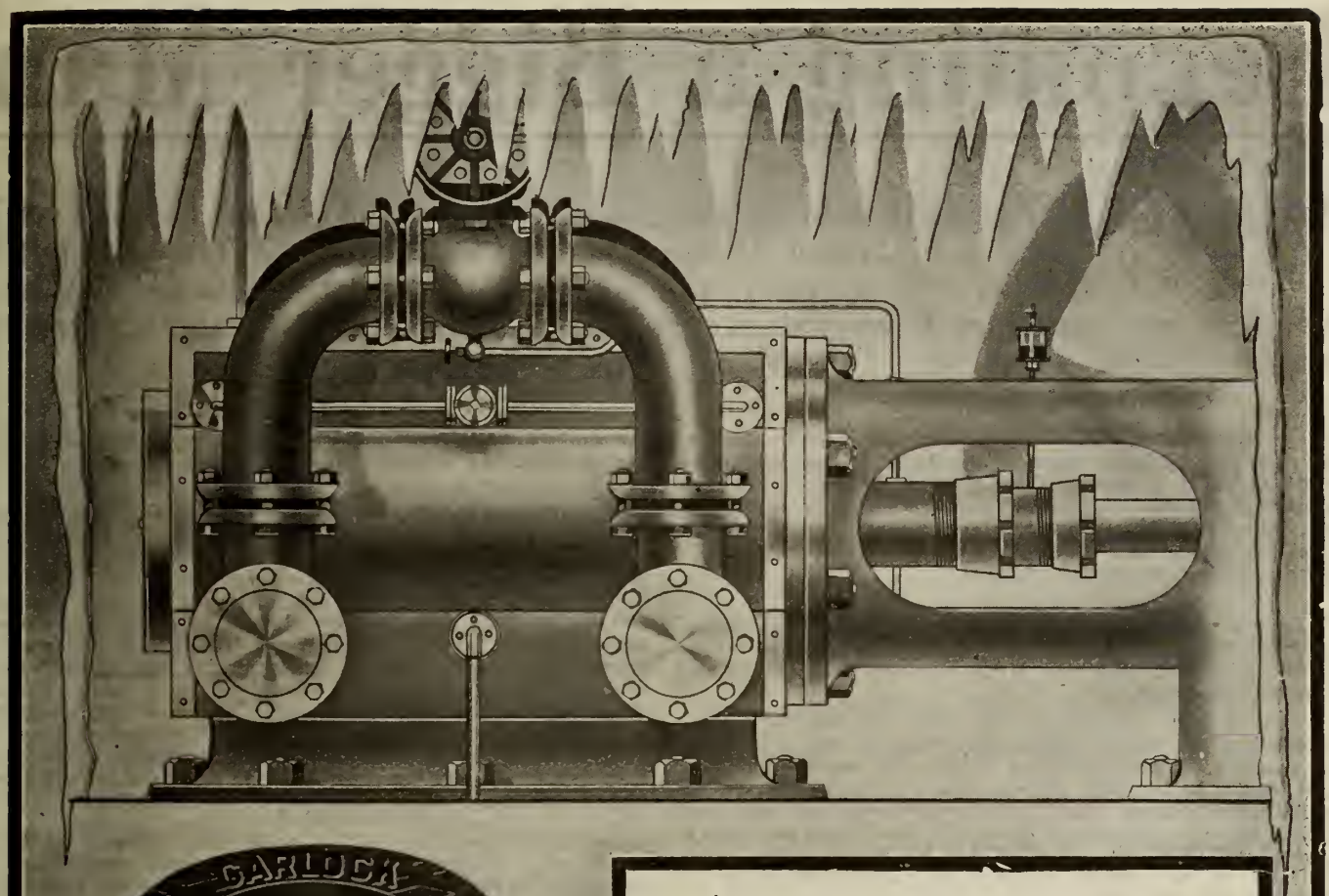

Refrigerating Engineers

and owners of ice plants do not care to experiment with Ammonia Packing during their busy season. Conditions of temperature and lubrication demand a scientifically made, high-grade packing, for this service. Before repacking your compressor stuffing boxes this Spring write to our nearest branch for catalog illustrating and describing several styles and combinations of

Garlock Ammonia Packings

or send us a statement of your conditions and requirements and benefit by our many years' experience in this field.

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Toronto, Ontario - - 404 Continental Life Building
Winnipeg, Manitoba - - - - Galt, Building
Calgary, Alberta - - - 211 Eighth Avenue West

Bert Collins

If any advertisement interests you, tear it out now and place with letters to be answered.

Becoming a Bigger Man

WHAT is the difference between some men you know and others known to you? Why are some men earning $3,000 a year and some $30,000? You can't put it down to heredity or better early opportunities, or even better education. What, then, is the explanation of the stagnation of some men and the elevation and progress of others?

We are reminded of a story. A railroad man, born in Canada, was revisiting his home town on the St. Lawrence River. He wandered up to a group of old-timers who sat in the sun basking in blissful idleness. "Charlie," said one of the old men, "they tell me you are getting $20,000 a year," "Something like that," said Charlie. "Well, all I've got to say, Charlie, is that you're not worth it."

A salary of $20,000 a year to these do-nothing men was incredible. Not one of the group had ever made as much as $2,000 a year, and each man in the company felt that he was a mighty good man.

Charlie had left the old home town when he was a lad. He had got into the mill of bigger things. He developed to be a good man, a better man, the best man for certain work. His specialized education, joined to his own energy and labor sent him up, up, up. To put it in another way: Charlie had always more to sell, and the world wanted his merchandise—brain, skill and ability. Having more to sell all the time, he got more pay all the time.

Charlie could have stayed in the old home town; could have stagnated like others; could have been content with common wages. In short, Charlie could have stayed with the common crowd at the foot of the ladder. But Charlie improved himself and pushed himself, and this type of man the Goddess of Fortune likes to take by the hand and lead onward and upward. Almost any man can climb higher if he really wants to try. None but himself will hold him back. As a matter of fact, the world applauds and helps those who try to climb the ladder that reaches towards the stars.

The bank manager in an obscure branch in a village can get out of that bank surely and swiftly, if he makes it clear to his superiors that he is ready for larger service and a larger sphere. The humble retailer can burst the walls of his small store, just as Timothy Eaton did, if he gets the right idea and follows it. It is not a matter of brain or education so much as of purpose joined to energy and labor. The salesman or manager or bookkeeper or secretary can lift himself to a higher plane of service and rewards if he prepares himself diligently for larger work and pay. The small manufacturer, the company director, the broker—all can become enlarged in the nature of their enterprise and in the amount of their income—by resolutely setting themselves about the task of growing to be bigger-minded men.

Specialized information is the great idea. This is what the world pays handsomely for. And to acquire specialized information is really a simple matter, calling for the purposeful and faithful use of time. This chiefly.

One does not have to stop his ordinary work, or go to a university, or to any school. One can acquire the specialized information in the margin of time which is his own—in the after-hours of business. Which means: If a man will read the right kind of books or publications, and make himself a serious student at home, in his hours—the evening hours or the early morning hours—he can climb to heights of position and pay that will dazzle the inert comrades of his youth or day's work

IF business—BUSINESS—is your chosen field of work, we counsel you to read each week THE FINANCIAL POST. It will stimulate you mentally. It will challenge you to further studious effort. It will give you glimpses into the world of endeavor occupied by the captains of industry and finance. With the guidance of the POST, and with its wealth of specialized information, you, a purposeful man, aiming to go higher in life and pay, will find yourself becoming enlarged in knowledge and ambition, and will be acquiring the bases and facts of knowledge which become the rungs of the ladder you climb by.

It is the first step which costs. But this cost is trivial—a single dollar. We offer you the POST for four months for a dollar. Surely it is worth a dollar to discover how right we are in our argument. If you have the will to go higher in position and pay, sign the coupon below.

THE MACLEAN PUBLISHING COMPANY, LIMITED,
.—143-153 University Avenue, Toronto.

Send me/us THE FINANCIAL POST for four months for one dollar.

Money to be enclosed/remitted

Signed .....

P.H. .....

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MURPHY AUTOMATIC FURNACES

Take The Drudgery Out of Firing

RILEY and MURPHY stokers are so completely automatic in their operation that they have taken the drudgery out of firing.

The coal is fed—the fuel distributed—the fire cleaned—the ash removed—continuously and automatically. All is done without waste or effort—efficiently and economically.

Remember! Riley and Murphy stokers are in such general use that we can direct you to plants in your vicinity where you can learn about their experience—and what these stokers have saved—in money—men—and fuel.

Whether your conditions call for Riley Stokers for large boilers or Murphy Furnaces for small boilers we have the stoker exactly suited to your needs. We cover the field from Hospital to Industrial and Central Station Service.

Our catalogs will interest managers, engineers and other executives. A request to either Company brings information.

Catalog 10R on Riley Stokers

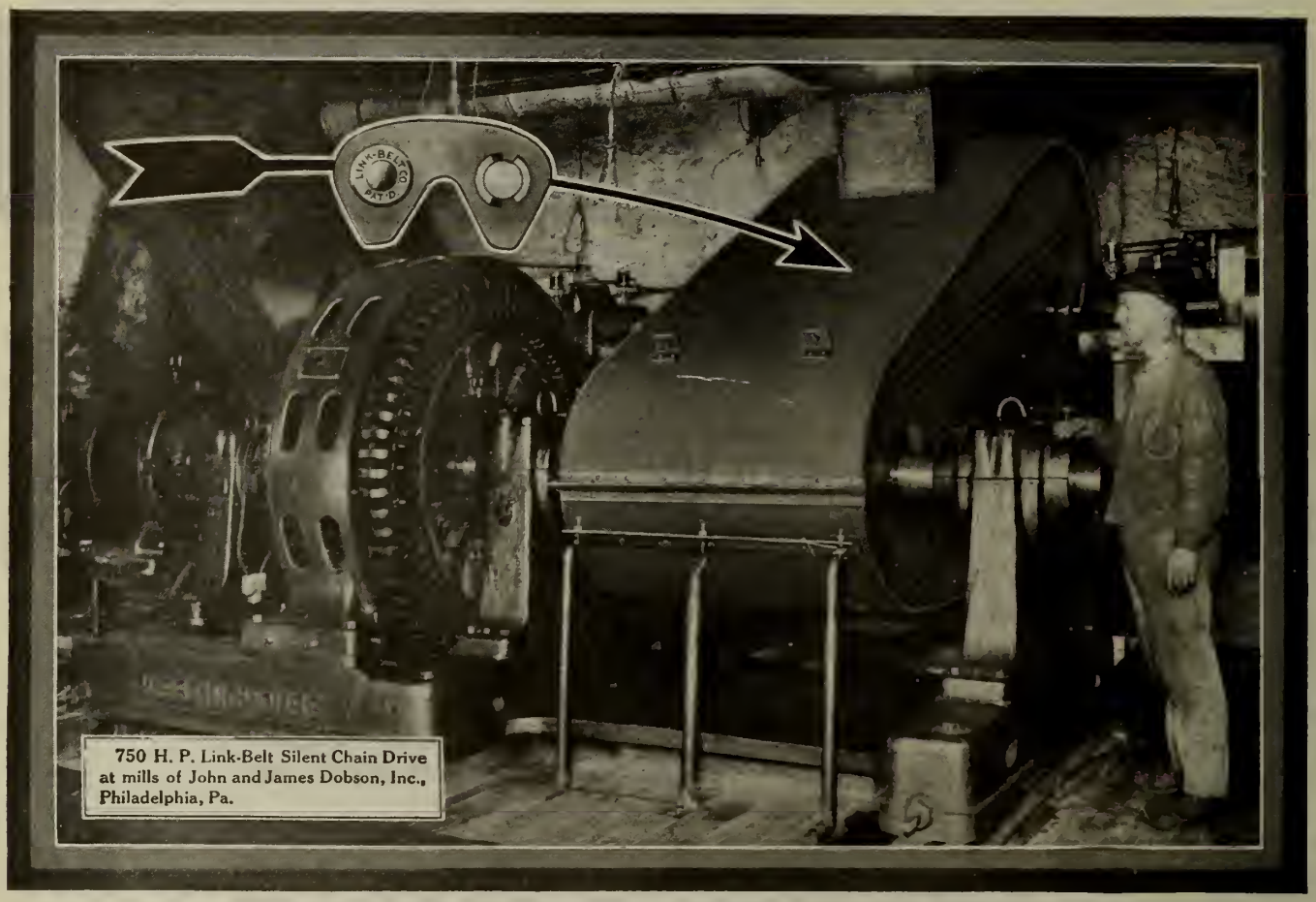
Catalog 10M on Murphy Furnaces

SANFORD RILEY STOKER CO.

Worcester, Boston, Philadelphia, New York, Pittsburgh, Buffalo,

Detroit, Cleveland, Cincinnati, Chicago, St. Paul.

∴ MURPHY IRON WORKS ∴



750 H. P. Link-Belt Silent Chain Drive at mills of John and James Dobson, Inc., Philadelphia, Pa.

CHAIN the Load to the Prime Mover

GIVES you the most positive, most flexible, most direct application of power that is possible to secure.

LINK-BELT
SILENT CHAIN DRIVES

transmit 98.2% of the power to the driven machine. They eliminate belt slippage with its consequent loss of power and machine efficiency. They permit short center drives, thus saving floor space. They cushion the motor against sudden shock when heavy loads are applied and they protect and lengthen the life of the driven machine. They are "flexible as a belt, positive as a gear, more efficient than either."

Our 128 page Data Book No, 125 gives details on Link-Belt Silent Chain Drives up to more than 500 H. P. It also tells how to figure drives and prices. Send for a copy.

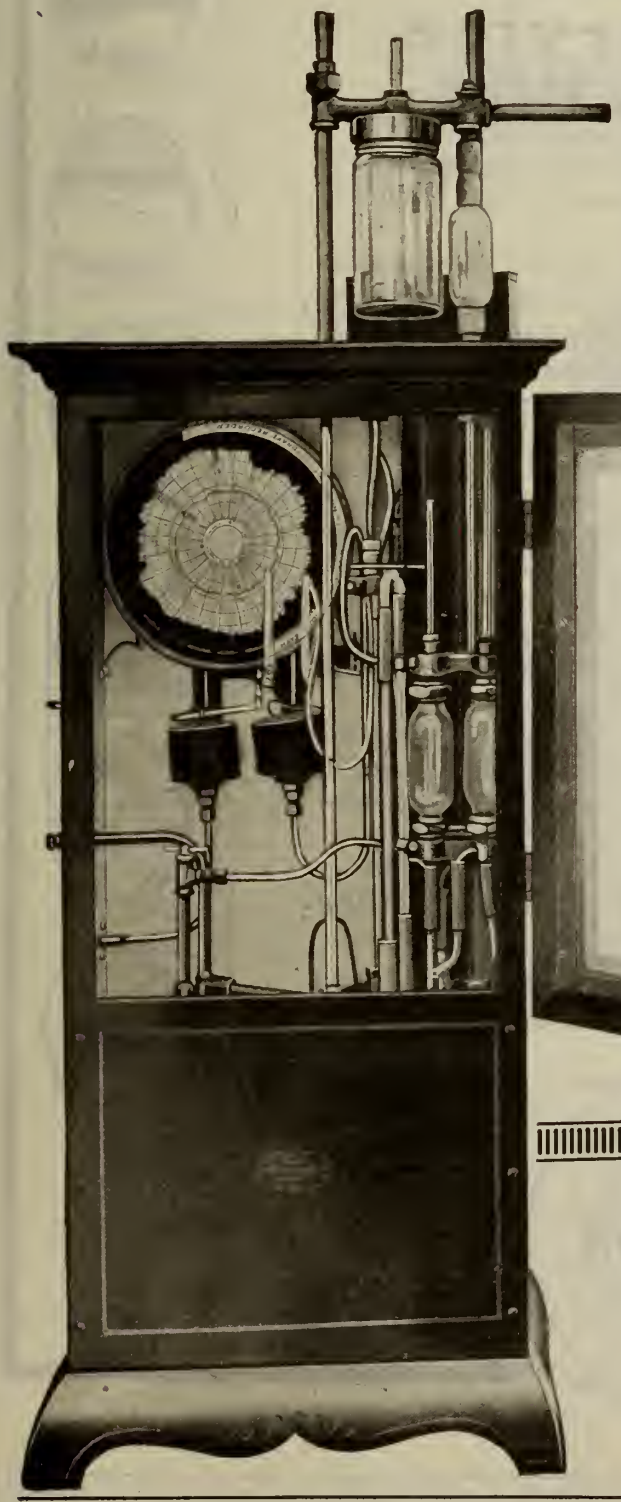
193

CANADIAN
LINK-BELT COMPANY, LTD.
WELLINGTON AND PETER STS. TORONTO

Hays CO_2 and Draft Recorder

Tell the Story of Boiler Efficiency

The exact reason why 30 to 50 per cent. more fuel is consumed in your plant than should be, is shown by the Hays CO_2 and Draft Recorder. With these appliances installed, your firemen can fire intelligently; they will work with accurate facts before them—instead of groping in the dark. For Hays CO_2 and Draft Recorder permanently record the story of efficient combustion



and Point Out Errors in *Firing, Draft, Boiler Settings, Etc.*

YOU

need this Hays CO_2 and Draft Recorder to fire your Boilers intelligently

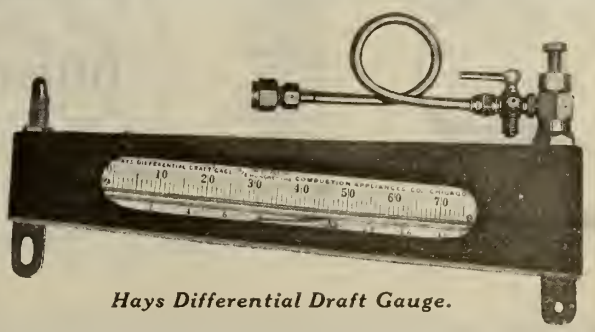
Hundreds of plants are using these Hays Appliances and saving 30 to 50 per cent. of their fuel expense as a result.

The Hays Recorder is automatic, self-adjusting, infallible. It does not depend on hand adjustment and mechanical action for accurate operation. Indications are controlled by rising and falling columns of mercury, water and caustic potash.

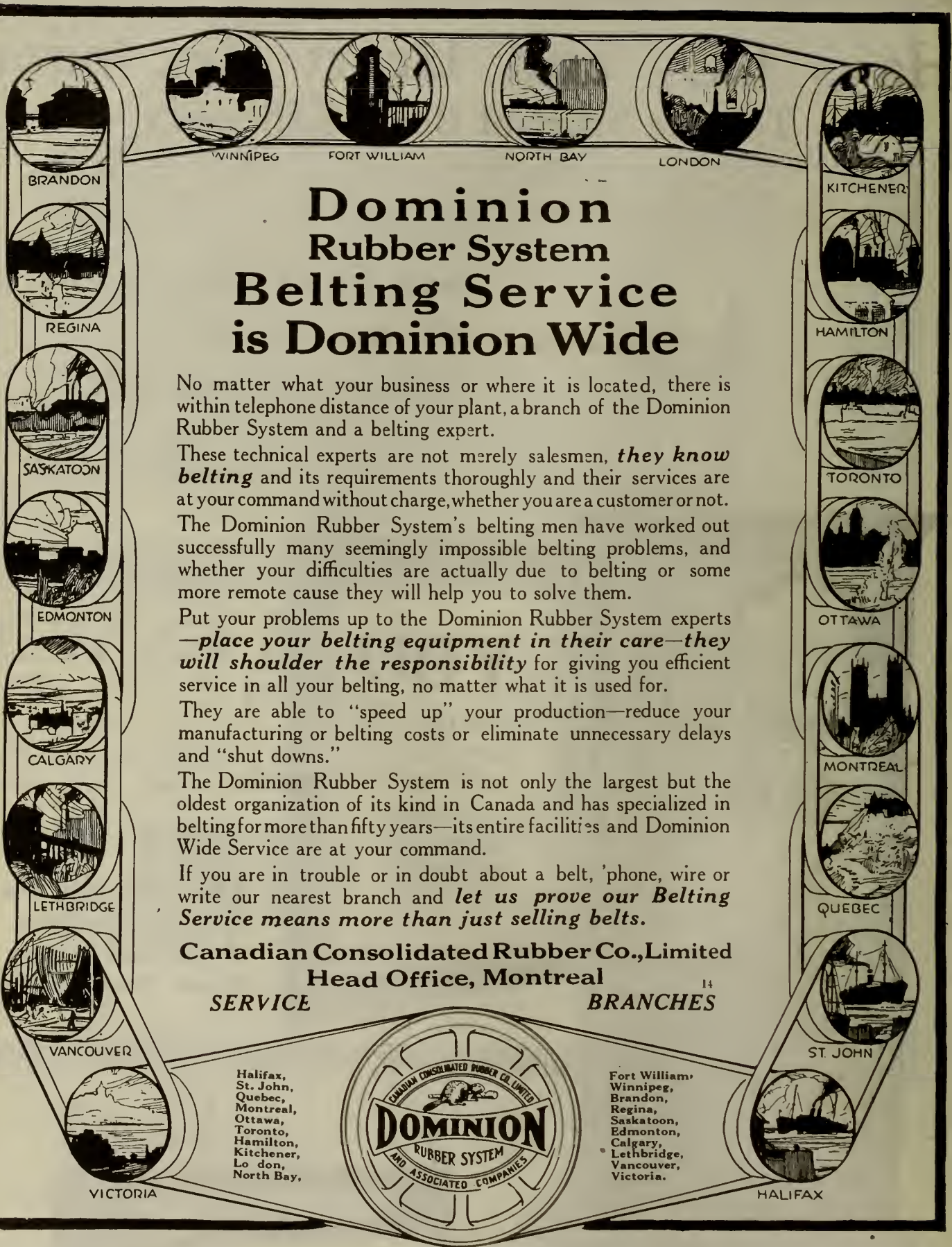
We invite you to investigate, believing the facts will convince you that these Hays Appliances would quickly earn their cost in your plant.

Write for booklet "FUEL"

The Jos. W. Hays Corporation
300 Hays Avenue
Michigan City, Indiana, U. S. A.



Hays Differential Draft Gauge.



Dominion Rubber System Belting Service is Dominion Wide

No matter what your business or where it is located, there is within telephone distance of your plant, a branch of the Dominion Rubber System and a belting expert.

These technical experts are not merely salesmen, ***they know belting*** and its requirements thoroughly and their services are at your command without charge, whether you are a customer or not.

The Dominion Rubber System's belting men have worked out successfully many seemingly impossible belting problems, and whether your difficulties are actually due to belting or some more remote cause they will help you to solve them.

Put your problems up to the Dominion Rubber System experts ***—place your belting equipment in their care—they will shoulder the responsibility*** for giving you efficient service in all your belting, no matter what it is used for.

They are able to "speed up" your production—reduce your manufacturing or belting costs or eliminate unnecessary delays and "shut downs."

The Dominion Rubber System is not only the largest but the oldest organization of its kind in Canada and has specialized in belting for more than fifty years—its entire facilities and Dominion Wide Service are at your command.

If you are in trouble or in doubt about a belt, 'phone, wire or write our nearest branch and ***let us prove our Belting Service means more than just selling belts.***

Canadian Consolidated Rubber Co., Limited
Head Office, Montreal

14

SERVICE BRANCHES

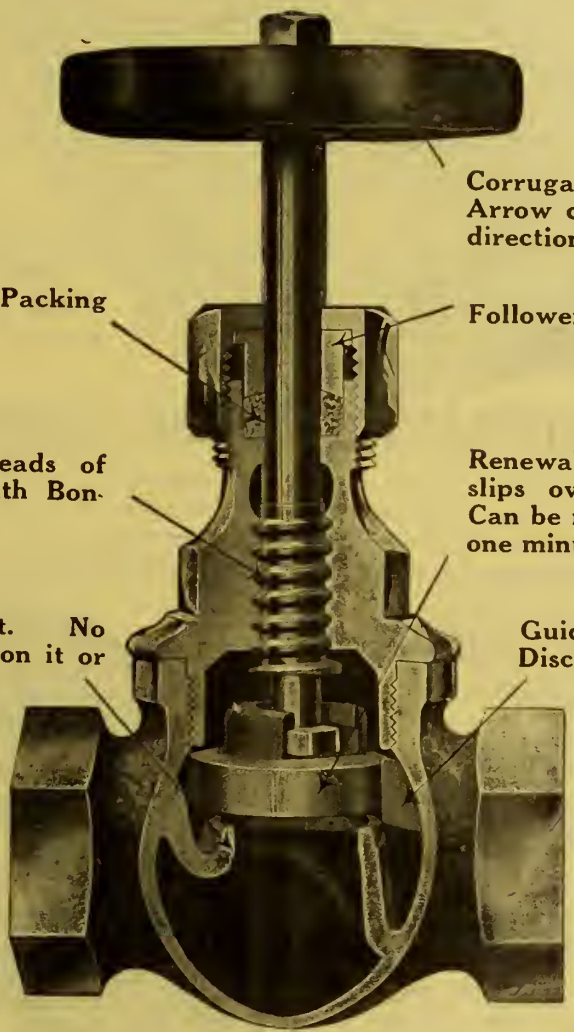
Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Kitchener, Lo don, North Bay,

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION
RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Fort William, Winnipeg, Brandon, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Palmetto Twist Packing

Follower in Stuffing Box.

At least Four Threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised Round Seat. No sediment can lodge on it or injure disc.

Guide cast on Body holds Disc centrally over seat.

Globe or Angle

Screwed or Flanged

The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

Everything in Mechanical Goods

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

It will pay you to send for the booklet o METLSKIN. It describes the method of feeding, the principle of action, and other vital information.

Scale Prevention

By the logical principle of the **BOILER METAL TREATMENT** is easily obtainable. Not only will **METLSKIN** remove old scale, but it also will prevent feed-water solids from adhering to boiler-metal.

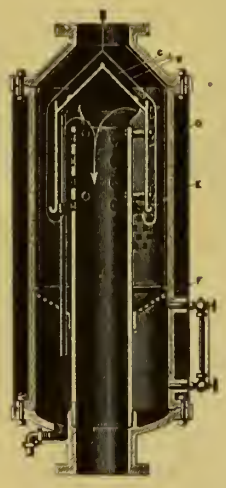
A small daily dose, at low cost, has solved the scale-problem in a host of plants in Canada, the U.S., and abroad.

Why not familiarize yourself with this method of treatment? If your boilers carry as little scale as 1/32 of an inch **METLSKIN** will show you an actual cash saving on fuel-bills. Let us prove it.

CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

St. John Quebec Montreal Ottawa Hamilton Toronto
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

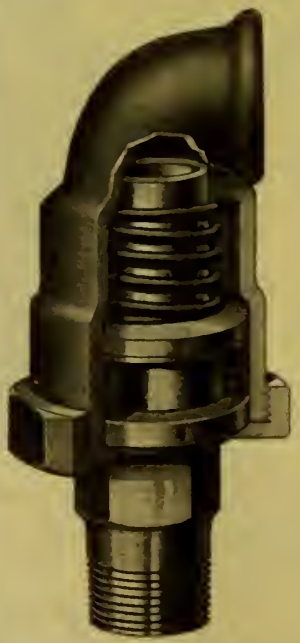
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y.

General Sales Agents:
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda
SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

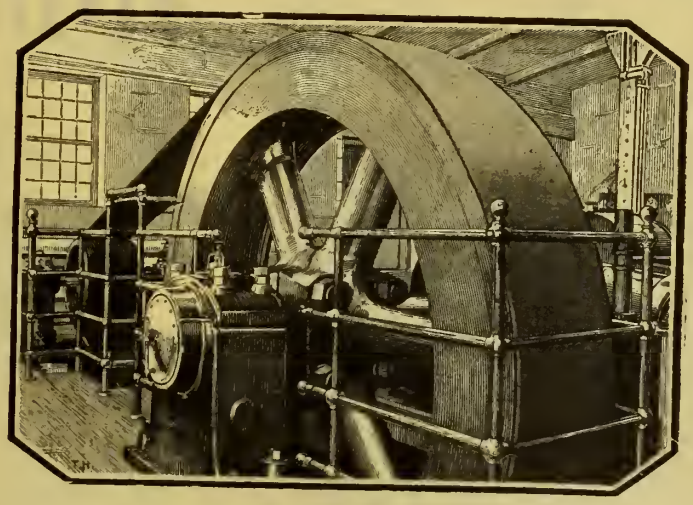
A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
New York City
General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

GRATON AND KNIGHT



GRATON AND KNIGHT

Doing the thing that "Couldn't Be Done"

This Graton & Knight Spartan 24-in. double belt was installed in July, 1912, on a generator drive in the plant of the Bosch Magneto Co., Springfield, Mass. The extremely short pulley centres caused some belting men to throw up their hands and say, "It can't be done." But this Spartan Belt has been doing it successfully for more than six years. Now, note its low cost. At the purchase price per foot, the bill figures ninety-six cents per week or .004½ per delivered horsepower per week.

The above result, at so low a cost, is due to the Graton & Knight standardization—using the right belt for the work to be done, at a price that it ought to cost—no more and no less. Economy in belting means the longest and best service possible under given conditions. We make all kinds of leather belting for all uses—large or small.

The nature of the drive always governs the wear of any belt. Two belts of exactly the same quality on two different drives will make showings varying greatly in length of service. Using Graton & Knight Standardized Series Leather Belts means full delivery of power for every dollar invested.

The G. & K. idea is economy through standardization. It means the right belt in the right place.

For example, Spartan—the belt illustrated—is especially adapted for hard drives, high speed, intermittent loads and where belts are subjected to the action of steam, oil, water and other agencies destructive to ordinary belting. It may be that you are using too good a belt for some purposes and belts not good enough for another. Cost Equalization will spell Economy for you in capital letters.

One factor in the solution of *your* belting problems is the use of belting made from properly tanned leather. The hide of a steer is Nature's tough, elastic, resilient protection during years of activity. G. & K. tanning *preserves* all of those qualities. Nothing can really take the place of the matted *fibre* of leather which locks and unlocks in response to the demands of expansion and contraction, to the very end of its life.

It will save you money to let us recommend belts for every drive in your plant. Then, in buying, call for "Graton & Knight—Brand or equal." This does not commit you buying our belts. It does put your buying on the one economical basis—that of the work to be done.

Write for Booklet on Standardization as applied to Belting

THE GRATON & KNIGHT MFG. CO., Worcester, Mass., U.S.A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Packings and Specialties

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Canadian Graton & Knight, Ltd., Montreal. Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria

GRATON & KNIGHT
Standardized Series
LEATHER BELTING
Tanned by us for belting use

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

U. S. S. "Faith," 5,500 Tons, San Francisco Shipbuilding Co.

DURABLA

DURABLA
TRADE MARK REGISTERED

ASBESTOS SHEET

In the nation's service

Durabla is again proving its high quality.

This is the S. S. "Faith," the first concrete ship built in America.

Every joint is packed with Durabla. There was not a leak on her trial trip.

Durabla Manufacturing Co.
New York

Distributors for Canada
The Canadian Fairbanks-Morse Co., Ltd.

P&C CO

Pratt & Cady

VALVES
ASBESTOS PACKED
COCKS

FEED WATER HEATERS HOT WATER GENERATORS

POWER PUMPS

PRATT & CADY COMPANY, INC.
HARTFORD ~~~ CONN.

Canadian Representatives:
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CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Reconstruction of Industry

will demand a very careful consideration of the economy of operation, and real economy lies in the length of service you secure from the materials you use.

TRADE MARK
"PALMETTO"

is really the last word in packing economy, because the high-grade materials of which it is made have been maintained in spite of war conditions.

The great tensile strength and graphite grease lubricant carried in each separate strand insure long service even under very hard conditions.

Why not let us send you working samples to test for quality? No charge.

Braided for Rods

Two Forms
Both the Same Quality

Twist for Valves

Greene, Tweed & Co.

Sole Manufacturers

109 Duane St. - New York

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Why Longer Tolerate
Heater Trouble and Expense?

You do not have to put up with those bothersome and expensive repairs common to ordinary heaters. You do not have to continue paying out money for fuel just to have a considerable portion of it wasted by inefficient heaters. Then, why do you? It would pay you over and over in money saved and satisfaction gained to replace your old heaters with

Alberger Heaters are furnished in capacities from 200 to 200,000 gallons per hour.

ALBERGER
MULTI
HEAD
HEATERS

Once you do, you will never experience the cost and trouble of repairing internal defects, such as leaks, split tubes, cracked heads, etc. Nor will you ever have occasion to wait for hot water. We would like to explain fully. May we?

ALBERGER HEATER COMPANY, BUFFALO, N.Y.

GENERAL SALES AGENTS:
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St. John Montreal Ottawa Toronto Hamilton Quebec Calgary
Windsor Vancouver Winnipeg Victoria

Voorhees Rub-Steel Valves
The Valve with a Backbone

The BEST for Boiler Feed Pumps

A perfect and permanent adhesion of rubber and steel. Gives **lasting support** against conditions that discredit all-rubber types, make all-metal a source of continual annoyance and emphasize the complexity of other combinations.

The **simplest** valve to instal. No extra equipment involved in interchange with other valves.

No pumping heat too great for our "Superhot" Grade.

Ask for special booklet.

The Canadian Fairbanks-Morse Co., Limited
Exclusive Canadian Agents for
Voorhees Rubber Mfg. Co., Jersey City, N.J.

Continue Conservation
SAVE STEAM
Use American Ideal Steam Traps

to keep Steam Lines free from condensation.

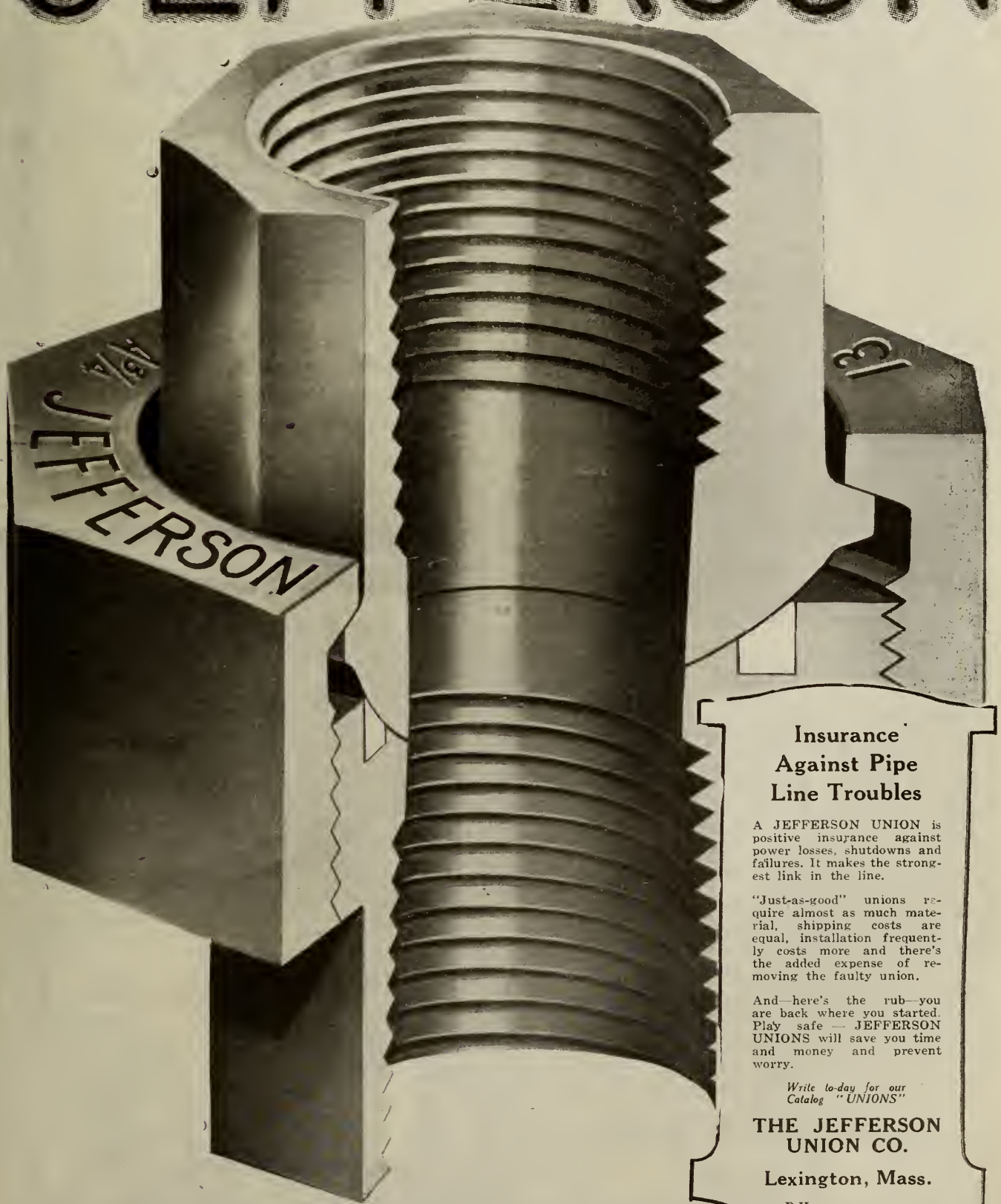
Do not fail to carry out your plans to SAVE COAL, STEAM, MONEY.

SEND FOR BOOKLET.

CANADIAN AGENTS:
CANADIAN FAIRBANKS-MORSE CO., LTD.
MONTREAL QUEBEC TORONTO CALGARY

American Steam Gauge & Valve Mfg. Co.
New York Chicago BOSTON Atlanta Pittsburg

JEFFERSON



Insurance Against Pipe Line Troubles

A JEFFERSON UNION is positive insurance against power losses, shutdowns and failures. It makes the strongest link in the line.

"Just-as-good" unions require almost as much material, shipping costs are equal, installation frequently costs more and there's the added expense of removing the faulty union.

And—here's the rub—you are back where you started. Play safe — JEFFERSON UNIONS will save you time and money and prevent worry.

Write to-day for our Catalog "UNIONS"

THE JEFFERSON UNION CO.

Lexington, Mass.

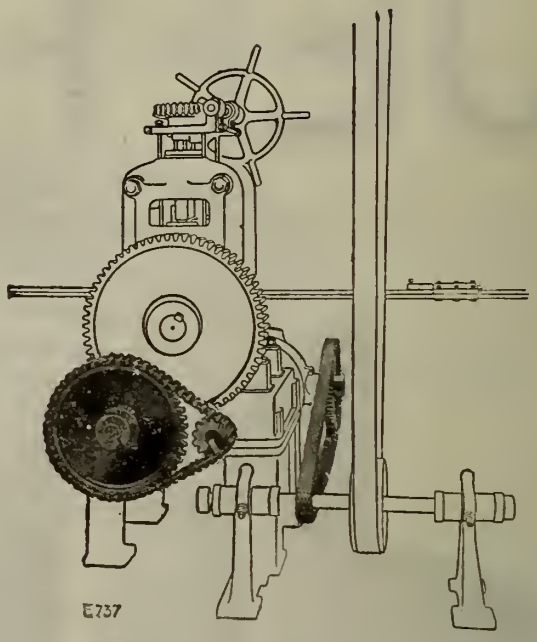
P.H.

"THE COVENTRY" CHAIN DRIVES

THE ideal drive for all kinds of power transmission. In the case of the rolling mill illustrated, considerable power, large reduction of speed ratio, even flexible torque, silence and short centres are required. Note short distance between centres in front chain drive.

THE
COVENTRY
REGISTERED TRA DE MARK

THE "COVENTRY" CHAIN Co., LTD.
COVENTRY, ENGLAND
Cables: Chains, Coventry. Codes A.B.C., 4th and 5th Editions, and Western Union



Rolling Mill for producing stream line wire for aeroplanes. Diameter of rolls 9", rolling speed 20.0 per minute.

PACKINGS
AND
ENGINEERS' SUPPLIES
FOR
Satisfactory Service

Thomson-Gordon Limited
Hamilton, Ont.

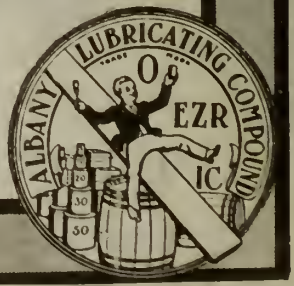
For More Than 50 Years

Albany Grease has given a lubrication service of great efficiency and economy on all bearings of power and industrial plant equipment. Albany Grease is the most universally used lubricant sold to-day.

ALBANY GREASE

will keep engines and all kinds of machinery and line shafting operating cool and easy at all times. It is sold by reliable hardware and mill supply stores—everywhere. We will gladly send samples upon request.

Albany Lubricating Co.
708-10 Washington St
New York, U.S.A.
Established 1868



"Things Going Better?"

"Better? Well, I should say they are. There's absolutely no joint trouble since I standardized on

VULCABESTON

Red Fibre Sheet Packing

"And you must see the supply room. Where I used to have half a dozen packings—each for a special purpose—now there's just the one roll of Vulcabeston. That serves in every kind of joint in pipe lines of all kinds, including superheated steam, acid and ammonia, on engine and pump cylinders, everywhere there's a gasket."

Vulcabeston Red Fibre Sheet Packing is easy to cut, resilient and pliable, but cannot squeeze out or stretch. You can depend upon it always.

If your regular dealer cannot supply you, write us direct.

The JOHNS-PRATT CO.

Hartford, Conn., U.S.A.

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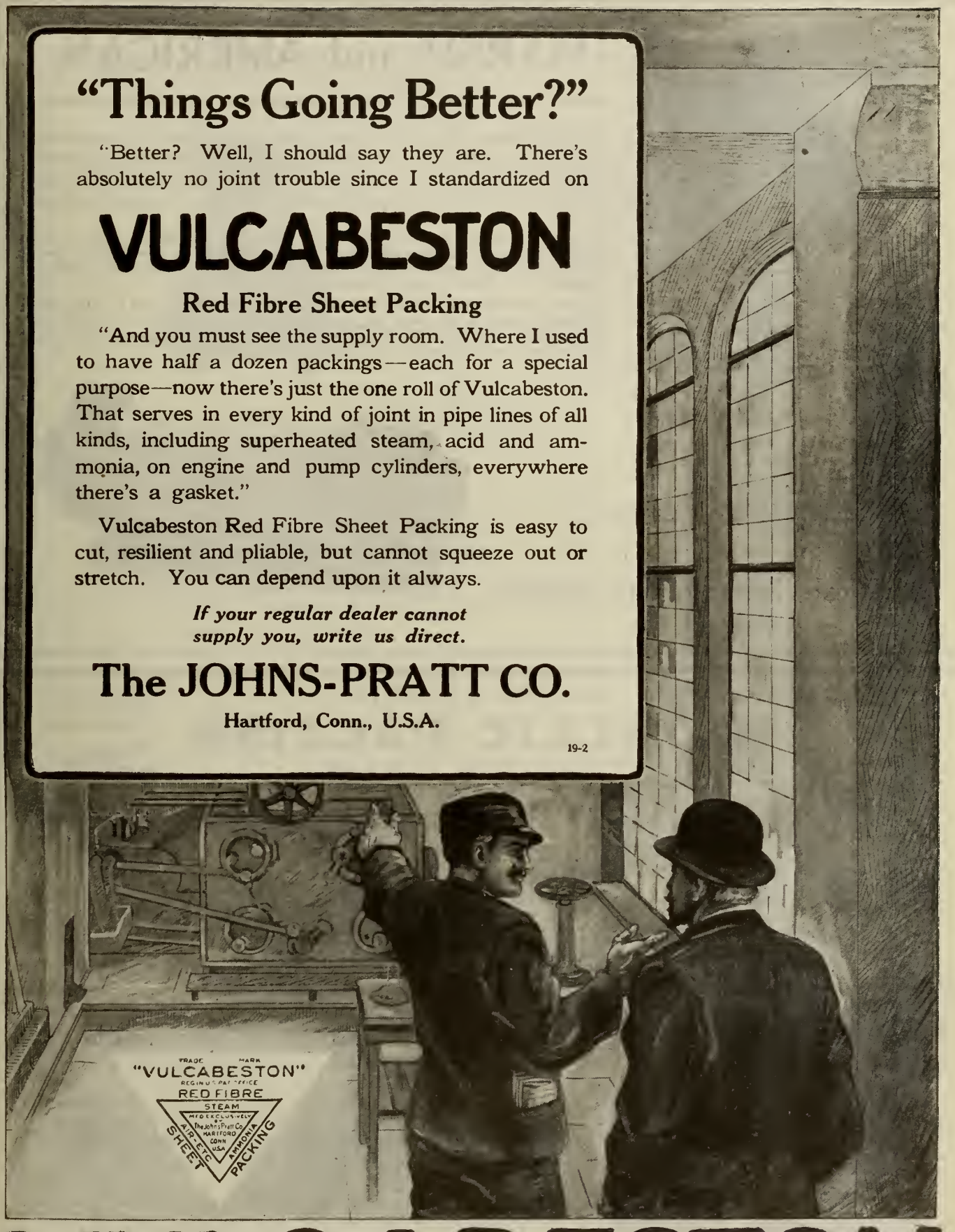

VULCABESTON

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically ***eliminates expensive shut-downs***. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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A. R. Williams Machinery Co., Toronto.
Williams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.

American-Marsh Centrifugal Pump.

Self-Lubricating

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Practically Frictionless

In Bulk

In Cotton Tubes

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Boiler Room Efficiency Instruments

NO MORE GUESSING IN YOUR BOILER ROOM
THE DEFENDER SYSTEM (READS)

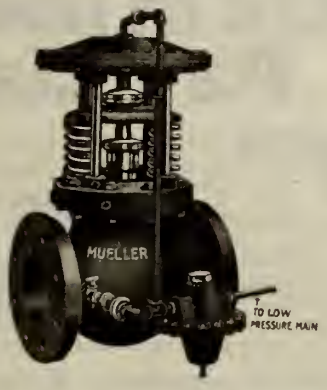
Draft, Temperature and CO_2 on each Boiler. Determine the Draft over the fire and at the last pass of the Boiler and the drop in Draft through the Boiler—that gives the highest percentage of CO_2 in the Flue Gas and the lowest Flue Gas Temperature.

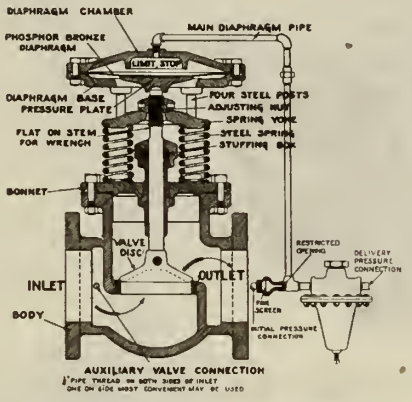
This gives the highest Boiler and Furnace Efficiency. The Defender Catalogue No. 10, which is just off the press, shows a very complete line and price list of Combustion Appliances and Damper Regulators for the Boiler Room.

The Defender Automatic Regulator Co., 709 Pine St., St. Louis, Mo., U.S.A.

MUELLER Reducing and Regulating Valve

SINGLE SEAT; AUXILIARY OPERATED





E5030 for Water, Gas and Air
E5130 for Steam
(Flanged or Screwed)

Very Popular with Shipbuilders

USES

This valve is for use on exacting installations. It will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations of the initial pressure.

CONSTRUCTION OF STOCK REGULATORS

All valves have iron bodies, bronze stem and stuffing box, phosphor bronze diaphragms, seats of composition suitable for the required service; iron diaphragm chamber and steel springs. The main valve is controlled entirely by the small auxiliary valve. This auxiliary valve closes and opens the main valve by admitting initial pressure to, and releasing it from, the diaphragm chamber of the main valve according to the demand of the delivery side. Regulators of this description are suited for pressures up to 150 pounds, and will be furnished at above prices. When regulators are required for pressures in excess of 150 pounds we will furnish suitable material. Prices upon application.

STRAINER

In all cases it is advisable to use a strainer to prevent obstruction from grit, scale, cuttings, etc. Blow out pipes thoroughly before installing valve.

INFORMATION IN ORDERING

In ordering give highest and lowest initial pressure and required low or delivery pressure, approximate quantity or volume to be used per minute, size of high pressure pipe and low pressure pipe.

In ordering flanged end valves give diameter of flanges and bolt circles and the number and size of bolts.

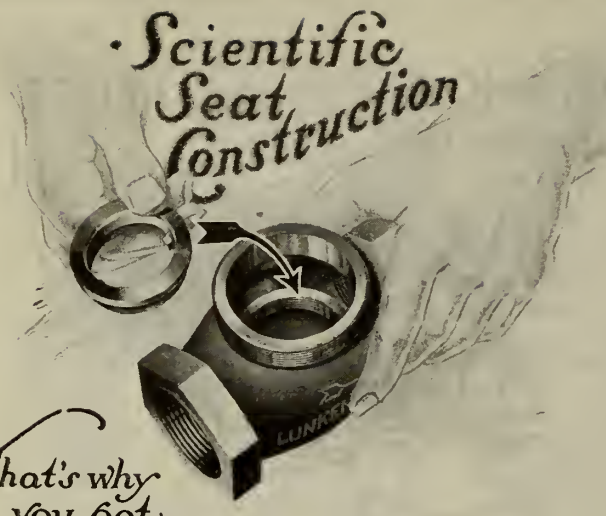
INSTALLATION

Note.—Any proper working regulator acts as a check valve. Where the building up of the pressure is to be avoided use our diaphragm operated relief valve E5060.

We will not be responsible for improper selection of valves.
Consult us regarding the best type for your service.

H. MUELLER MFG. CO., LIMITED

SARNIA - CANADA



That's why you get continuous service from

LUNKENHEIMER "RENEWO" VALVES

The "seat guard" with which the "Renewo" is provided aids in preserving the seating surfaces and keeping them clean. The seating surfaces are regrindable and all the parts, including the **seat ring** and **disc** are renewable. To further enhance their durability, both the **seat ring** and **disc** are made of Lunkenheimer "Valvenickel" — a material having exceptional wear resisting qualities.

The body, bonnet, stem, ec., are made of high-grade bronze composition formulated especially for the duty each part performs, making the **"Renewo"** the most practical, durable and economical valve to be had.

Globe, Angle, Cross, Straightway and Horizontal and Angle Check types for pressures up to 200 and 300 pounds.

Specify **Lunkenheimer "Renewo"** and insist on getting the genuine. Your local dealer can furnish them, if not, write us.

Write for Booklet No. 535—D.C.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World
CINCINNATI

New York Boston
Chicago London

1-17-43

ENGINEERS Are in the Big Pay Class

You can get into the big pay class too and make the chief's salary your own if you will take advantage of this opportunity.

The Library of Steam Engineering—packed full of the very things an engineer must know—will fit you to pass the engineer's license examinations and help you to step up into the biggest kind of job, and it won't cost you a cent to use them for one whole week.

Engineers—Assistants—Firemen and Oilers all need these great books, written by the greatest authorities in the profession. They will bring you more usable information in your spare time than you can get in years of the old-time, learn-by-doing methods.

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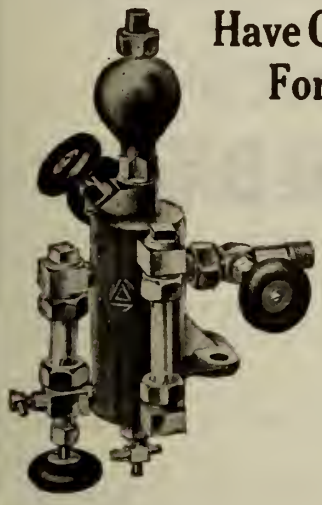
Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

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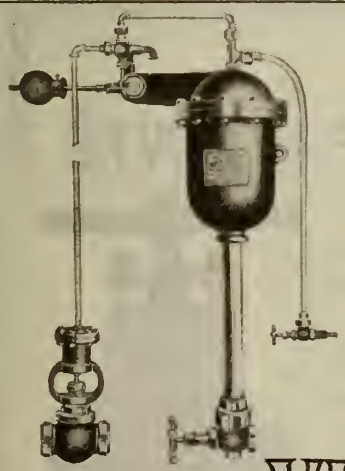

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Can you keep your boiler water within a ¼" of middle gauge? That is what the Vigilant does regardless of the load or firing. The Vigilant Automatic Feed Water Regulator has many points of interest economically.

Our catalogue will interest you —write for it.

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Brass and Iron Body VALVES

Globe, Angle or Check

Manufactured in sizes from ¼" to 24".

Suitable for all purposes, STEAM, AIR, WATER, OIL or GAS.

Every Valve is guaranteed of the best workmanship and absolutely tight before leaving the factory.

To insure obtaining the best specify "McAVITY."

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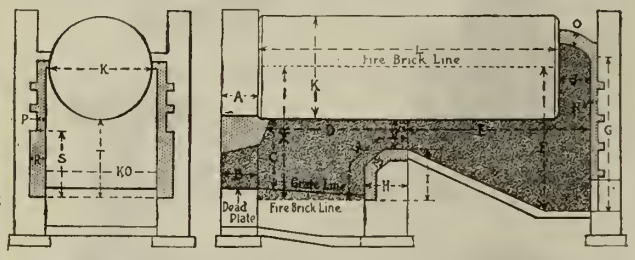
Front Arch With Fire Doors Complete, Ready for Firing.



For Fire Box Side Walls: { X....and S.... } For Height and
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For Bridge Face .....H.....I.....M.....W.....K.....
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FILL OUT THIS SKETCH FOR OUR ESTIMATE

Don't Risk Shut-Downs by Using Experimental Substitutes

There Is But One Plastic Fire Brick—

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REG. U.S. TRADE MARK PAT. OFF PLASTIC FIRE BRICK

We pioneered this field and overcame the difficulties. There is nothing mysterious about Betson's; it is merely an exceptionally high-grade compounding of the best fire clays, using the special mechanical preparation which we have found essential for making a satisfactory one-piece, formed-in-place furnace lining.

Betson's comes in bulk in barrels, in a plastic condition, ready for use, and can be placed by almost anyone. No need to wait for shipments of fire brick or special blocks, or for experts to lay them.

The largest industrial concerns, who run their boiler plants continuously are using Betson's. Durability and air-tightness are its great advantages, both due to the fact that there are no joints in Betson's, which forms a one-piece, monolithic lining for the whole boiler setting.

Try out a barrel or two in repairs to your present fire-brick linings, and when the time comes for relining you will replace with Betson's complete.

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("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

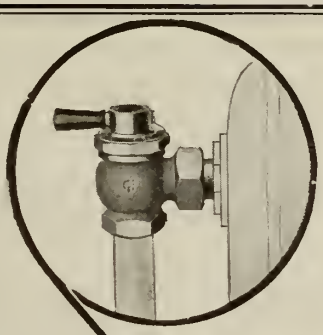
Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Heating Efficiency

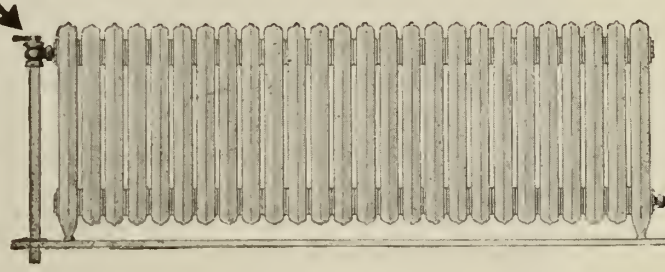
Two important elements of Dunham Heating Service are here pictured in their proper relation to the radiator.

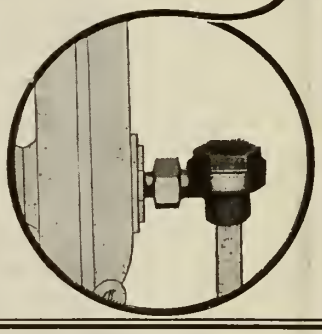
The valve is really packless. Seven-eighths of a turn fully opens or closes it.

The Trap is extremely simple: just three parts—a body, cover and a corrugated thermostatic disc secured in the cover. No loose parts, no sliding contacts, nothing to gum up, no guide or pin to obstruct the valve opening. It operates perfectly under conditions varying from 10 pounds' pressure to 15 inches of vacuum, without adjustments.



The DUNHAM HEATING SERVICE





Write for the interesting details of both the valve and trap.

C. A. Dunham Company, Ltd.

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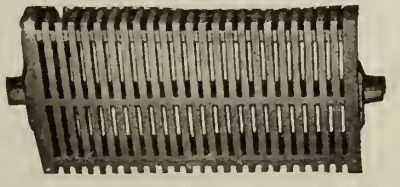
Cyclone  Grates

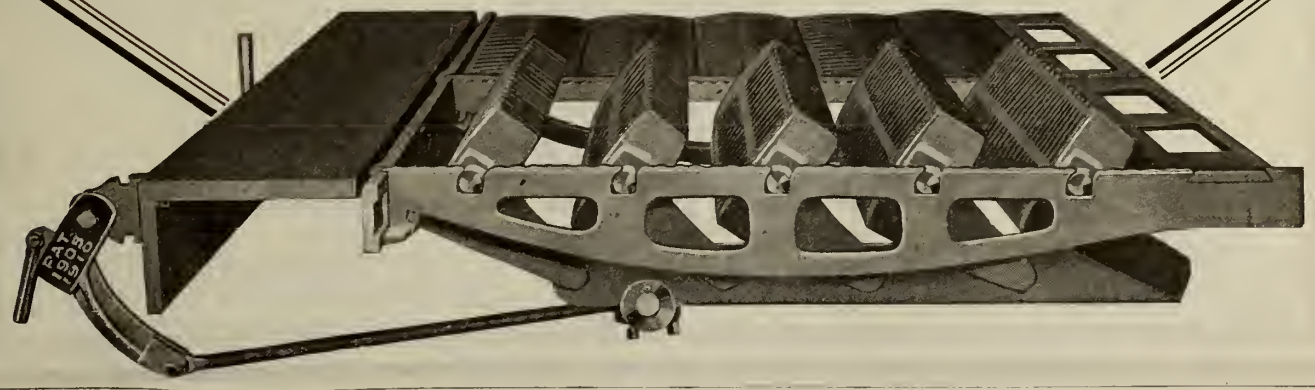
60% air space and 90% underdraught insure positively perfect combustion, whether the fuel used is screenings, soft coal or the highest grade hard coal. Their use means that all the energy in the fuel will be used to make steam.

No clinker formations, no coal lost in the ash pit, no waste where Cyclone Improved Shaking and Dumping Grates are used. Cyclone Grates can be installed without delay or trouble. A 30-day trial offer will prove these facts to you. Write for complete information to

The Canadian Steam Boiler Equipment Co., Limited

20 McGEE ST., TORONTO, ONT. *Sole Makers for Canada* **Phone Ger. 3660**

AGENTS: St. John, N.B., F. W. Blizzard, 329 Charlotte St.; Montreal, Mason Regulator Co., Ltd., St. James St.; Hamilton, Robt. Fitzsimmons, 8 Grove St.; Winnipeg, Vulcan Iron Works.



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Cutting the High Cost of Pneumatic Tool Hose

PNEUMATIC Tool Hose is an important item of expense in your business. Not so much in its actual cost as in the frequent need for renewal.

Ordinary Pneumatic Tool Hose is built with one idea only—to carry air pressure.

But the thing that wears out pneumatic tool hose is not the work it is designed for but the usage it receives.

So Goodyear has produced a new pneumatic tool hose—a hose that is protected against **wear.**

It is built with an outer cover of tough white rubber—of a grade that can be used for treads on automobile tires.

This cover will resist wear—the daily dragging over ship plates, steel girders, cinders—under any of the conditions to which pneumatic tool hose is submitted.

It will stand up also under unusual shocks and blows.

Thus Goodyear Pneumatic Tool Hose will yield longer service—service that means important economies.

A hose purchase may bob up in your place any day. Write or telephone the nearest Goodyear Branch. Ask to have a hose specialist call—with samples. No obligation—you need not be immediately in the market for hose. Tear out this ad. and file for easy reference.

The Goodyear Tire & Rubber Co.
OF CANADA, LIMITED
St. John Montreal Ottawa Toronto Hamilton London Winnipeg
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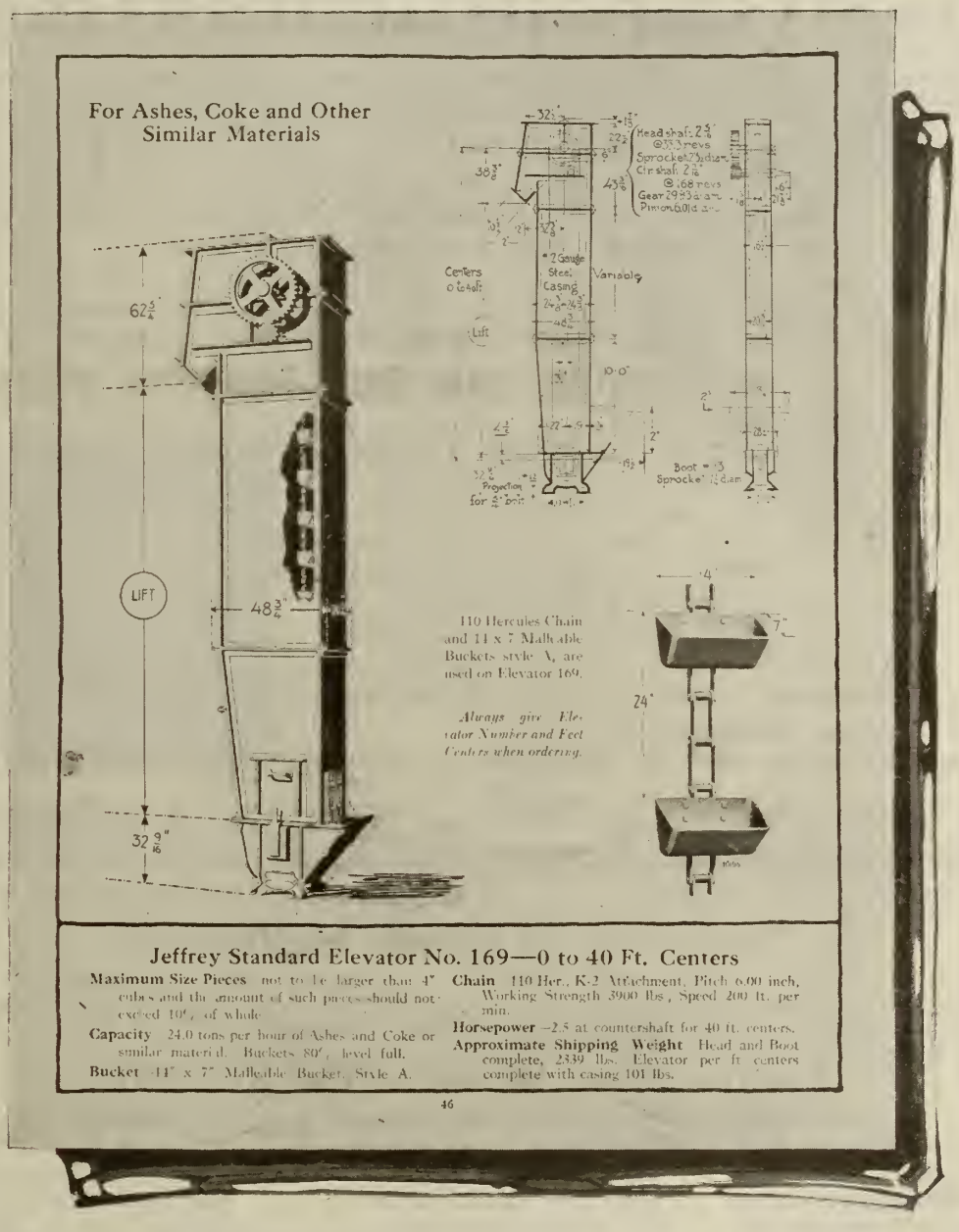

For Ashes, Coke and Other Similar Materials
62 5/8"
LIFT
48 3/4"
32 9/16"
Centers 0 to 40 ft.
2 Gauge Steel Casing
Variable
Lift
10-0"
Boot
Sprocket
Projection for 1/2" bolt
110 Hercules Chain and 11 x 7 Malleable Buckets style A, are used on Elevator 169.
Always give Elevator Number and Feet Centers when ordering.
24"
7"
Jeffrey Standard Elevator No. 169—0 to 40 Ft. Centers
Maximum Size Pieces not to be larger than 4" cubes and the amount of such pieces should not exceed 10% of whole
Capacity 24.0 tons per hour of Ashes and Coke or similar material. Buckets 80% level full.
Bucket 11" x 7" Malleable Bucket, Style A.
Chain 110 Her., K-2 Attachment, Pitch 6.00 inch, Working Strength 3900 lbs., Speed 200 ft. per min.
Horsepower —2.5 at countershaft for 40 ft. centers.
Approximate Shipping Weight Head and Boot complete, 2339 lbs. Elevator per ft centers complete with casing 101 lbs.
46

Here's A Specimen Page From The New Jeffrey Catalog on Standardized Elevators

The book contains 40 of these pages, each page containing all the information, illustrations and specifications relating to a Standard Elevator. To select the Elevator you need, just pick out the number of the Elevator from this Catalog and give us the Feet Centers and write or wire us for Price and Delivery.

Write to-day for Catalog No. 244-4.

THE JEFFREY MFG. COMPANY

CANADIAN BRANCH AND WAREROOMS : MONTREAL

Handle it Mechanically

If any advertisement interests you, tear it out now and place with letters to be answered.

"The Mysterious German Onions"

On nights when the German air raiders were out, they sent up strange, luminous balls behind their lines and anchored them above the clouds—globes of fire which could be seen for forty miles or more. What these "onions" were, or how they were kept in stationary position above the clouds, is still a profound mystery. The Allies never learned anything about them, but the Allied night bombing crews steered their course to the Rhineland by the luminous buoys thus provided.

What is known about the onions is told by Lieut. J. Vernon McKenzie in the course of an article, "Raiding the Rhineland," in MARCH MACLEAN'S. It is an intensely interesting article, telling all about the great reprisal campaign which implanted the fear of war in the German civilian heart.

"NO HOPE FOR THE WETS"

"Already the temperance forces are lined up to stop any possible break in the prohibition dam," writes J. K. Munro, in discussing what is going to happen at the coming session at Ottawa. He predicts that Union Government will hold together, but that the habit it has contracted of promising everything asked is going to make a lively session. He expects:

Dry legislation at the earliest possible moment.
The moral reform forces in control.
No change in the Divorce Law.
Tariff concessions made to the West.

The March number, in fact, is full of live, up-to-the-minute features.
The famous Canadian Ace, Lieut.-Colonel W. A. Bishop is on the cover.

Some of the outstanding articles and stories are:

The Transformation (a new serial)—By Frederic S. Isham.
A Canadian King-maker (the story of Lord Beaverbrook in Britain)—By Maurice Woods.
Fitting in the Returned Soldier—By George Pearson.
The Three Sapphires—By W. A. Fraser.
The Strange Adventure of the Nile Green Roadster—By Arthur Stringer.
Fakers—and Others—By E. Ward Smith.
Lend Me Your Title—By Onoto Watanna.
A Shady Deal—By Archie P. McKishnie.
The City of Lost Laughter—By Mary Josephine Benson.

"The Voice of Canada Interpreted"

A new department starts in this number given over to summarizing and presenting opinion in Canada on outstanding topics, as reflected in the press. In this issue the department is given over to a careful compilation of opinion on the problems of the returned soldier.

Events of the World in the Remaking

The Review of Reviews section of MACLEAN'S, which contains extracts from the best articles selected from all magazines the world over, includes in the March issue the following articles:

Germany Ready for Trade War
Three-Year Marriages in France
No Solution in Ireland Possible?
Controlling Booze in Britain
Germans Hoped to Raise Ships
Making Over a Nation
The Secret British Ferry
Is Germany Shamming?
Woodrow Wilson—Dictator
The Mysterious Sinn Fein Leader
Why Harrison Fought Lloyd George
Hughes' Stand for Imperial Interests
Hun Spies Outwitted
Will Trotzky Hire Huns?

Over 65,000 Canadian Families Buy

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

MARCH ISSUE *Now On Sale At All News Dealers*

20c PER COPY. $2.00 PER YEAR.

Dealers who have not been handling MACLEAN'S should secure copies at once from their nearest Wholesaler

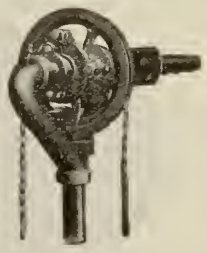
If there are no newsdealers in your town, or if your newsdealers cannot supply you, send 20 cents for a sample copy or $2.00 for a whole year's subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto, Canada.

SAVE 4 to 8 PER CENT FUEL

COST MORE AND WORTH MORE

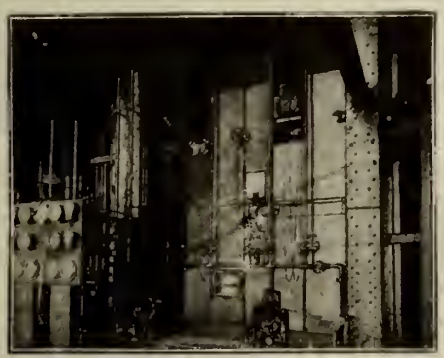
IT'S STANDARD OF THE WORLD

Are the Names of Your Friends in This List?



If the names of Canadian power plants equipped with Diamond Soot Blowers were set in 8-point type, like this—Goldie-McCulloch Co.—they would fill a 7 x 10 page. That is to say, there are several hundred of them. For instance:

Canadian Kodak Company
Canadian Locomotive Company
J. R. Booth
Levis Ferry Ltd.
Canadian Pacific Railway Co.
Toilet Laundry Co.
Bird & Son.
Canadian Electro Products Co.
New Brunswick Power Company
Canadian Pulp & Paper Company
Powell River Co.
The Canada Starch Co.
Robert Simpson Company
Singer Mfg. Co.
Ritchie & Ramsey
Fairville Providential Hospital
Howard Smith Paper Mills, Ltd.
Canadian Consolidated Rubber Co.
Dominion Textile Co.
W. K. Kellogg Cereal Co.
Ford Motor Company
Dominion Forge & Stamping Co.
The Beaver Wood Fibre Co.
British Munitions Co.
Western Electric Company
Canadian Westinghouse Co.
Canadian Starch Company
Wilputte Coke Oven Corporation
Stewart & Adams
British Cordite Co., Ltd.
The Steel Co. of Canada, Ltd.
Imperial Tobacco Co. of Canada
Gunn's Limited
Canadian Vickers
Goodwin's Limited
Belgo-Canadian Pulp & Paper Co.
The Canadian Salt Company
Nova Scotia Steel & Coal Co.
Imperial Munitions Board
T. McAvity & Sons, Ltd.
St. Maurice Paper Company
Canadian Government Railway
Fraser Companies, Ltd.
The Donnacona, Quebec
Canadian Explosives Co., Ltd.
Jos. Simpson's Sons, Ltd.
Goodyear Tire & Rubber Co.
Harris Abattoir Co.
Rosamond Woolen Company
Britannia Smelting & Refining Co,
Eastern Car Company
Abitibi Power Company
Brunner Mond, Canada
Riordon Pulp & Paper Company



Diamond Soot Blowers at Plant of Buffalo General Electric Co.

These concerns find Diamond Soot Blowers a good paying investment because they effect the following economies:

1. Fuel; a saving of 4 to 8%.
2. Boiler efficiency; an increase of 4%.
3. Labor; a saving of many hours per day.
4. Longevity; an increase in the length of service of boiler tubes, through the prevention of corrosion.
5. Steam; a saving of 25 to 75% of steam used for cleaning.

If your boilers are not equipped with Diamond Soot Blowers—your friends are benefiting by lower costs of power than you enjoy.

For full information write for Bulletin 119.

Diamond Specialty Company

Windsor Ontario

MADE OF CALORIZED STEEL

922 POWER Vol. 48, No. 23

Coal Saving by the Scientific Control of Steam Boiler Plants*

By D. Brownlie

THE author has been associated for about ten years with the investigation on scientific lines of the working of every description of steam-boiler plant, and in the present article it is proposed to give the average figures for 250 typical steam boiler plants, with the object of supplying accurate data as to the tremendous national economy that can be effected by the adoption of scientific methods in the boiler-house.

In the burning of coal for the generation of steam, the loss because of lack of scientific methods is hardly realized and, apart from the national point of view, offers to the individual firm a means of most substantial economy in running expenses.

It is not possible to find out what is the exact amount of coal used for the production of steam for purposes other than power, there being, for example, no statistics available showing the number of steam boilers at work in Great Britain.

The author proposes therefore to assume, until further information can be obtained by a proper engineering census of the country, that the total amount of coal used for steam generation in the United Kingdom is between 75 and 100 million tons per annum, being 60 to 70 million tons for power production and 15 to 30 million tons for purposes other than power, corresponding to 40 per cent. to 53 per cent. of the total coal used, and is of the opinion that the 250 boilers to be dealt with in the present article are really representative of all the boiler plants of the country, and the results of such a very large number of exhaustive investigations carried on continuously during [illegible] as to judge with [illegible] rine" boiler, 2 "vertical" boilers, and 3 "patent" boilers difficult to classify. It would be most interesting to know the exact number of each type of steam boiler at work in the country, although there is no doubt that the chief type in use is the "Lancashire."

Amount of Fuel Used—The average shows 20.9 lb. of fuel burnt per square foot of grate area per hour, referring, of course, to the average amount burnt per hour per working day, and not to the amount for any particular hour. This figure is considerably below what is possible on a boiler plant run on modern lines, which would burn something like 25 lb. to 30 lb. per square foot grate area per hour with the average quality of fuel. The boiler plants of the country are working under very easy conditions in this respect, and much more fuel could be burnt per boiler. Figures for fuel consumption depend largely on the quality of the fuel. Thus a good quality washed coal of, say, 13,000 B.t.u. and 7 to 8 per cent. ash could easily be burned economically at the rate of 35 lb. per square foot per hour, whereas purely refuse coals would only give [illegible] Coke of good quality can be burnt [illegible] per square foot grate [illegible] 15 pounds.

[illegible] to the efficient [illegible] some other works.

Economizers—Out of the 250 plants, 155 were fitted with economizers, the other 95 plants having no means of utilizing the waste heat from the boiler flues.

Taking the 155 plants fitted with economizers, the average saving is 11.4 per cent. of the coal bill. The highest figure found was 19 per cent. on a cotton-mill plant. The ordinary figure obtained on a well-managed plant is 15 to 20 per cent. saving, depending on the conditions.

Estimation of CO_2—Out of the 250 plants, 225 [illegible] not [illegible] CO_2 recorded [illegible]

Consult Us—

Our Engineers will be glad to furnish information regarding Economisers for your plant.

GREEN'S ECONOMISER, LTD.
TORONTO

Williams' "Vulcan"
Drop-Forged
Chain Pipe Vise

MADE entirely of drop-forgings and wrought steel, these Vises are unbreakable, compact, rapid in action and positive in gripping pipe. They are attachable **anywhere**—any handy bench, post, or other support will answer. Remember, Williams' Chain Pipe Tools have been **Standard** for nearly half a century—they are all backed by our absolute and unconditional guarantee of service.

Vises in 3 sizes for ⅛ to 8-inch pipe.

Descriptive Booklet on Request.

J. H. WILLIAMS & CO.

"The Drop-Forging People"

78 Richards St., Brooklyn, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, British Columbia and Alberta

Western Office and Warehouse: 78 So. Clinton St. Chicago, Ill.

To Cut in Two
Replacement Costs

To permanently stop leakage of steam, oil, air, water or acids, to end the labor expense of needless, troublesome work.

USE

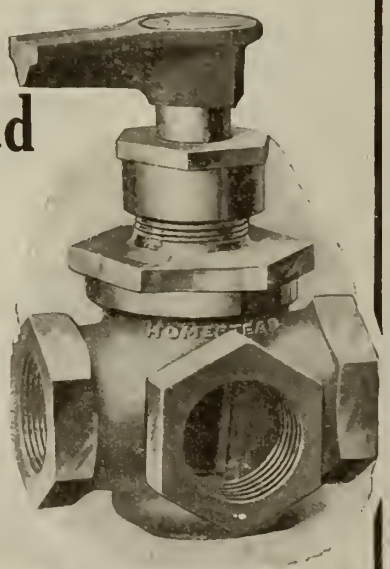
Homestead

Quarter-Turn

Valves

In hundreds of power plants these Homestead Valves have proven best for all services under conditions unusually severe.

Instead of globe and gate valves, use these Quarter-Turn Valves. They will keep your pipe lines absolutely tight.

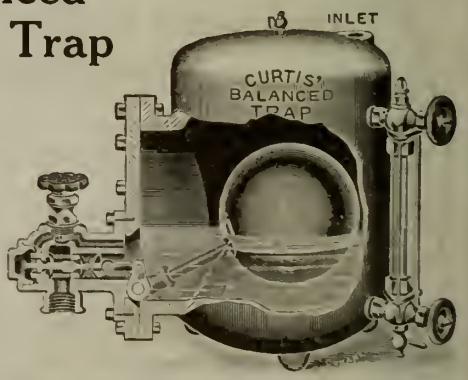


Homestead Three-Way Type

WRITE NOW.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

CURTIS Engineering Specialties
Balanced Steam Trap



This trap is often used as a waterline trap on large plants where there is need to balance any particular circulation to prevent snapping and cracking in pipes and radiators.

This Trap Has These Points of Difference and Superiority

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

The great merit of this trap, its simplicity, its dependability and serviceability make it well worth being better acquainted with. Send for special printed matter describing it and giving prices. Address the Manufacturers.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.

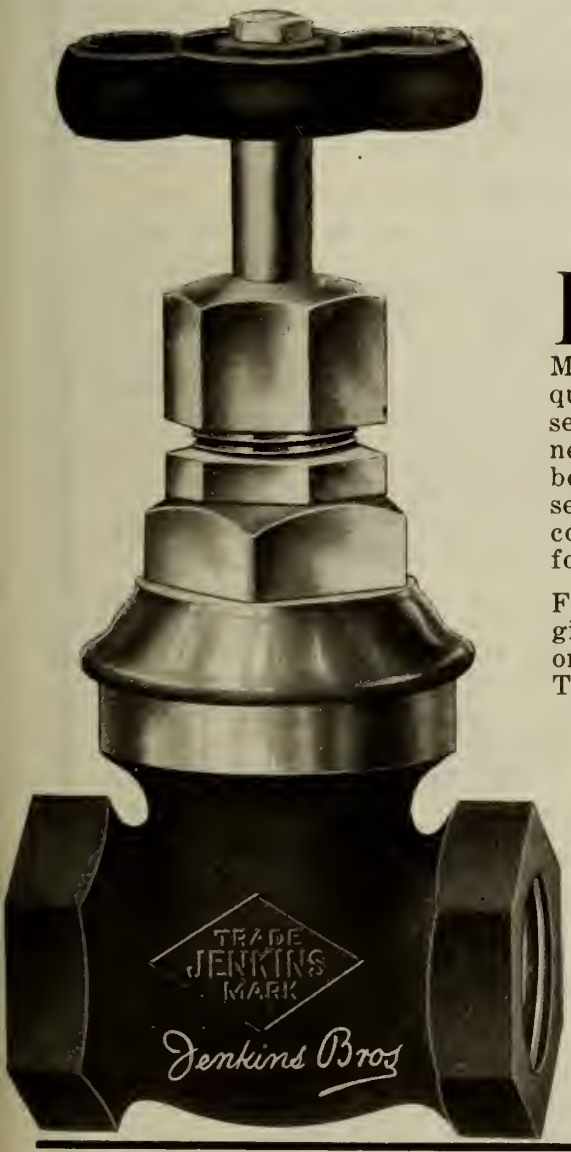
Agencies: 216 Fulton St., New York City; 174 N. Market St., Chicago, Ill.

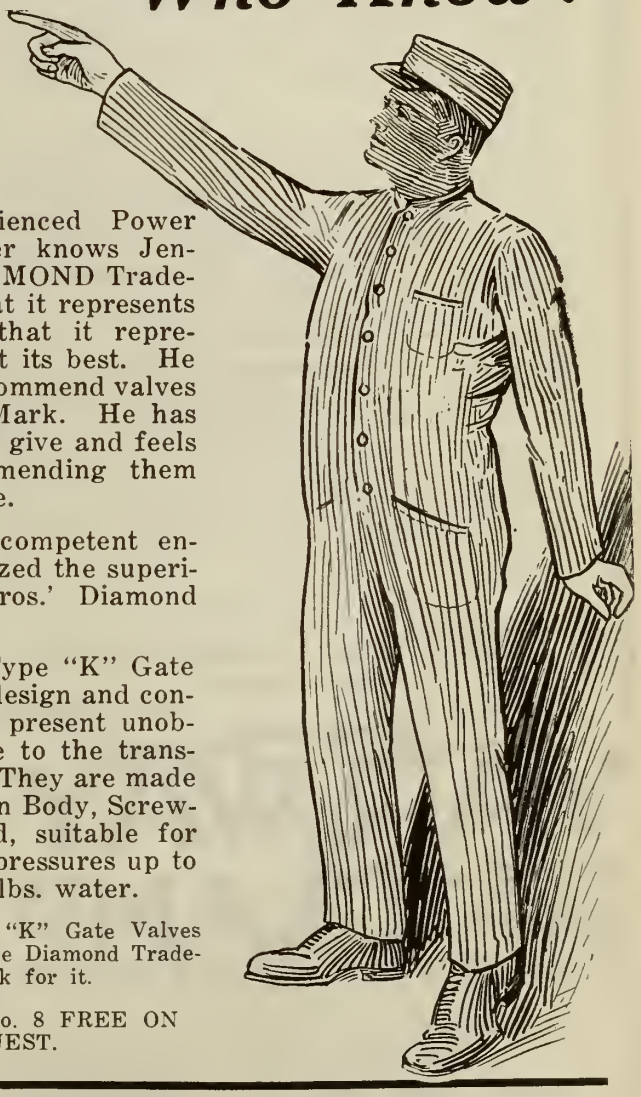
If any advertisement interests you, tear it out now and place with letters to be answered.

TRADE JENKINS MARK

Type "K" Brass and Iron Body Gate Valves

Appreciated by Men Who Know!





EVERY experienced Power House Engineer knows Jenkins Bros.' DIAMOND Trade-Mark—he knows that it represents quality—he knows that it represents valve service at its best. He never hesitates to recommend valves bearing this Trade-Mark. He has seen the service they give and feels confident of recommending them for any valve service.

For over 50 years competent engineers have recognized the superiority of Jenkins Bros.' Diamond Trade-Mark Valves.

Jenkins Bros.' Type "K" Gate Valves excel in design and construction. They present unobstructed passage to the transmitted medium. They are made in Brass and Iron Body, Screwed and Flanged, suitable for working steam pressures up to 125 lbs. or 175 lbs. water.

All Genuine Type "K" Gate Valves are identified by the Diamond Trade-Mark. Always look for it.

CATALOGUE No. 8 FREE ON REQUEST.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street, Montreal, Canada

Agencies in all Principal Countries of the World

European Branch: 6 Gt. Queen St., Kingsway London, W.C., 2, England

TRADE JENKINS MARK Jenkins Bros

There's a Big Waste in Little Leaks

Do you know that a one-tenth inch pipe-joint leak at 150 lbs. pressure will waste steam in a year at a cost to-day of approximately $825? Figure it out for yourself. Leak one-tenth inch; pressure 150 lbs.; 9 lb. steam per lb. coal; coal $5.50 ton; 10 hours per day; 300 days per year.

And it's such an unpatriotic waste in these days of coal conservation—such a needless and careless waste at any time—for the leak can be stopped in a few minutes' time with a YARWAY (formerly Simplex) PIPE JOINT CLAMP.

More than 13,000 leaks have been stopped since this effective clamp was first placed on the market. Millions of dollars have been saved. The saving in coal can only be guessed.

The Yarway (formerly Simplex) can be attached in a few minutes by any workman. The principle can be seen from the illustration shown here.

If there is a pipe-joint leak in any of your lines, tell us the size and we will send you a Yarway for 30 days' trial. Instead of returning it, you will probably be as enthusiastic over its success as the man who said of a Yarway Clamp, "It's worth its weight in gold."

Write To-day

YARNALL WARING CO.
7604-20 Queen St.
CHESTNUT HILL PHILADELPHIA

YARWAY
PIPE-JOINT CLAMP
Formerly the SIMPLEX

1 2 3

Canadian Representatives Carrying Stock

CUNNINGHAM HDWE. CO.
New Westminster, B.C.

JAS. ROBERTSON CO.
Montreal

GORMAN CLANCY GRINDLEY CO.
Calgary, Alta.

Here Is a Good Formula

TO SAVE MONEY

$$C\left(0.98 - \frac{dn}{DN}\right) = \$ \text{ wasted per year}$$

Where—

C=cost of power per year for the given drive dollars;

d=diameter of driven pulley plus belt thickness, inches;

n=r.p.m. of driven pulley,

D=diameter of driving pulley plus belt thickness, inches;

N=r.p.m. of driving pulley.

If you don't like formulas, do it this way:

(1) Add diameter of driven pulley to belt thickness, inches, and multiply by r.p.m. of driven pulley.

(2) Add diameter of the driving pulley to belt thickness, inches, and multiply by r.p.m. of driving pulley.

(3) Divide (1) by (2)

(4) Subtract (3) from 0.98

(5) Multiply (4) by the cost in dollars per year of power for the drive.

The result is the dollars wasted per year because of unnecessary belt slip. These dollars can as well be saved by simply treating the belt with Cling-Surface.

Cling-Surface primarily stops slip. It also permits easy or slack running, thus permitting a belt to embrace the pulleys through maximum arcs. Hence Cling-Surface treated belts are doubly insured against slip.

Cling-Surface also makes the belt impervious to dampness and resistive to heat, cold, chemical fumes, etc. It reduces internal friction and adds greatly to belt life.

If you are at all interested in saving belt money you should take advantage of our trial offer. Order a 50-lb. can of Cling-Surface for a 30-day trial. Pay for it if you're satisfied. If unsatisfactory, the trial won't cost you a cent.

Cling-Surface Co.
1057 Niagara Street
Buffalo, New York
U. S. A.

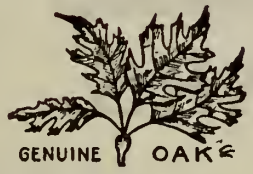
Let what users say guide you in your selection *of that New Belt*

Many of Canada's largest and most efficient Power Plants are constant users of

D. K. McLAREN'S

Genuine British Oak-Tanned

LEATHER BELTING



This trade-mark guarantee is on every piece of D. K. McLaren's Leather Belting.

Look for it.

WE'LL be glad to put you in touch with some of our many customers in your particular district, in order that you can ask them for their opinions regarding our manufacture and you judge accordingly.

COULD any but a good, reliable belt bear such an investigation?

D·K·McLAREN LIMITED

Head Office and Factory:

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VANCOUVER, B.C. 849 Beatty St.

ST. JOHN, N.B. 90 Germain Street

Dominion Belting Company, Limited
Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

TRADE MARK

TRADE MARK

THIRTY YEARS

TEXAS BANNER MILLS,
Terrell Milling Company,
Terrell, Texas.

Magnolia Metal Co. Aug. 30, 1918.

Gentlemen:—

Wish to state that we have been using Magnolia Metal for the past THIRTY YEARS.

Magnolia has been used continuously on the wrist of our Buckeye Engine, 85 H.P., 115 pounds pressure, with perfect satisfaction.

We shall continue to use Magnolia Metal.

Yours truly,
TERRELL MILLING CO.,
E. M. Friend, Supt.

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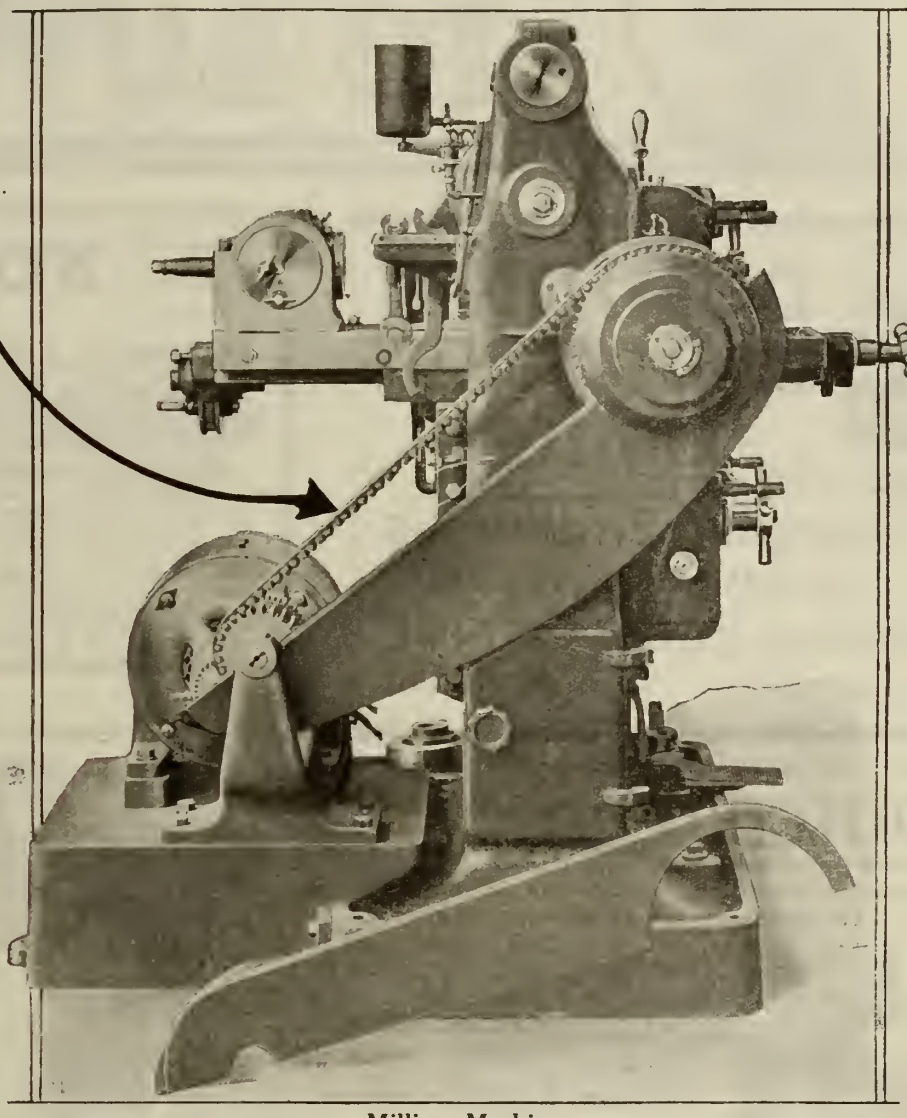
MORSE CHAIN COMPANY ITHACA, NEW YORK

99%

Quiet as a Belt.

Positive as Gears.

Oil Bath not Required.



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The drive that will do the most work, the steadiest work, the best work. Made for every purpose from ¼ H.P. to 5,000 H.P. Adopted by engineers as durable, simple, unaffected by heat, cold, oil or moisture. Let us have your general lay-out and design your drives to suit your special conditions.

Secure our Estimate. Write for Bulletins and 1919 Diary and Memo. Book.

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GREENSBORO, N.C. ..... 805 Ashboro Street
NEW YORK CITY ..... 50 Church Street, Hudson Terminal Bldg.
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LICENSEES FOR EUROPE AND EASTERN HEMISPHERE
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GENERAL SALES OFFICE

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NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 10 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

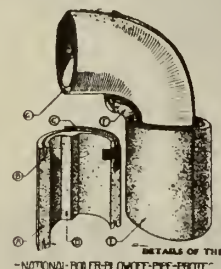
Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A: PH. D., Superintendent, Tradee & Labour Branch.

PROTECTION means Safety and Greater Efficiency

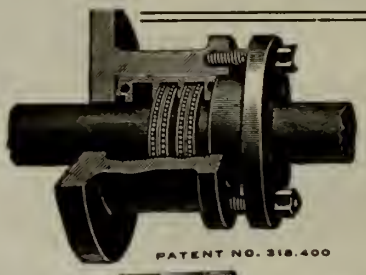
Endorsed by all Boiler Experts and Engineers

Details of the NATIONAL BOILER BLOW-OFF PIPE PROTECTOR



A Show One Half of Refractory Tile.
B Slot to Receive Locking Bar.
C Locking Bar Fitted in Slot.
D Ridge for Regulating Air Space
E Complete Cover for Pipe Locked
F Elbow or Bend Around Pipe
G Pipe Enclosed in Cover

National Boiler Protector Coy. of Canada
Room 24, Lombard Building
TORONTO, ONT.
Main 2623



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,630
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,637
" "	726,368	" "	895,791
" "	774,490	" "	898,066
" "	775,193	" "	906,103
" "	775,194	" "	934,629
" "	791,300	" "	979,206
" "	805,669	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
Incorporated 1897

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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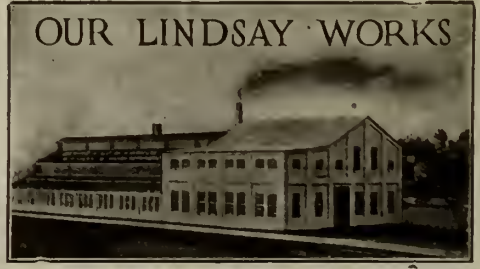
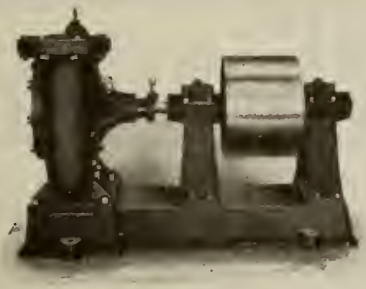
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
Lindsay, Ontario



Send that PUMP inquiry to

The Smart-Turner Machine Co.
LIMITED
HAMILTON, CANADA

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.

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Engineers, Manufacturers and Founders
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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
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TORONTO

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THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa.

Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

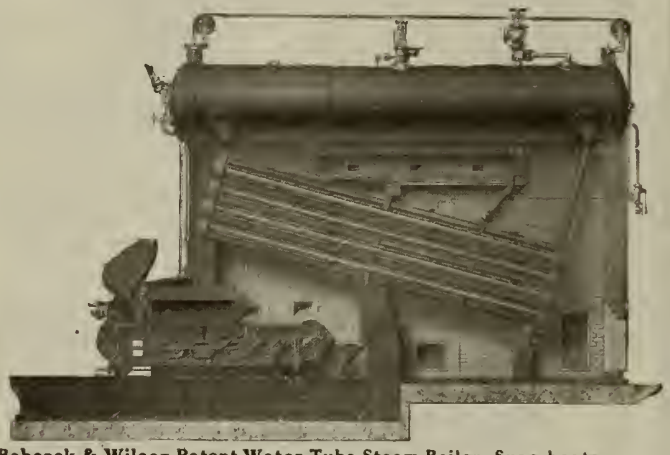
ADVERTISING to be successful does not necessarily have to produce a basketful of inquiries every day.

The best advertising is the kind that leaves an indelible, ineffaceable impression of the goods advertised on the minds of the greatest possible number of probable buyers, present and future.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

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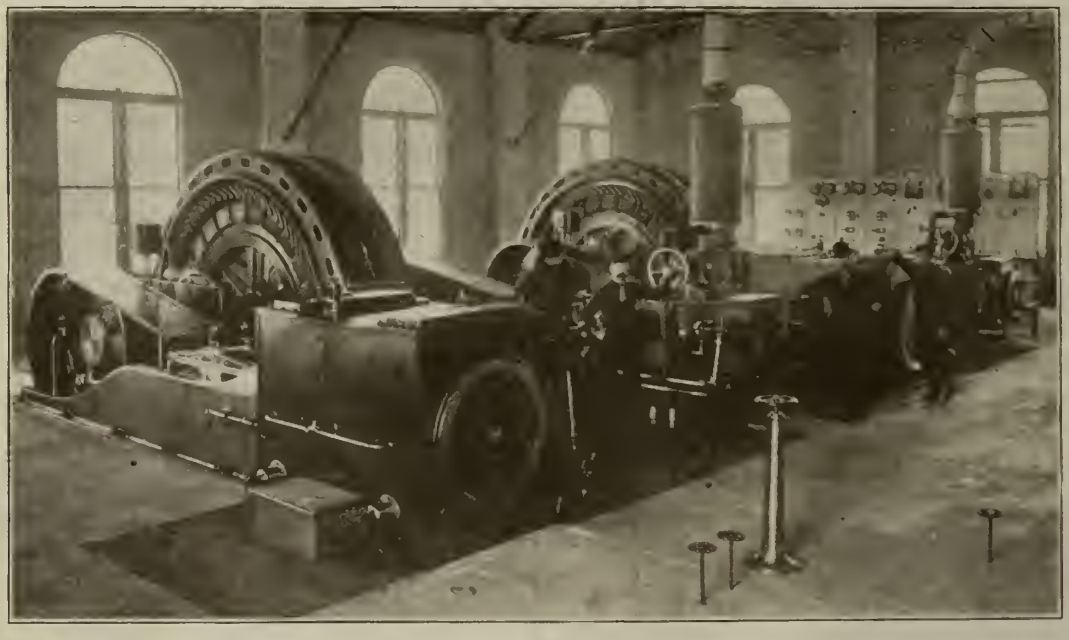
25 Cycle Engine Generator Sets For Sale



1—250 KW.
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Westinghouse
Generators
Direct
connected to
McIntosh &
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Gridiron Valve
Engines 150
R.P.M.

These units were in use only seven months and are in first class condition.
Write for further particulars and quotations.

Power Plant Equipment Co., Dominion Bank Building **Toronto, Ont.**

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If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

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Homestead Valve Mfg. Co., Pittsburgh, Pa.
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Frick Co., Waynesboro, Franklin Co., Pa.
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Canadian Fairbanks-Morse Co., Ltd. Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd. Montreal.
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Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Montreal.
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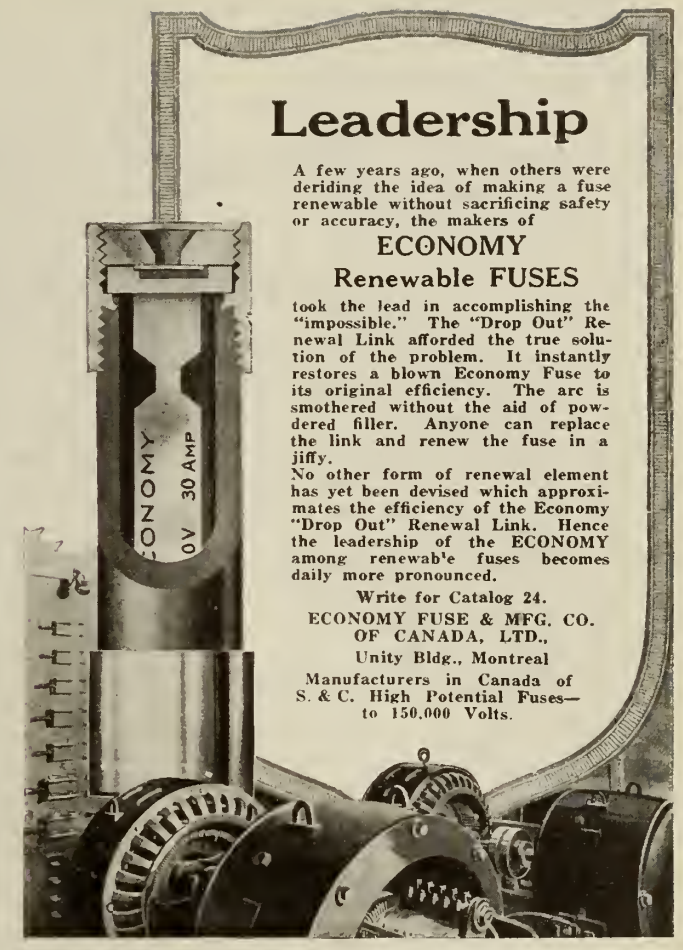

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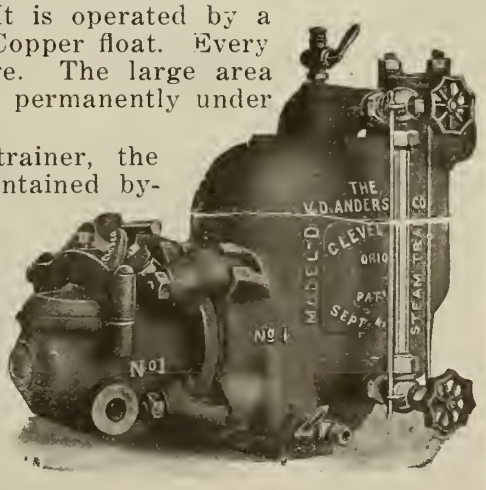

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Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
Milton & Prentiss, Toronto.
McAvity, T., & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

GRAPHITE, BOILER
Wm. C. Wilson & Co., Toronto.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Galt Foundry Co., Galt, Ont.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Albany Lubricating Co., New York City.
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.

GREASES
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Wm. C. Wilson & Co., Toronto.

GAUGES, DRAFT
Jas W. Hays Corp. Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Can. S K F Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOISTS, GRIP
Jordan Bros., Inc., New York, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

HOSE, METALLIC
Pennsylvania Flexible Metallic Tubing Co., Boston, Mass.

HOSE, STEAM, SUCTION AND WATER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.
Vorhees Rubber Co., Ltd., Montreal.

HOT WATER GENERATORS
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Wood & Co., R. D., Philadelphia, Pa.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Hamilton Mfg. Co., Wm., Peterboro, Ont.
John McDougall Caledonian Iron Wks., Montreal.

HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.

HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.

INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

KILNS

KEROSENE PUMPS (SELF MEASURING)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

KEROSENE TANKS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Wm. C. Wilson & Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont
Can. B. K. Morton Co., Toronto, Montreal.
Crane Packing Co., Chicago, Ill.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, ELECTRIC
Wm. C. Wilson & Co., Toronto.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, NITRO
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICANTS
Albany Lubricating Co., New York City.
Canadian Economic Lubricant Co., Montreal.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

LUBRICATING OIL STORAGE SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne Ind.

LUBRICATORS CYLINDER CUTTING COMPOUNDS
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

LUBRICATORS, FORCE FEED
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que
Beveridge Paper Co., Ltd., Montreal, Que

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

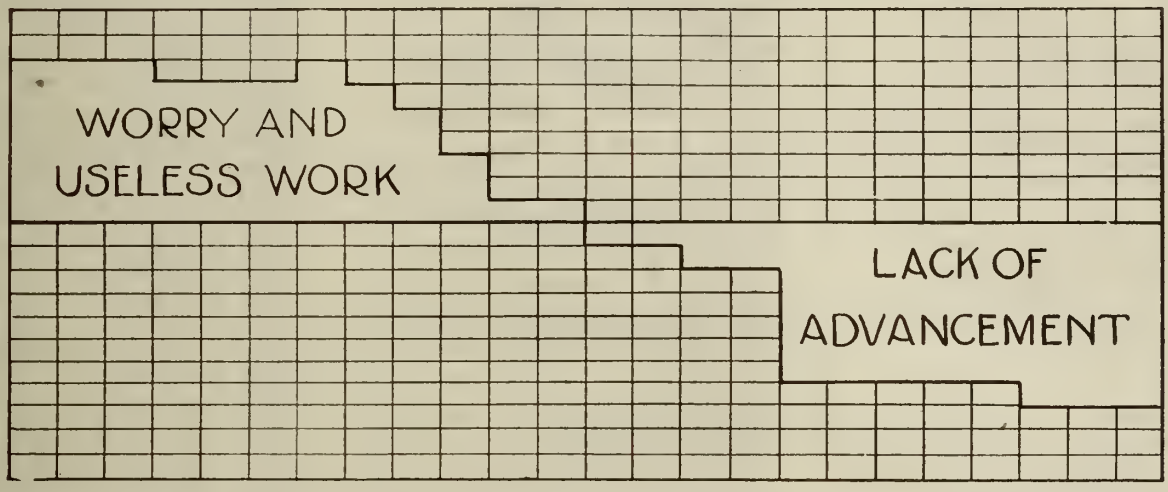
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Yarnall Waring Co., Philadelphia, Pa

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

If any advertisement interests you, tear it out now and place with letters to be answered.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

OAKUM
Wm. C. Wilson & Co., Toronto.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

OIL CUPS
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

OIL SEPARATORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Albany Lubricating Co., New York City.
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Kellogg & Co., E. H., New York, N.Y.
Wm. C. Wilson & Co., Toronto.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING ENGINE
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
Wm. C. Wilson & Co., Toronto.

PACKING, HYDRAULIC
Can. H. W. Johns-Manvillo Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Durahla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont
Crane Packing Co., Chicago, Ill.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesharre, Pa
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING, ROD
Can. H. W. Johns-Manville Co., Toronto, Ont
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.
Vorhees Rubber Co., Ltd., Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
Wm. C. Wilson & Co., Toronto.

PACKING PISTON
Crane Packing Co., Chicago, Ill.

PACKING, VALVE STEM
Crane Packing Co., Chicago, Ill.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

PAINTS
Wm. C. Wilson & Co., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE, CAST IRON
Wood & Co., R. D., Philadelphia, Pa.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Mueller Mfg. Co., H., Sarnia, Ont.
Wm. C. Wilson & Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Storey Pump & Equipment Co., Ltd., Toronto

POWER, TRANSMISSION MACHINERY
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., New York.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont

PRESSURE BLOWERS, CENTRIFUGAL
Can. Sirocco Co., Windsor, Ont.

PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

PULLEYS
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. Bond Hanger & Coupling Co., Alexandria Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Hamilton Co., Wm., Peterboro, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
Bawden Pump Co, Toronto.

PUMPS, FEED WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMP GOVERNORS AND REGULATORS
Darling Bros., Montreal.
G. M. Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

PUMP STRAINERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Liberty Mfg. Co., Pittsburgh, Pa.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal
Hamilton Co., Wm., Peterboro, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

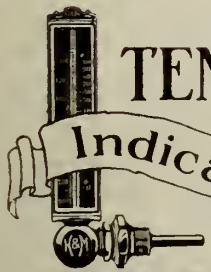
PUMPS, STEAM TURBO
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.

PUMP TANK, RECEIVER
American Steam Pump Co. Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM
American Steam Pump Co., Battle Creek, Mich
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.

Tycos

TEMPERATURE INSTRUMENTS



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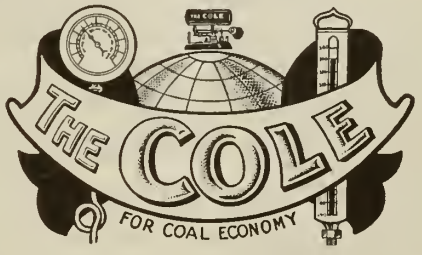
Boiler Feeding Methods	Amount of fuel used lbs.	Saving of fuel over the amount required by pump feeding cold water
Direct acting pump feeding cold water.	100	0%
Injector feeding and warming the water average temp. (150 deg. F.)	98	2%
Injector feeding thru heater at average temp. 210 deg. F.).	93	7%
Direct acting feed pump feeding thru heater	88	12%
Power pump through heater	86	14%
		Over direct acting pump feeding with hot or cold water
Direct return boiler feed traps as before explained	14	86%



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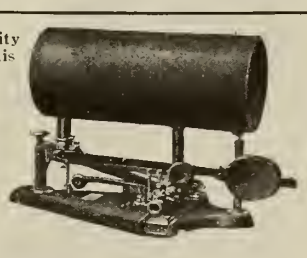

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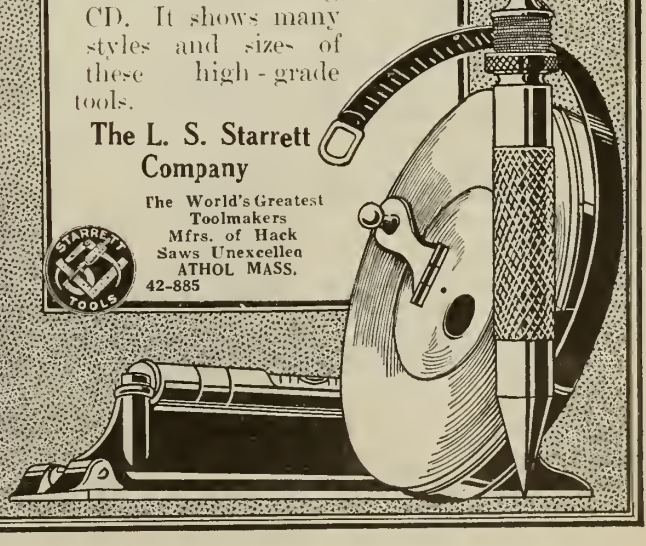

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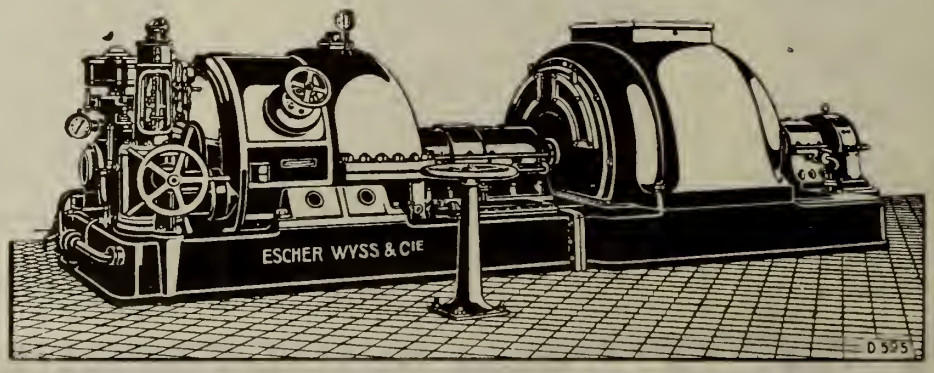

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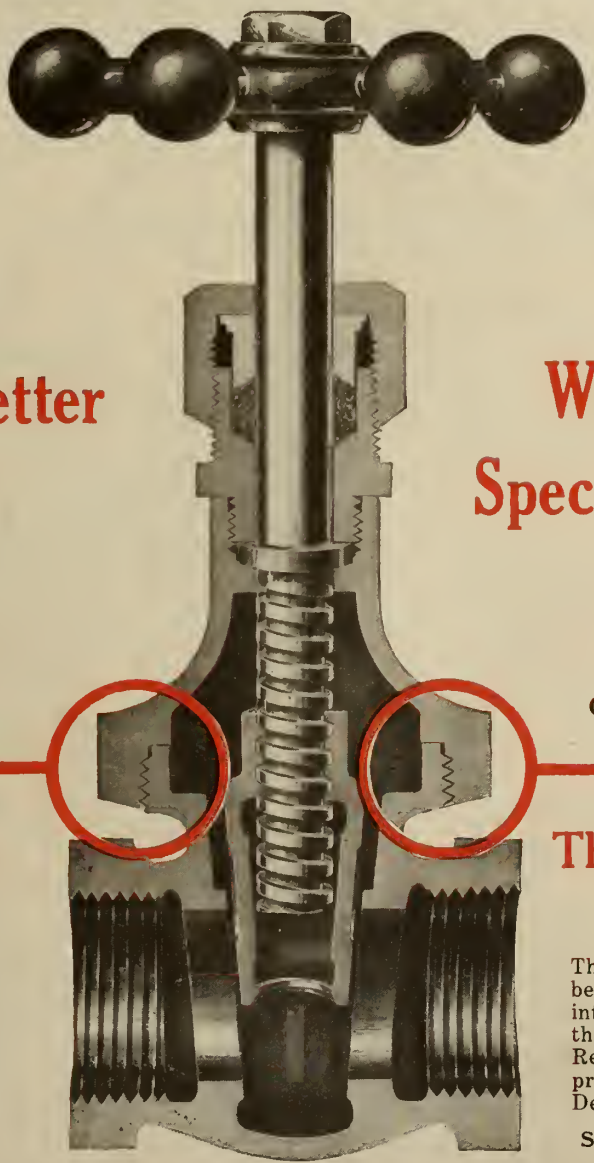

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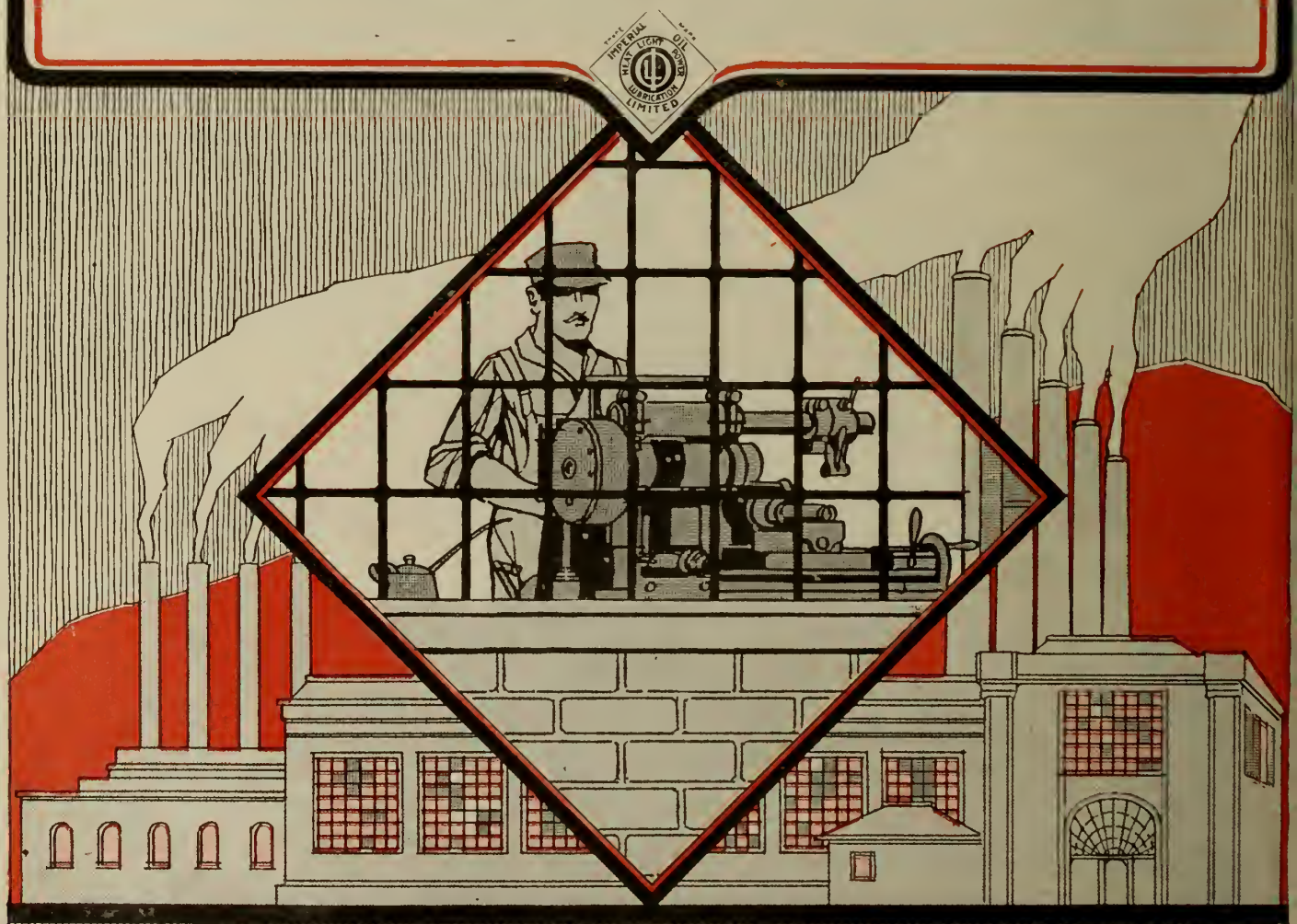

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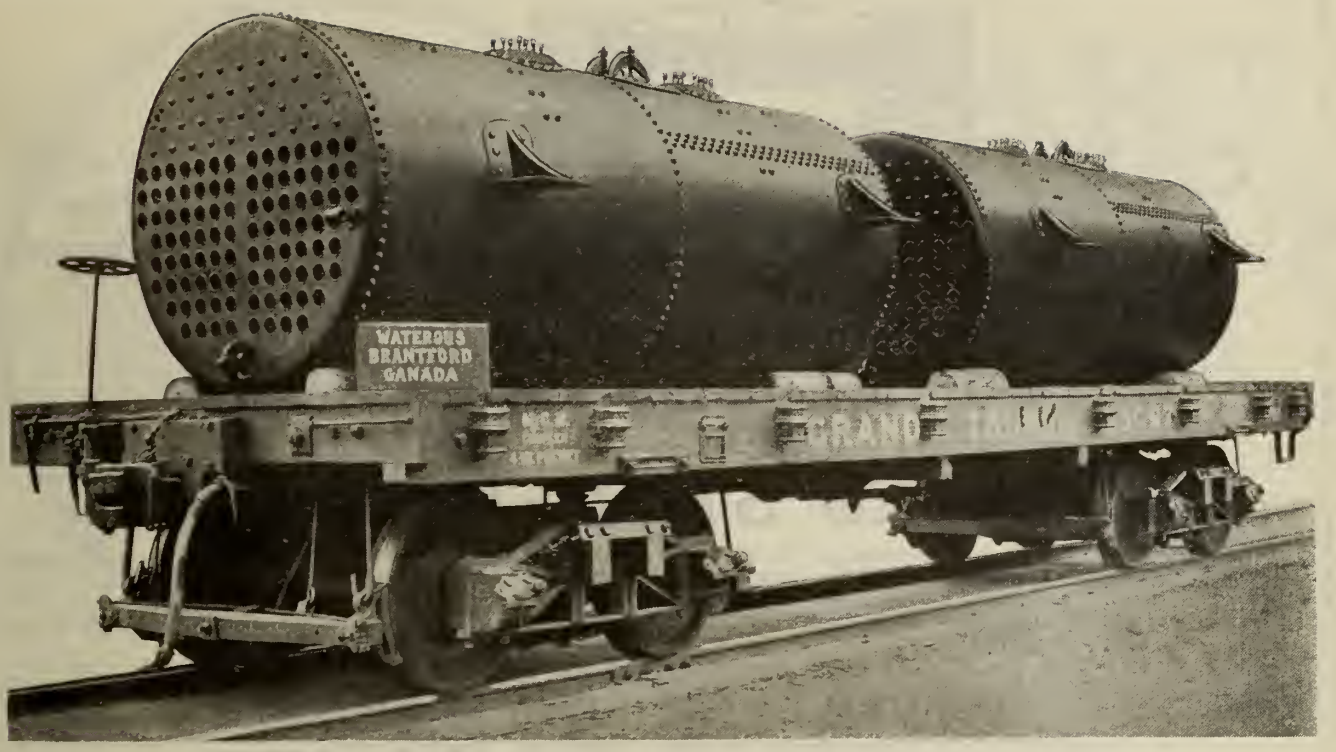

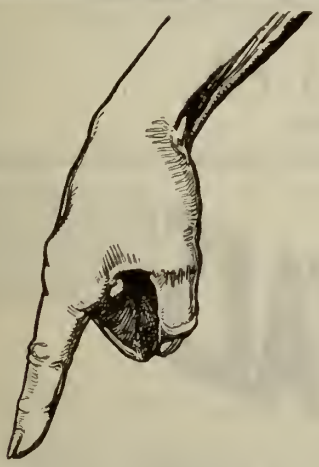

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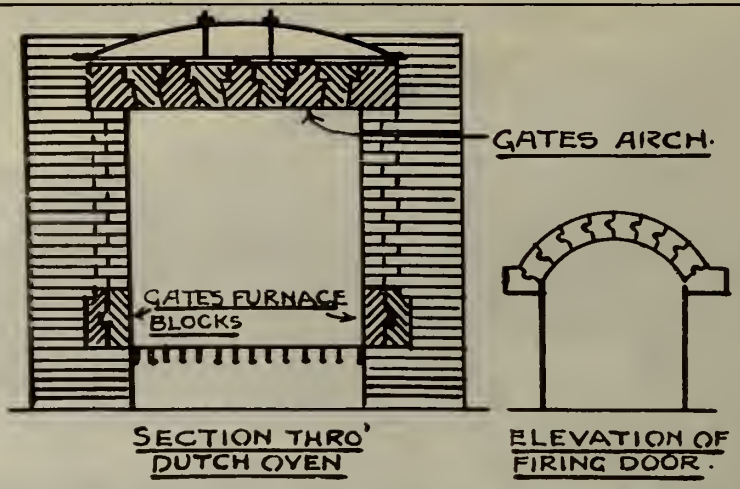

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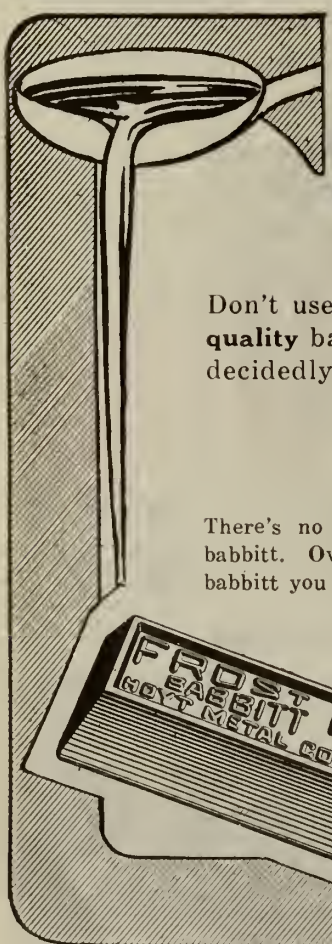

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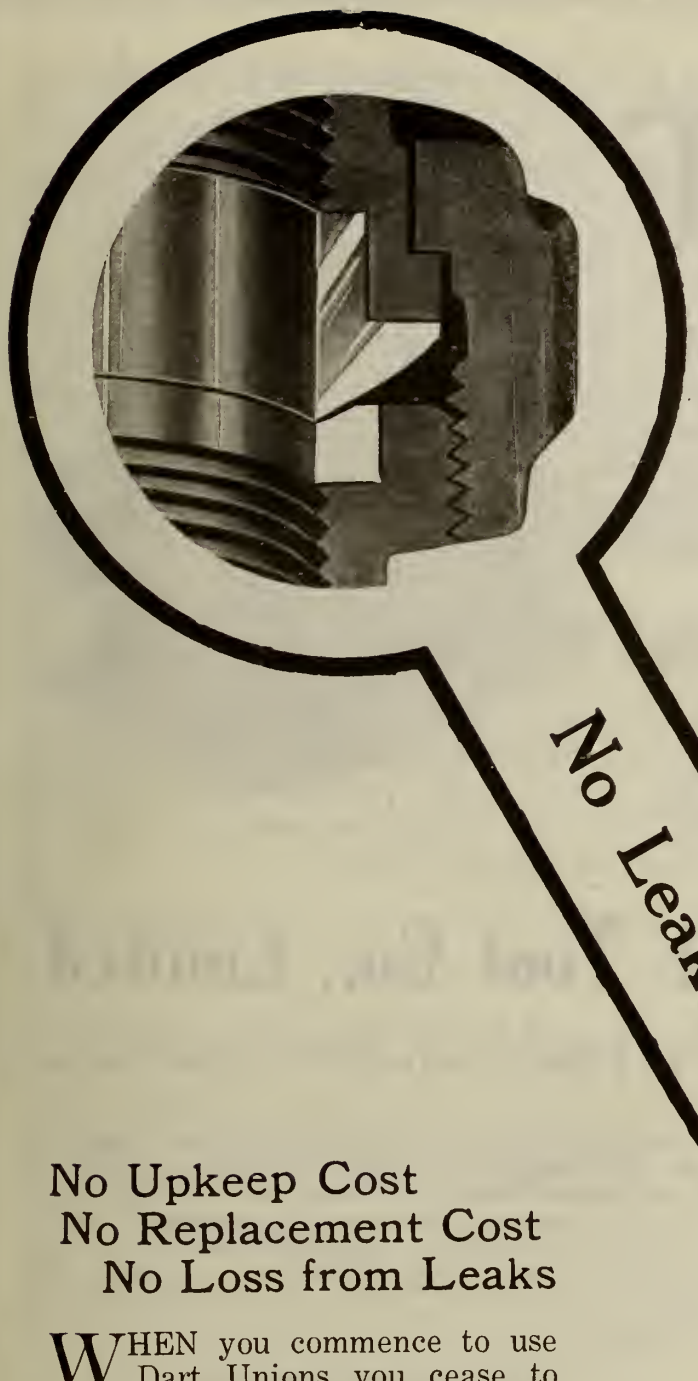

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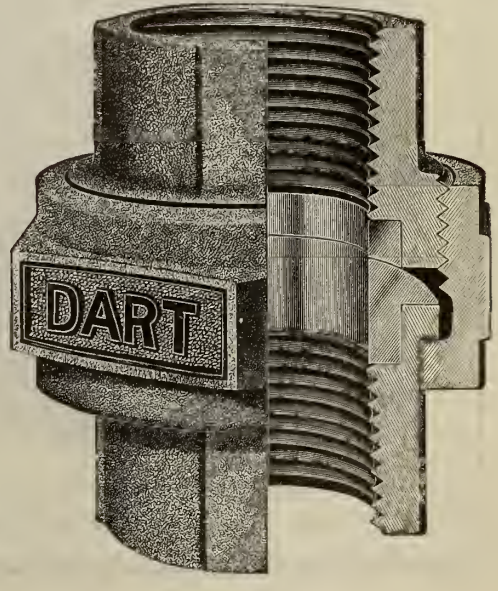

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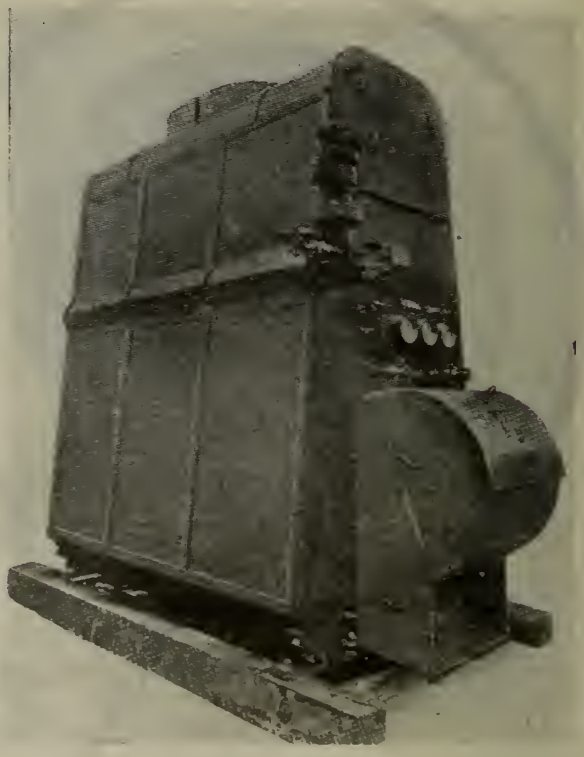

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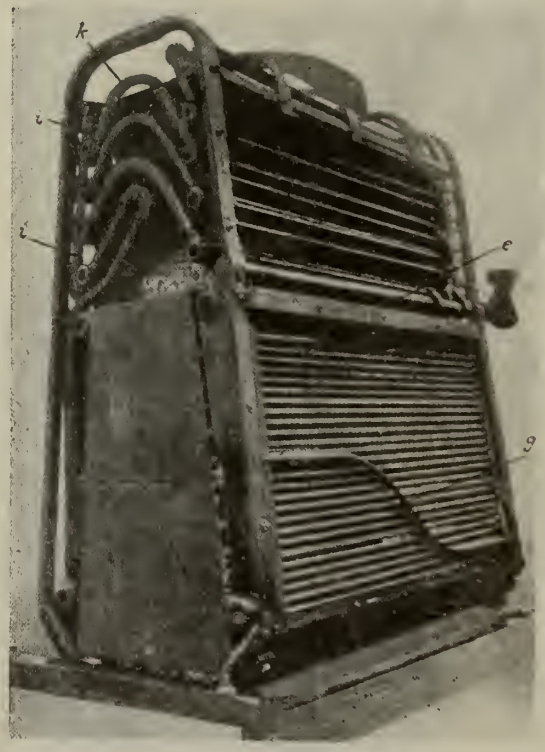

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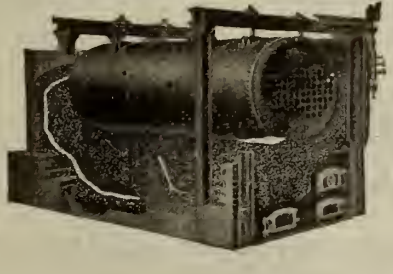

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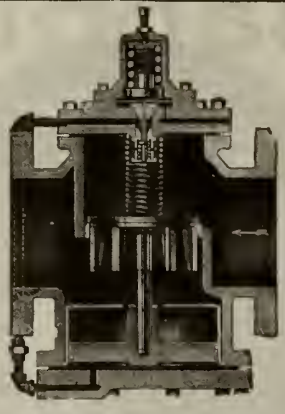

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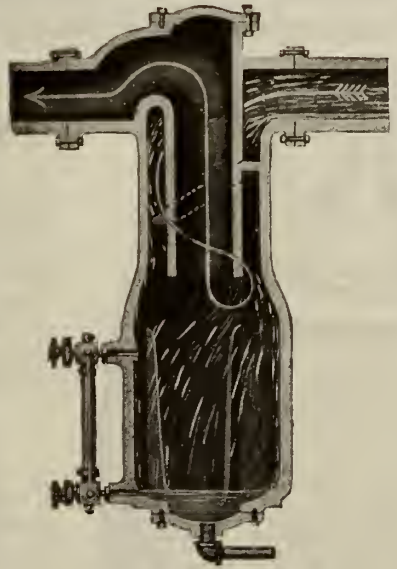

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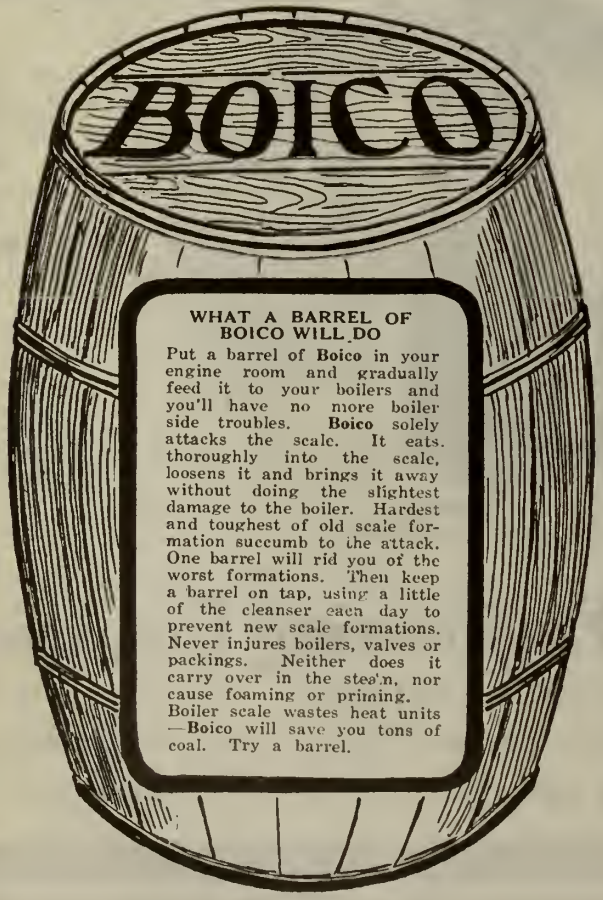
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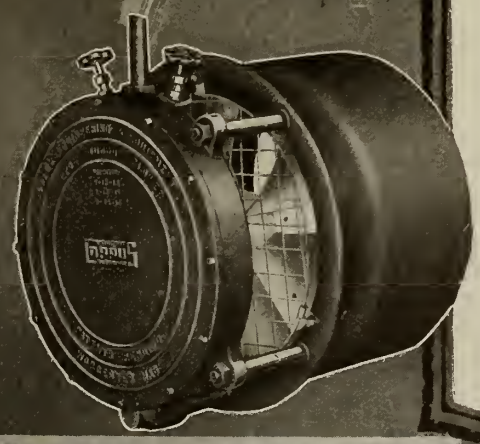

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341 Park Avenue **Worcester, Mass.**

Agents for Montreal: Mason Regulator & Engineering Co.
Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Building

COPPUS TURBO BLOWER

LINDE PRODUCTION STANDS SUPREME

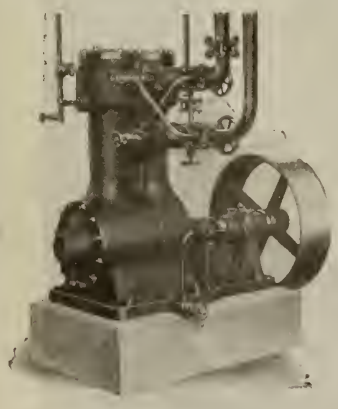
Because at all times really fine materials are used; and because each and every machine receives a degree of individual attention that is impossible in mass production.

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

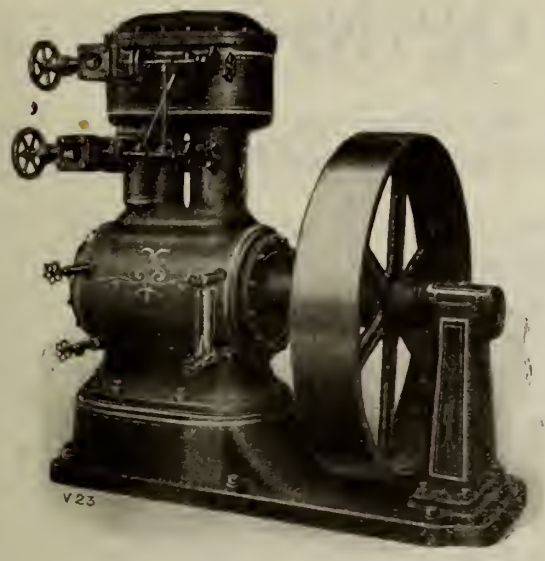
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



Get Your Plant Ready For Big Business

1919 is going to prove the fact that people of all classes have been taught to conserve food.

Ice-making plants will be taxed to capacity to supply the demands for household purposes.

Refrigerating Plants and Cold Storage Houses will also prove excellent investments.

All orders for Ice-making and Refrigerating Equipment will receive prompt attention. Ammonia Fittings and Supplies shipped on short notice.

Write for Catalogs.

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of "Ice and Frost."

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Temptations

In these days of high prices, the temptation is often strong to put off repairs and improvements until the last minute, and then try to save money by purchasing materials cheaper in first cost but of doubtful efficiency. Either policy is liable to prove disappointing and costly in the end.

The time to get ready for next season's business is not when the hot weather is upon you, but right now when winter is relieving the load on your cold storage rooms. The sooner you make your repairs and improvements, the better. Materials are scarce and transportation is very uncertain at best.

And nowadays the best is still the cheapest. You can get cold storage insulating materials that will be cheaper than Nonpareil Corkboard in first cost, but in the long run—after they have become moisture-soaked, worthless as heat-insulators and have to be replaced—they are many times more expensive.

Fruit storage room insulated with Nonpareil Corkboard. Altschul Bros. Company, Lima, Ohio.

If you are not already familiar with it, there are many facts about Nonpareil Corkboard Insulation that will interest you as a business man. The 152 page, illustrated book and samples of the materials will be sent, free of charge, on request.

ARMSTRONG CORK & INSULATION CO.
504 McGILL BUILDING MONTREAL, QUEBEC, CANADA

Branches in the principal cities of the United States and Canada. Also manufacturers of Nonpareil Cork Covering for all cold pipes.

Nonpareil Corkboard Insulation
For Cold Storage Rooms

AN UNBIASED OPINION

No matter how large nor how small the problem confronting you in connection with your Refrigerating requirements, our entire Organization is on the job to help you.

Sound advice in the beginning has saved many a firm and individual both time and money. We often learn something ourselves through these consultations, so we are always glad to help.

With our complete line of Ice-Making and Refrigerating Machinery, we are unbiased in our opinions. We fit the plant to your local conditions. We want every York Plant to stay sold and sell another.

List of customers, booklet, catalog, or information of any kind on the subject of Mechanical Refrigeration is yours for the asking without cost or obligation on your part.

Write us about your requirements and your inquiry will be referred to our Branch in your territory. The close personal touch is the best way to start any negotiation.

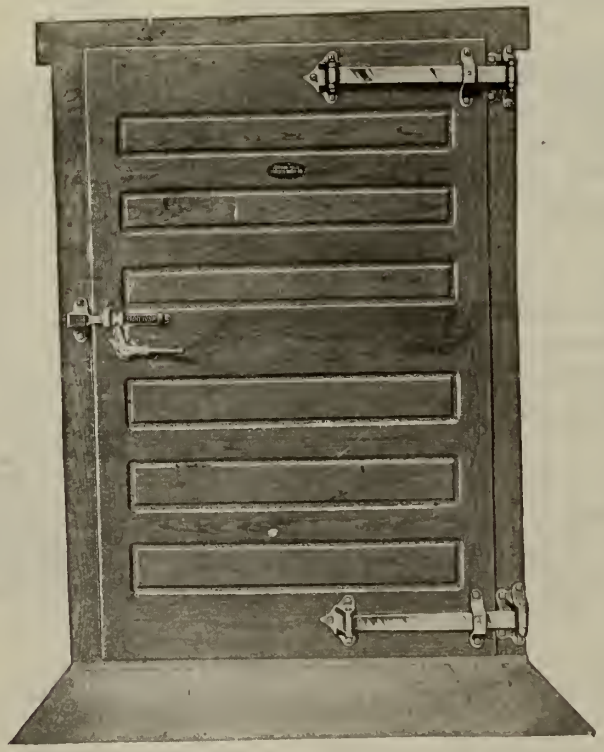
YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Ice Machine Company

WINNIPEG	TORONTO	MONTREAL	CALGARY
85 Lombard St.	82 Chestnut St.	626 Coristine Bldg.	605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

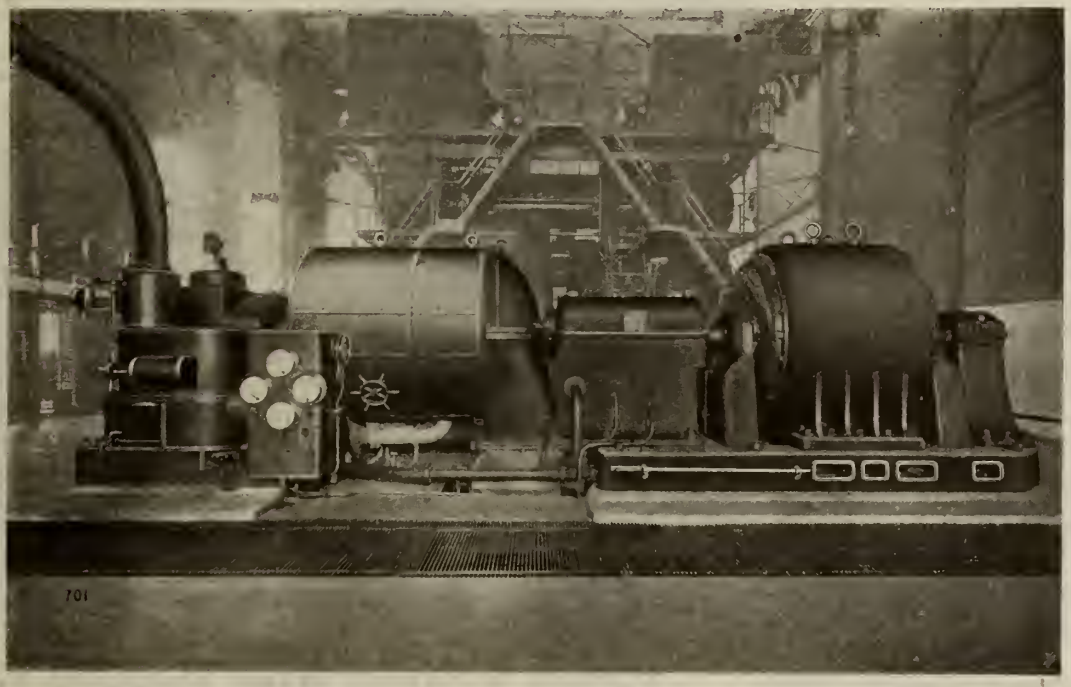
Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co.

HAGERSTOWN, M.D., U.S.A.

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom 2000 K.W. Steam Turbine at Montreal Tramways Power Plant

Belliss Steam Engines, Steam Turbines, Diesel Engines, Air Compressors, Condensing Plants

Heenan Refuse Destructors, Air Coolers, Water Coolers, Oil Coolers, Dynamometers

Paterson Water Softening Plants and Filters

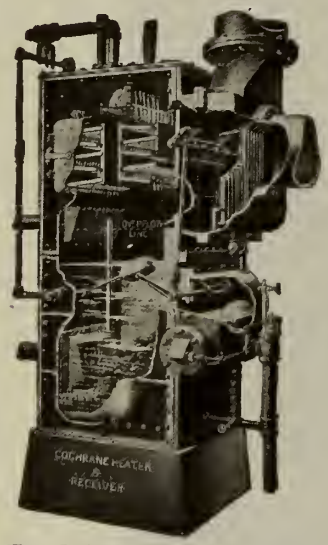
Centrifugal Pumps

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. - - MONTREAL

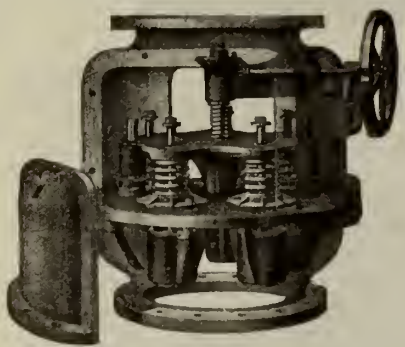
COCHRANE
COAL SAVERS



The Cochrane Open Feed Water Heater saves coal by utilizing exhaust steam to heat the feed water; 1% saving for each 11° F. rise.

The Sorge-Cochrane Hot Process Water Softener saves coal by heating the boiler feed water and by protecting the boilers against scale and corrosion.

The Cochrane Metering Heater saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.



The Cochrane Multiport Back Pressure Valve saves coal by preventing leakage of exhaust steam and by making it easy to adjust the back pressure whenever desired. The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.

The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.

Canada Is Saving Many Thousand Tons
of Coal Per Year by Using Cochrane Heaters

Here are the figures:

The horsepower of Cochrane Heaters in use is about 10,000,000 boiler horsepower.

The corresponding amount of coal burned is 35,000,000 lb. per hour.

Considering an average of 10 hours' operation per day, 300 days per year (many heaters run 24 hours per day, 365 days per year), this amounts to 105,000,000,000 lb. of coal per year, or 50,000,000 tons, worth at $5.00 per ton, **$250,000,000.**

The saving due to the use of Cochrane Heaters is 1% to each 11° F. rise in temperature. On the average, the water is raised from 100° F. to 210 F. using steam at atmospheric pressure, 10% or a saving of 10%. Cochrane Heaters are thus saving about **$25,000,000** per year, which is vastly more than the heaters cost.

In addition, Cochrane Oil Separators are saving millions of tons of coal by **purifying exhaust steam** so that it can take the place of live steam in heating and drying coils, low-pressure turbines and industrial processes.

Sorge-Cochrane Hot Process Water Softeners are saving millions by **keeping scale and corrosive substances out of boilers** and thus saving expense and labor in cleaning boilers, and for new tubes and other boiler repairs.

Cochrane Metering Heaters are also telling hundreds of **steam-plant owners**, managers and operators **how much they are gaining in economy** by using different coals, different methods of firing, different methods of controlling the draft, stopping up air leaks in boiler settings, cleaning soot and scale from heating surface, etc. The total gains realized in this manner often amount to 25% or more.

Our engineering department has given hard study to fuel economy for over 25 years. It will be glad to aid you with suggestions if you will describe your present boiler feed water heating, softening, or metering arrangements, the amount of exhaust steam you have available and what you are using it for.

Ask for a book on "The Profitable Utilization of Exhaust Steam."

CANADIAN-ALLIS CHALMERS
HEAD OFFICE: TORONTO **LIMITED**

Branch Offices: MONTREAL, QUEBEC, HALIFAX, OTTAWA, HAMILTON, LONDON, COBALT, SOUTH PORCUPINE, WINNIPEG, CALGARY, EDMONTON, NELSON, and VANCOUVER

Setting a Candle to Catch a Thief

OUTSIDE air that filters through the brick-enclosing walls of boilers, costs industrial America many thousands of dollars each year because such leakage "cools" the fire, kills draft and therefore wastes coal to the extent of thousands of tons in the national aggregate.

Yet, just as the detection of such leaks is easy (see note under picture), so is the remedy simple; but it is simple largely through the pioneer work of Johns-Manville in its practical contributions to boiler-furnace improvement.

Through a complete line of products listed below, Johns-Manville can assure plants of new standards of heat saving in the boiler-room; standards that met and satisfied the Government during the coal crisis just past, when tons of fuel were saved and many hours of shut-downs averted—at a consequenc increase in factory production.

Seldom has conservation been better served by Johns-Manville than in this branch of its service.

And it can be predicted that the products listed below, and the expert knowledge of their application, will be of as great service to the nation in this present period of post-war readjustment as they were during the war.

Because to the progressive plant, conservation has become permanently a national obligation, as well as a business expedient.

CANADIAN JOHNS-MANVILLE CO., LIMITED
Montreal Toronto Vancouver Winnipeg Hamilton
London Ottawa

These Johns-Manville Products save fuel in boiler-rooms:
High Temperature (Refractory) *Cements* for boiler settings.
Aertite Boiler Wall Coating for boiler wall exteriors.
Monolithic Baffle Walls—tight, durable, easy to install; prevent short circuiting of hot gases.
Asbestos Sheets and Blocks for insulating hot surfaces; *Insulating Cements.*
Heat Insulations for steam and hot water piping.
Steam Traps.
Sea Ring Packing—eliminates unnecessary friction between rod or plunger and packing.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos
and its allied products

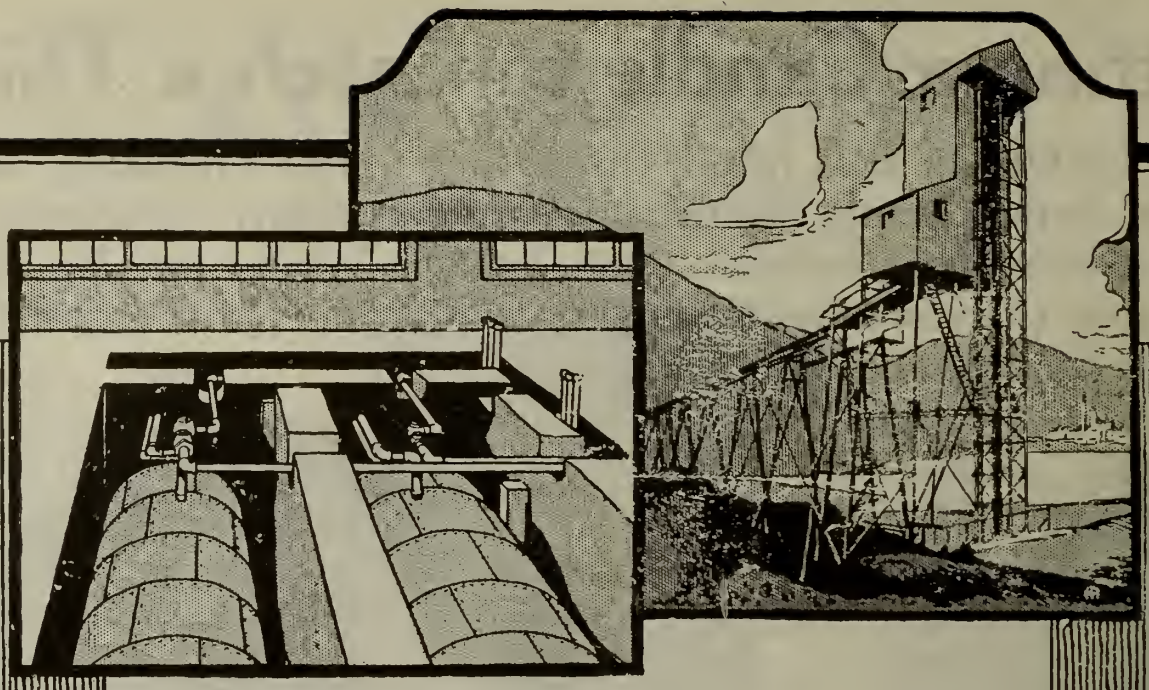
INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

A WOODEN frame, over which is fastened a square of cardboard having a small aperture at its center, is pressed against a boiler wall and the edges temporarily but completely sealed by some plastic material. It is obvious that any leakage in the part of the boiler wall covered by this frame, will immediately be detected by the inrush of air at the small aperture in the center of the cardboard, consequently, a candle flame held to this aperture will be sucked inward, thus immediately revealing the fact that there is an infiltration of air through the boiler wall, which means fuel waste.

Thousands of tons of coal have been saved by preventing boiler wall leakage and by similar corrective measures at and around the boiler furnace.

A complete service in this department of engineering was one of the important contributions made by Johns-Manville during the fuel crisis.

JOHNS-MANVILLE
Serves in Conservation



Most Efficient and Convenient

IMPERIAL FUEL OIL ushers in a new era in steam generating. It is highly concentrated, easily stored in small space and burns without ashes, litter or cinders.

Every pound of Imperial Fuel Oil delivers the same number of B.T.U. With it there are no furnace doors to remain open and no grates or stoking devices needed. It is easy to obtain an efficiency of 85% with Imperial Fuel Oil. It is impossible to obtain an efficiency greater than 65% with coal. Very few firms obtain anywhere near this degree of efficiency with coal as fuel.

When convenience of handling and storage are considered, advantages of Imperial Fuel Oil are at once apparent. The labor it takes to deliver coal from the ground, under the boiler makes up a big percentage of its price. There is little labor attached to the handling of Imperial Fuel Oil. There is no shovelling on and off the cars, into storage bins and then again into furnaces. Imperial Fuel Oil can be stored in small space at any convenient point (under ground if desirable), and unlike coal, it will not deteriorate in storage.

Those interested in efficient steam power—all concerned with the heating of buildings and steam navigation—will find it worth while to investigate the merits of Imperial Fuel Oil.

The Imperial Engineers will gladly advise regarding Imperial Fuel Oil and the installation of any equipment that may be necessary in connection with its use.

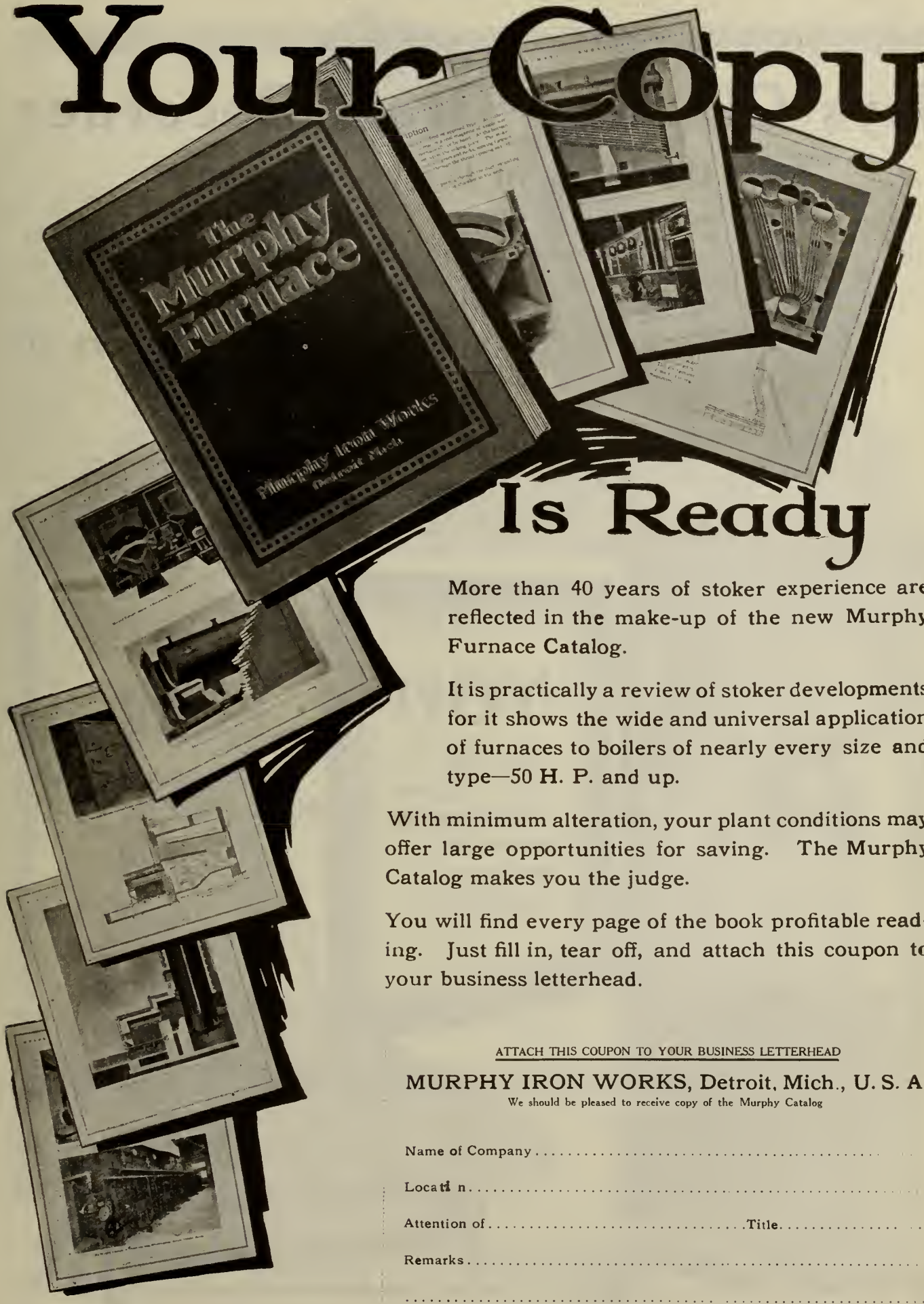
Inquire at Room 704, Imperial Oil Building, 56 Church Street, Toronto, Ontario.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

Your Copy



Is Ready

More than 40 years of stoker experience are reflected in the make-up of the new Murphy Furnace Catalog.

It is practically a review of stoker developments for it shows the wide and universal application of furnaces to boilers of nearly every size and type—50 H. P. and up.

With minimum alteration, your plant conditions may offer large opportunities for saving. The Murphy Catalog makes you the judge.

You will find every page of the book profitable reading. Just fill in, tear off, and attach this coupon to your business letterhead.

ATTACH THIS COUPON TO YOUR BUSINESS LETTERHEAD

MURPHY IRON WORKS, Detroit, Mich., U. S. A.

We should be pleased to receive copy of the Murphy Catalog

Name of Company .....

Location .....

Attention of ..... Title .....

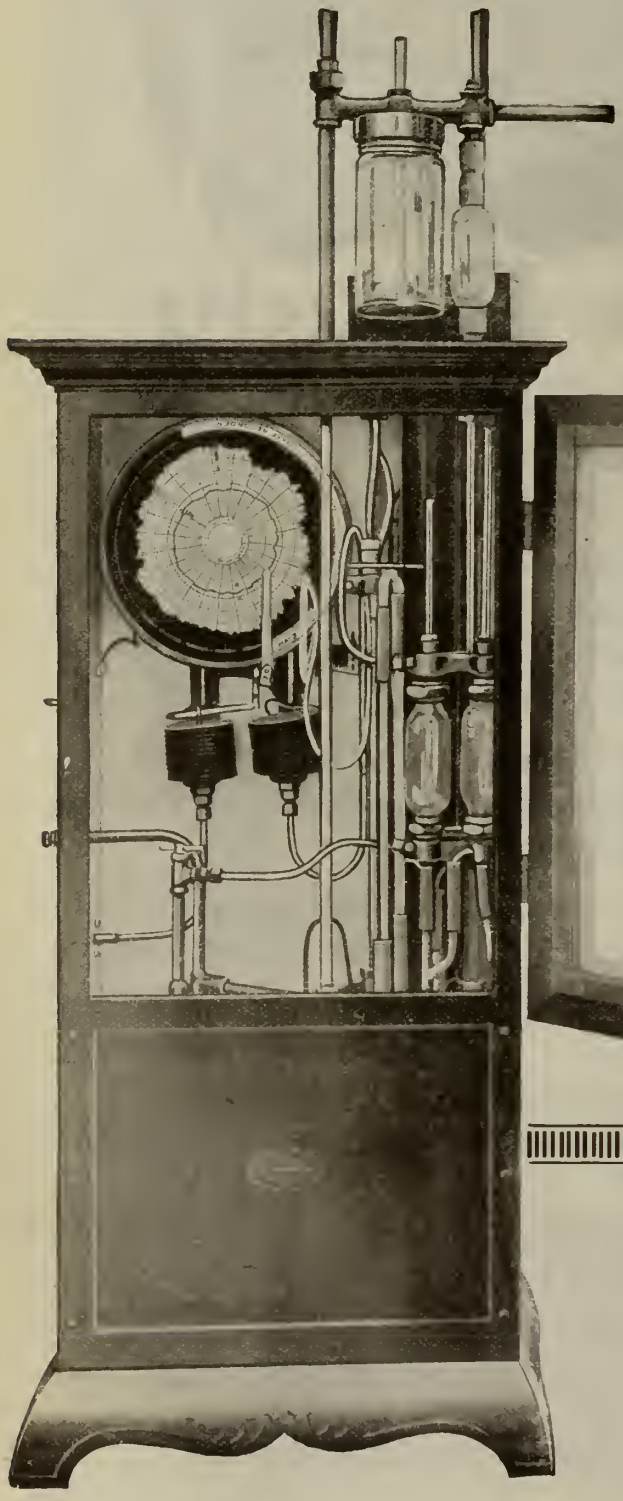
Remarks .....

.....

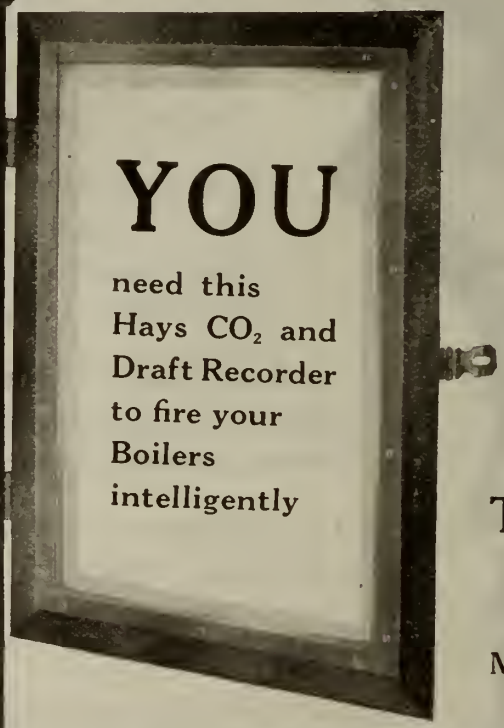
Hays CO_2 and Draft Recorder

Tells the Story of Boiler Efficiency

The exact reason why 30 to 50 per cent. more fuel is consumed in your plant than should be, is shown by the Hays CO_2 and Draft Recorder. With these appliances installed, your firemen can fire intelligently; they will work with accurate facts before them—instead of groping in the dark. For Hays CO_2 and Draft Recorder permanently record the story of efficient combustion



and Point Out Errors in *Firing, Draft, Boiler Settings, Etc.*



Hundreds of plants are using these Hays Appliances and saving 30 to 50 per cent. of their fuel expense as a result.

The Hays Recorder is automatic, self adjusting, infallible. It does not depend on hand adjustment and mechanical action for accurate operation. Indications are controlled by rising and falling columns of mercury, water and caustic potash.

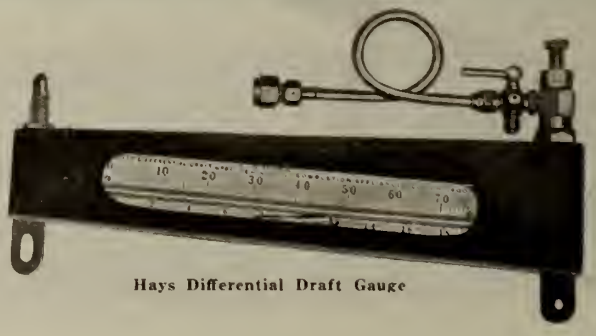
We invite you to investigate, believing the facts will convince you that these Hays Appliances would quickly earn their cost in your plant.

Write for booklet "FUEL"

The Jos. W. Hays Corporation

300 Hays Ave.

Michigan City, Indiana, U.S.A.



Hays Differential Draft Gauge

"See How That Thimble Locks Tight in the Side Bar"

In the Jeffrey Improved Carrier, a Steel Side Bar Chain with Double Bushed Joints is used.

Lugs in the steel side bars are locked tight to notches in both ends of the bushings confining all wear to the bushings which are readily renewable.

The two hardened steel bushings are assembled one within the other. The outer one is fixed to the inside bars and serves as a bearing for the chain roller. The inner bushing is fixed to the outside bar, and acts as a chain pin and receives the carrier cross rods.

Write for Catalog No. 210-4 describing in detail all the strong points of the Jeffrey Improved Carrier. Send for copy.

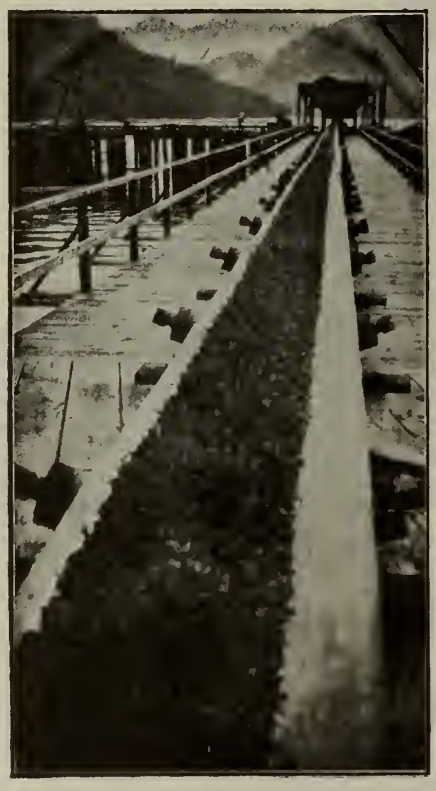
The Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL

Handle it Mechanically

Keeping Down the Cost of That Everyday Job of Conveying



FEW conveyor belts face extraordinary conditions, suffer extraordinary usage. It is on the everyday job—the steady grind—that a belt must make good to the last degree. Must give economical cost.

Take the Pacific Mills, Ocean Falls, B.C. Their conveyor job is to handle 45 tons of pea coal per hour over a distance of 476 feet. The conveyor runs level for 311 feet, and rises 30 feet in the remaining 165 feet. Motor 20 h.p. Head pulley 36 inches. Tail pulley 30 inches. Speed 285 feet per minute. Top rolls 6 feet apart. Return rolls 10 feet apart. Not a big belt problem. But a place where the conveyor belt must give long, economical service.

We recommend Goodyear Extra Duty Conveyor Belting *5 ply* with a 3-32 inch cover. This belt has a perfect service record up to the present—is still running and looks good for five years more service.

It is on just such jobs as this that Goodyear Conveyor Belting is winning the closest friends. If you have a conveyor drive on which costs are high, ask for a Goodyear belt man to advise with you. No obligation on your part. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co.
OF CANADA, LIMITED

Branches: Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Calgary, Edmonton, Vancouver

GOODYEAR
MADE IN CANADA

CONVEYOR BELTING

VULCABESTON

The General Utility Packing that works right in every class of service

"VULCABESTON" RED FIBRE STEAM SHEET PACKING

Wherever There's A Gasket

In great power houses and small ones, in refrigeration plants, in chemical factories, where corrosive acids are pumped like water, on shipboard and in locomotives—wherever a gasket is used—you'll find

VULCABESTON

Red Fibre Sheet Packing

Vulcabeston is the universal packing—the one packing that serves everywhere regardless of temperature or pressure, corrosion or moisture.

It is made from long-fibre asbestos by a special process which gives it resiliency and pliability. But, unlike rubber, Vulcabeston cannot squeeze out or stretch.

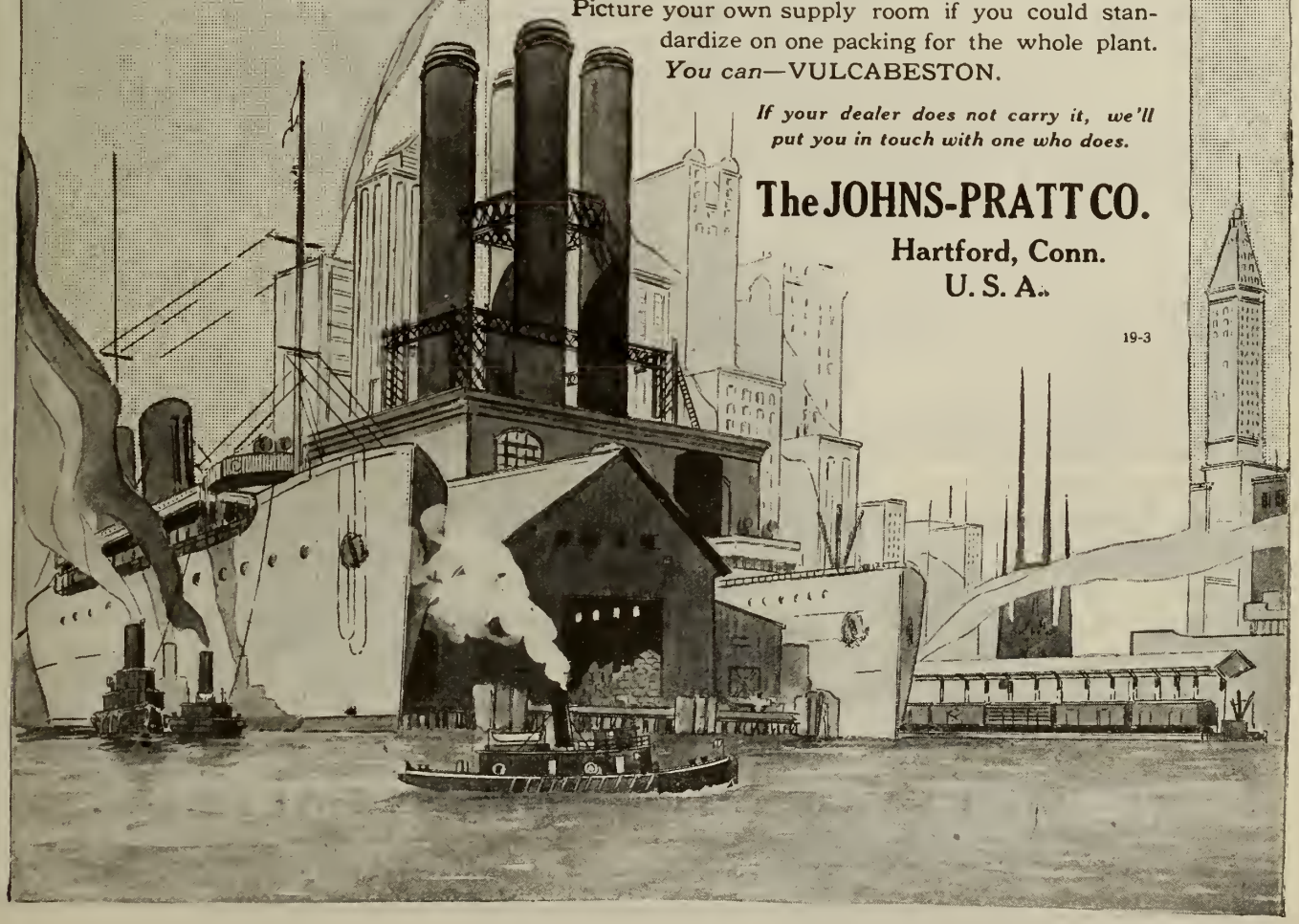
Picture your own supply room if you could standardize on one packing for the whole plant. *You can*—VULCABESTON.

If your dealer does not carry it, we'll put you in touch with one who does.

The JOHNS-PRATT CO.

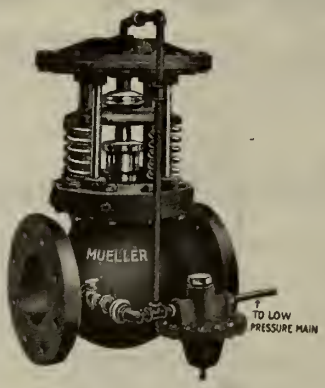
Hartford, Conn.
U. S. A.

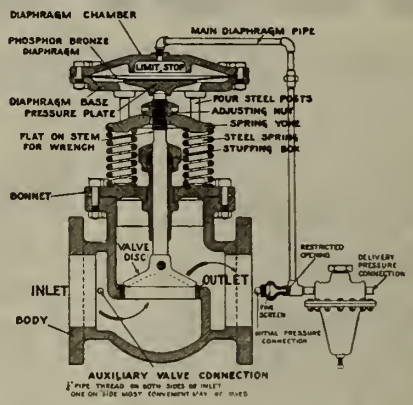
19-3



MUELLER Reducing and Regulating Valve

SINGLE SEAT; AUXILIARY OPERATED





E5030 for Water, Gas and Air
E5130 for Steam
(Flanged or Screwed)

Very Popular with Shipbuilders

USES

This valve is for use on exacting installations. It will make any desired reduction and will maintain a constant delivery pressure regardless of fluctuations of the initial pressure.

CONSTRUCTION OF STOCK REGULATORS

All valves have iron bodies, bronze stem and stuffing box, phosphor bronze diaphragms, seats of composition suitable for the required service; iron diaphragm chamber and steel springs. The main valve is controlled entirely by the small auxiliary valve. This auxiliary valve closes and opens the main valve by admitting initial pressure to, and releasing it from, the diaphragm chamber of the main valve according to the demand of the delivery side. Regulators of this description are suited for pressures up to 150 pounds, and will be furnished at above prices. When regulators are required for pressures in excess of 150 pounds we will furnish suitable material. Prices upon application.

STRAINER

In all cases it is advisable to use a strainer to prevent obstruction from grit, scale, cuttings, etc. Blow out pipes thoroughly before installing valve.

INFORMATION IN ORDERING

In ordering give highest and lowest initial pressure and required low or delivery pressure, approximate quantity or volume to be used per minute, size of high pressure pipe and low pressure pipe.

In ordering flanged end valves give diameter of flanges and bolt circles and the number and size of bolts.

INSTALLATION

Note—Any proper working regulator acts as a check valve. Where the building up of the pressure is to be avoided use our diaphragm operated relief valve E5060.

We will not be responsible for improper selection of valves.
Consult us regarding the best type for your service.

H. MUELLER MFG. CO., LIMITED

SARNIA - CANADA

MORSE DRIVES THE WORLD AROUND

About 2½ MILLION HORSE POWER in WORLD-WIDE SERVICE

MORSE CHAIN CO. Largest Manufacturer of Silent Chains in the World **ITHACA, N. Y.**

MORSE ENGINEERING SERVICE — Address Nearest Office — ASSISTANCE WITHOUT OBLIGATION

BOSTON, MASS. ..... 141 Milk Street
CHICAGO, ILL. ..... Merchants Loan and Trust Bldg.
CLEVELAND, OHIO ..... Engineers Bldg.
DETROIT, MICH. ..... 1003 Woodward Avenue
GREENSBORO, N. C. ..... 805 Ashboro Street
NEW YORK CITY .. 50 Church Street, Hudson Terminal Bldg.
PITTSBURGH, PA. ..... Westinghouse Bldg.
SAN FRANCISCO, CAL. ..... Mondanook Bldg.

ATLANTA, GA. ..... Earl F. Scott, M. E., 702 Candler Bldg.
CANADA ..... Jones & Glassco, Regis'd
MONTREAL, St. Nicholas Bldg., Toronto, Bank of Hamilton Bldg.
KANSAS CITY, MO. . Morse Engineering Co., R. A. Long Bldg.
MINNEAPOLIS, MINN. ..... 413 3rd St., Strong-Scott Mfg. Co.
ST. LOUIS, MO. ..... Morse Engineering Co., Chemical Bldg.
LICENSEES FOR EUROPE & EASTERN HEMISPHERE
The Westinghouse Brake Co., Ltd., 82 York Road, London, N.

"The Mysterious German Onions"

On nights when the German air raiders were out, they sent up strange, luminous balls behind their lines and anchored them above the clouds—globes of fire which could be seen for forty miles or more. What these "onions" were, or how they were kept in stationary position above the clouds, is still a profound mystery. The Allies never learned anything about them, but the Allies night bombing crews steered their course to the Rhineland by the luminous buoys thus provided.

What is known about the onions is told by Lieut. J. Vernon McKenzie in the course of an article, "Raiding the Rhineland," in MARCH MACLEAN'S. It is an intensely interesting article, telling all about the great reprisal campaign which implanted the fear of war in the German civilian heart.

"NO HOPE FOR THE WETS"

"Already the temperance forces are lined up to stop any possible break in the prohibition dam," writes J. K. Munro, in discussing what is going to happen at the coming session at Ottawa. He predicts that Union Government will hold together, but that the habit it has contracted of promising everything asked is going to make a lively session. He expects:

Dry legislation at the earliest possible moment.
The moral reform forces in control.
No change in the Divorce Law.
Tariff concessions made to the West.

The March number, in fact, is full of live, up-to-the-minute features.
The famous Canadian Ace, Lieut.-Col. W. A. Bishop, is on the cover.

Some of the Outstanding Articles and Stories are:

The Transformation (a new serial)—By Frederic S. Isham.

A Canadian King-Maker (the story of Lord Beaverbrook in Britain)—By Maurice Woods.

Fitting in the Returned Soldier—By George Pearson.

The Three Sapphires—By W. A. Fraser.

The Strange Adventure of the Nile Green Roadster—By Arthur Stringer.

Fakers—and Others—By E. Ward Smith.

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A Shady Deal—By Archie P. McKishnie.

The City of Lost Laughter—By Mary Josephine Benson.

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Three-Year Marriages in France
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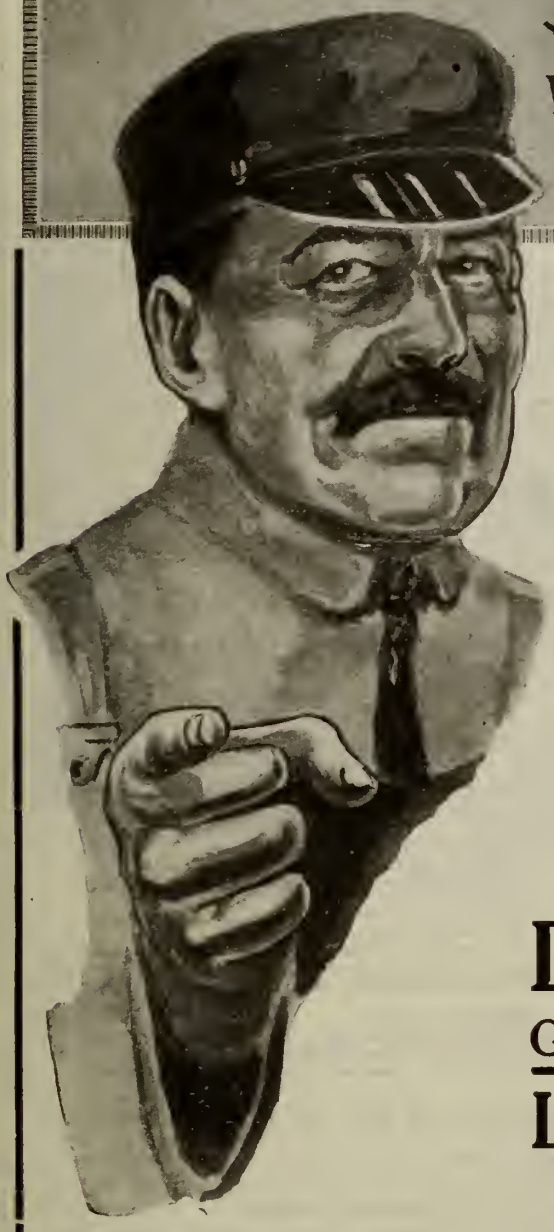

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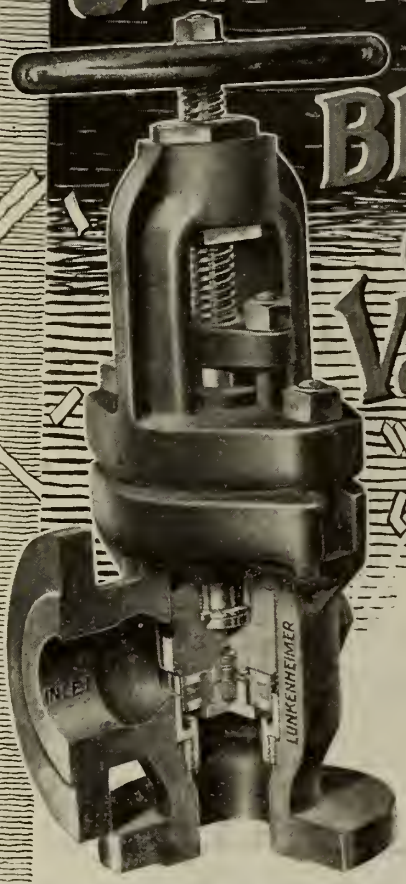

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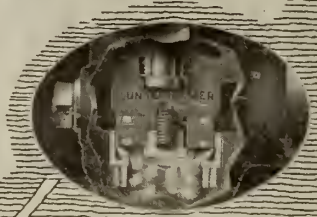

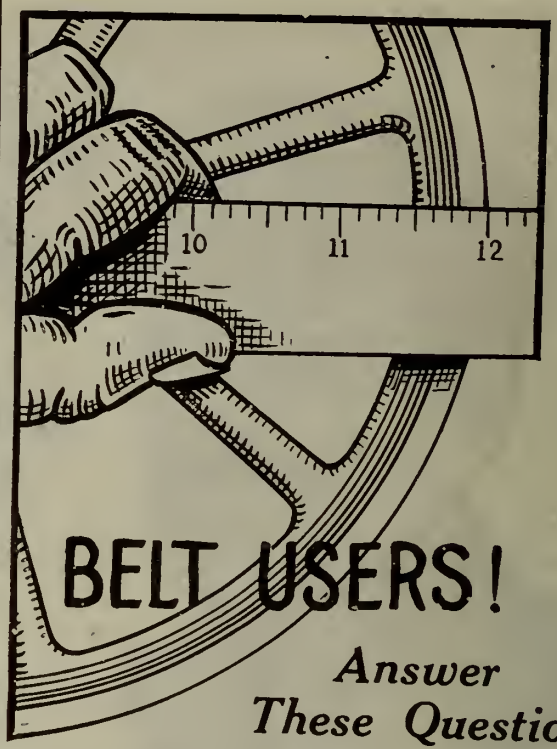

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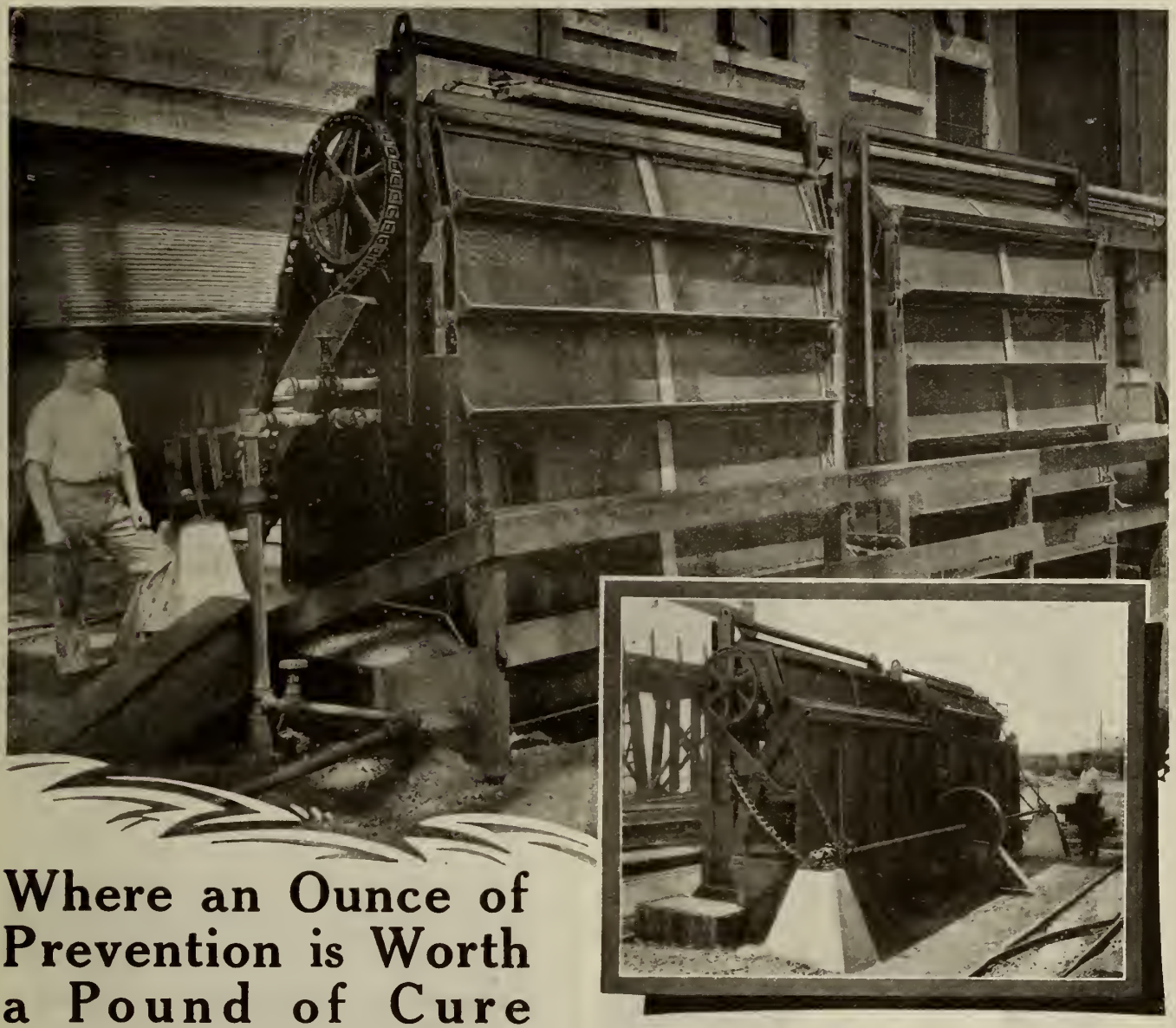

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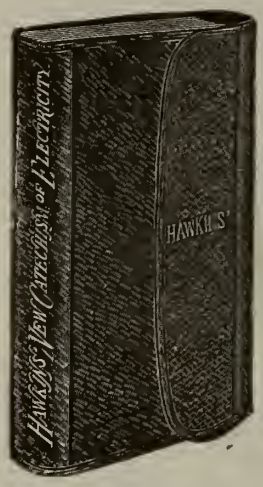

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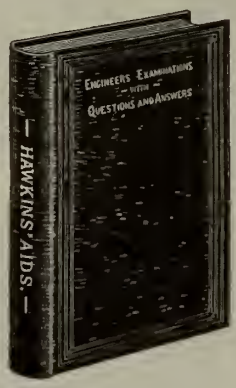

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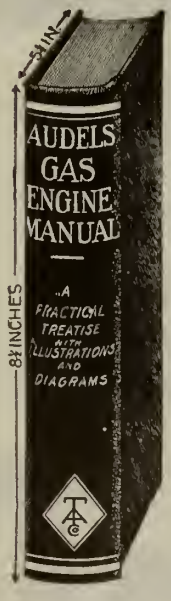

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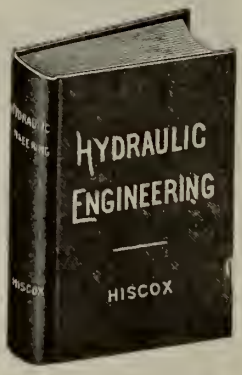

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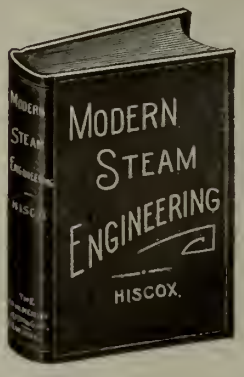

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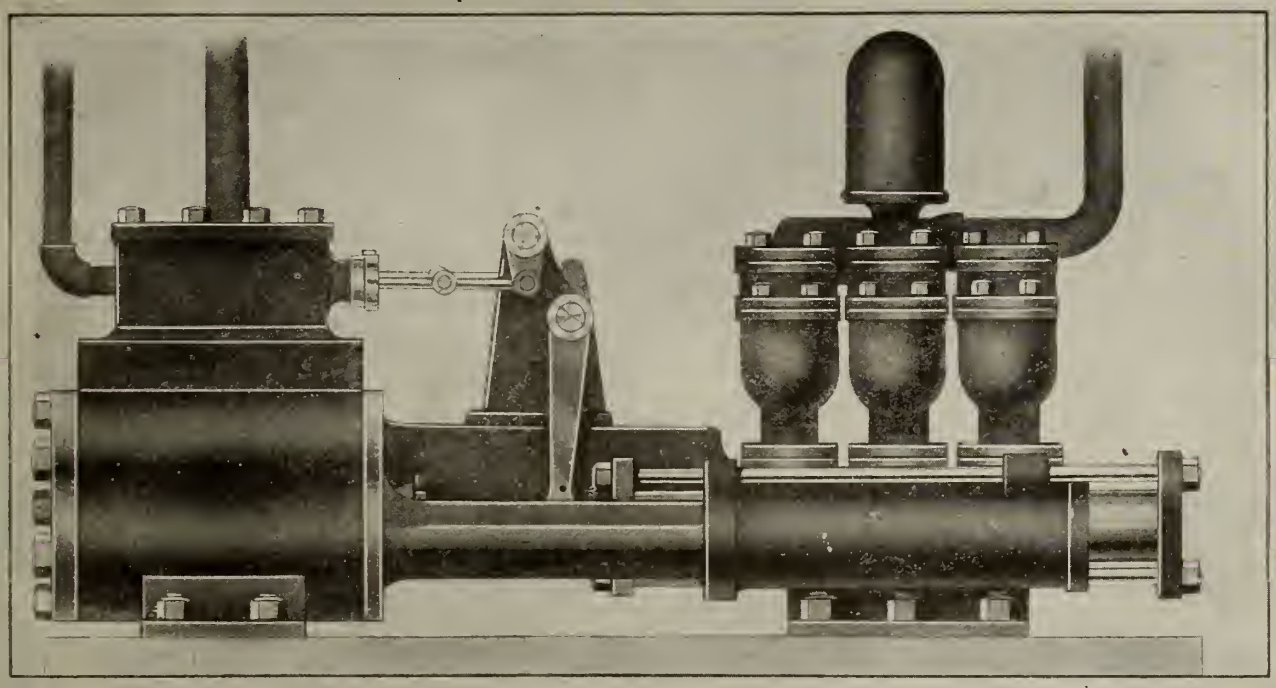

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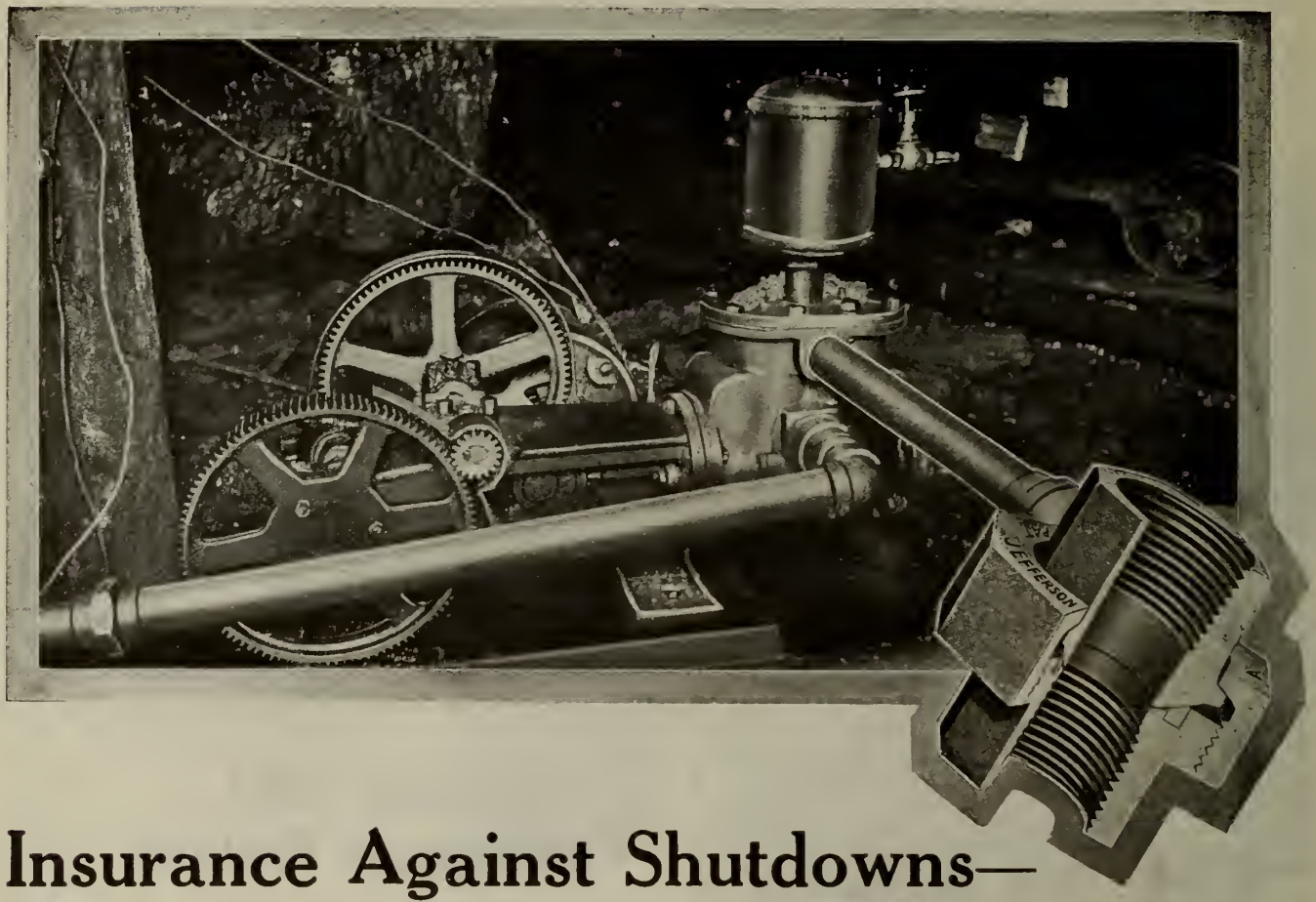

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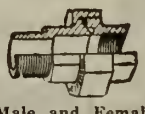

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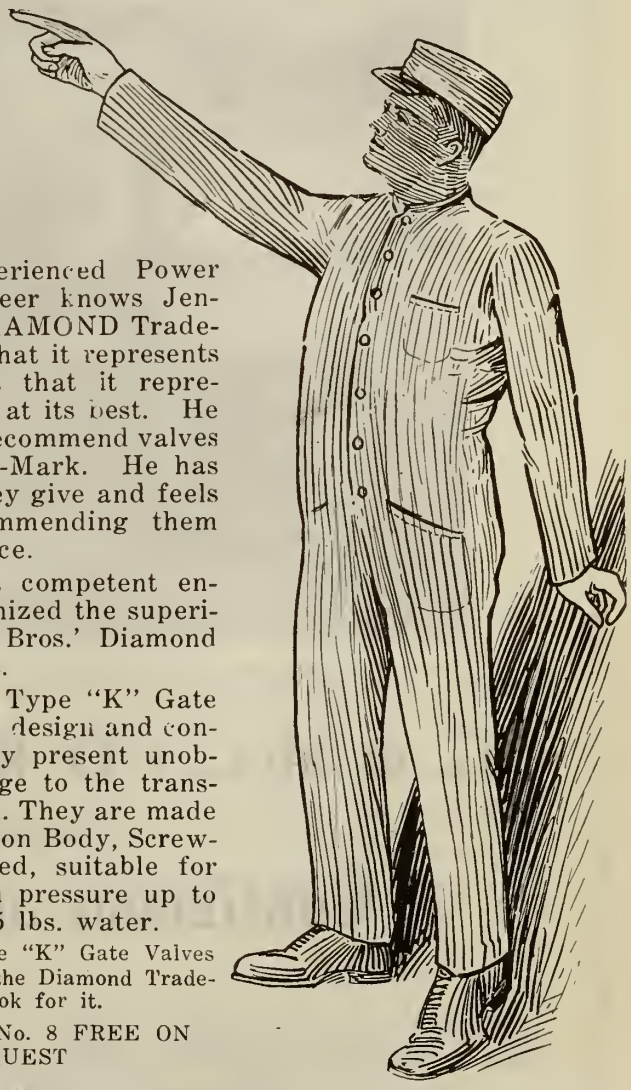

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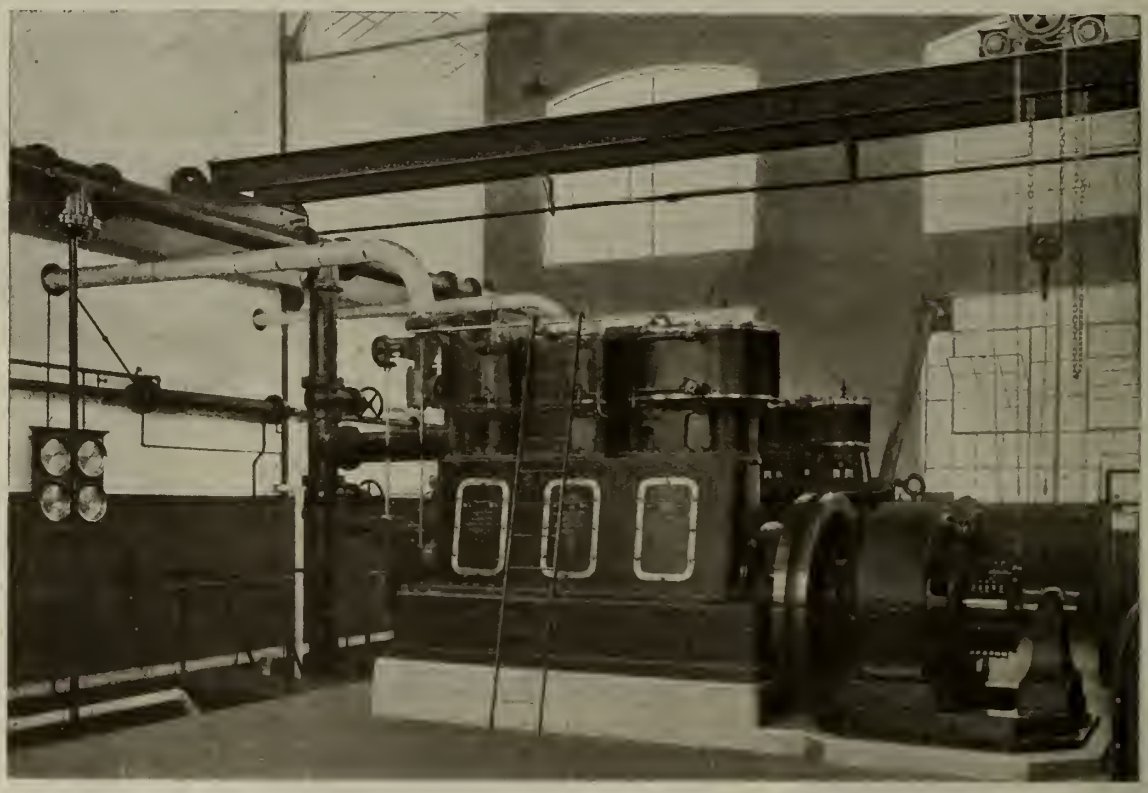

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Our opportunities for service in this respect will be doubled by a change made with the coming issue. POWER HOUSE will now be published semi-monthly, a step that has been urged by our readers for some time.

The trade paper is successful only to the extent to which it is a power for education and self-improvement. In the coming months our facilities for serving the engineering field will be doubled and the several branches of power plant engineering will receive the attention they all merit.

The field of power plant engineering has developed immensely of late years and the competent engineer has not only to be well versed in the science of steam engineering but has to be familiar with the design and operation of electrical apparatus. This is particularly true in Canada where water powers are so plentiful and coal, in some localities, scarce. Not only is this true, but the smaller power plants of manufacturing industries in almost every case are supplied with motive power from an outside station or use electricity for the shop transmission of power, in some degree. In meeting the need for educational opportunity along this line we have greatly strengthened the electrical section of POWER HOUSE, and during the coming year will cover the practical side of electrical engineering in a very thorough manner with the aid of several contributors of recognized standing. The more advanced and theoretical side of this branch of science will also be ably dealt with.

The operation of the modern steam plant is becoming more complex and greater attention is being given to its economical operation. The present trend in plant design towards higher steam pressures, the use of the turbine, increasingly evident in the smaller sizes of power units, the more efficient engines being installed to-day and the enormous strides taken towards greater efficiency in the boiler room all necessitate more knowledge on the part of the operating engineer.

As in the past, this phase of power plant engineering will be made one of the strongest editorial features.

The internal combustion engine is rapidly assuming a place in the generation of power that its economical and simple operating characteristics deserve, and articles will appear from time to time on the latest developments of this prime mover.

Mention has been made of Canada's abundant water-powers. A number of articles are in the course of preparation dealing with some of the more interesting developments which have taken place in this field.

The other departments, refrigeration, hydraulics, our new equipment pages and all will increase in usefulness in direct proportion to the increase in space available for their appearance.

In addition to the above features, our regular departments will also gain through our more frequent publication. And in particular those departments dealing with new power plant equipment, questions and answers and the operators' point of view will be greatly strengthened and will be of still greater value to the engineer in consequence.

The Utilization of Solar Energy

A Review of Some of the Attempts That Have Been Made to Utilize Directly the Sun's Heat and an Indication as to What May Be Accomplished in the Future

By J. F. HEFFRON

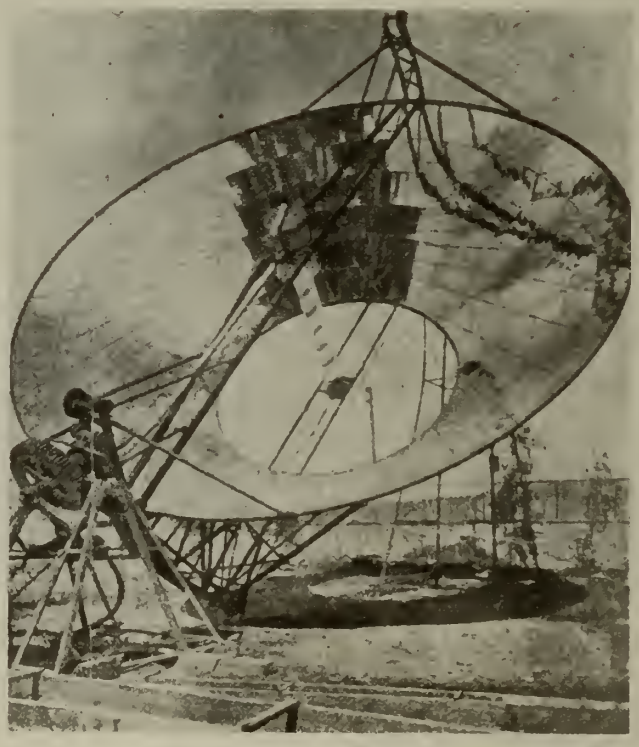
IN writing on this subject, it will no doubt interest the readers if a few observations are made regarding the principal factor in all schemes for the utilization of solar energy, viz., the sun.

Since the sun is presumably the source of all our earthly energy and heat, and man could not exist without its beneficient radiation, we can well understand that speculation regarding its qualities and constitution has ever attracted the attention of physicists, and we are not surprised that several intelligent and cultured races, such as the ancient Indians, Mexicans and Peruvians, directed their prayers to it, and looked upon it as one of the gods.

Some years ago a French artist of great imaginative power painted an extraordinary picture called "The Last Man and Woman." Two skeletons, huddled together in a close embrace, crouched in a weird icy cavern, from whose roof huge icicles depended, while the walls and floors glistened in set glossiness—the last human couple frozen to death. The painting left a deep impression on all who saw it. It was a pictorial representation of the now discredited theory that the earth must steadily grow colder in consequence of a decrease in solar heat, and that the last generation of mankind will perish of cold at the equator as a tribe of Eskimo.

Truly a ghastly outlook for the human race. But fortunately, later theories do not permit us to longer regard the sun as a monster fire, burning in the manner of fires in our grates. Tremendous as is the sun's mass, it would be comparatively rapidly consumed if such combustion were taking place. Another reason for discarding this old idea is that the temperature of the sun has been determined by a number of experimenters; all agree that it is about 6.000 degrees C. This temperature is far too high to permit of the formation of most chemical compounds, and for the production of heat by combustion, it is necessary that such compounds be formed. Briefly, such a temperature decomposes nearly all compounds into their elements and prevents their reuniting and the consequent production of heat.

Scientists are by no means certain how the sun's heat is produced, but one theory is that it is due to radioactivity; and another, due to Helmholtz, that the energy to keep up the radiation could be supplied by a relatively microscopic contraction of the sun's volume, though even this theory is not a complete success, as it implies that the age of the sun is 17,000,000 years. Great as is this lapse of time, geology indicates that our earth is considerably older; but as the earth can not very well be older than the sun, we must conclude that the sun is older than 17,000,000 years.



—From Smithsonian Report, 1915
FIG. 1—THE PASADENA SUN-HEAT ABSORBER OF 1901

As to what constitutes the structure of the sun there is also doubt; but the inner portion is spoken of as the nucleus and the outer portion as the atmosphere, and as the outer layers of the atmosphere become relatively cooled in rising from the surface of the nucleus, they sink back to a lower level, and their place is taken by hotter layers. Thus there is a continual circulation of the sun's atmosphere.

The specific gravity of the sun is only about a quarter of that of the earth, whose specific gravity is 5.53. A cubic foot of water weighs 62½ pounds, and hence an average cubic foot of the sun weighs 86¼ pounds, while an average cubic foot of the earth weighs 345 pounds. For comparison it may be mentioned that a cubic foot of granite weighs 165 pounds. The density of the sun being so small, it is concluded that it can still go on contracting, and hence that it is probably getting hotter instead of cooler, as is popularly supposed. If this be true, it is a hopeful feature for future workers in the field of solar energy.

The diameter of the sun is 863,600 miles, or about one hundred times the diameter of the earth. The glowing surface which the sun presents to us, even considering it as a flat disk, has the enormous area of 585,753,000,000 square miles, each square foot of which emits the enormous amount of about 12,500 h.p., and the radiant energy received at the outer surface of the earth's atmosphere is equivalent to 7,300 h.p., per acre. Of this about 70 per cent. (about 5,000 h.p. per acre) is transmitted to the land surface of the earth at noon on a clear day, and less in the morning and evening, owing to the greater thickess of the atmosphere through which the radiation has to pass at these times.

The quantity of solar heat per unit area which arrives in unit time at the outer surface of our atmosphere is called the solar constant, and its value, as determined in 1913 by C. G. Abbot, after making 696 experiments in different parts of the globe, is 1.93 calories per square centimeter per minute, which equals 7.12 B.t.u. per square foot per minute.

Perhaps the most remarkable things about solar radiation are that it passes without change through the 93,000,000 miles of space between the sun and the earth, the temperature of which is nearly absolute zero, and that only three-fifths of it produces any impression on the human eye. It is not till the radiant energy impinges on some material body that it is converted into heat. The best body for causing such conversion is a dead black one.

The absorption of solar energy by the atmosphere is about 20 per cent. greater in summer than in winter. This may be due to there being a larger total quantity of water vapor in the atmosphere of the earth in summer than in winter. It has long been known that the greater the humidity of the atmosphere the greater the amount of heat intercepted by it.

Although the theoretical power value of the heat reaching the surface of the

earth is no less than 5,000 h.p. per acre, it must not be thought that anything like this amount can be converted into mechanical power any more than can all the heat of coal be converted into its theoretical equivalent of mechanical power. For example, the heat value of good coal is about 14,500 B.t.u. per

—From Smithsonian Report, 1915
FIG. 2—ADAMS' SOLAR COOKER, 1876

pound, equal to 12,760 h.p. hours per ton, but in fact the best result, even under test conditions, ever obtained from a ton of coal by means of a boiler and steam engine is only about 1,470 brake h.p. hours, or 11.5 per cent. of the heat value, while in the case of a gas engine the corresponding figure is 25.5 per cent., and of a Diesel oil engine 31 per cent. The chief loss is in converting the steam into mechanical energy, and most of the loss is inevitable for thermodynamic reasons. With this fact in mind, one is not surprised to learn that the best overall thermal efficiency obtained from the most modern sun power plant, the Shuman-Boys plant (Fig. 1) in Egypt was only 4.32 per cent., the chief reasons for this being that the steam pressure was so low, and that the highest efficiency of the sun-heat absorber was only 40.1 per cent., compared with 75 per cent. for the best coal-fired boiler. But it has taken boilermakers many years to attain this efficiency, so that 40.1 per cent. is not a bad result when the number of sun boilers that have been made is taken into account.

Thermal efficiencies of engines are materially affected by the heat fall of the steam, just as the effciencies of water turbines are affected by the height of the waterfall. The greater the fall in either case the better the efficiency.

It will be interesting to learn from the foregoing figures that the value of 2½ acres of bright sunshine for an hour is one ton of coal. Mr. J. C. Hawkshaw in his address to the Institution of Civil Engineers (London, 1902), pointed out that the wood fuel produced by an acre of land in Europe is equivalent to at least one ton of coal a year. The great possibilities that lie in the utilization of solar energy, and the obvious fact that there is a limit to our supplies of coal and oil, have naturally attracted a number of workers, the results obtained by some of these savants dating back as far as the fifteenth century.

Sun Power Plants

Having given some consideration to the nature of the source and to the quantity of heat available, we may now direct our attention briefly to a description of some of the plants that have been constructed by various experiments for the purpose of utilizing solar heat.

Perhaps Buffon, the celebrated French naturalist, was one of the earliest workers in this field whose work resulted in any measure of success. On April 10, 1747, he succeeded, we are told, in setting fire to a plank of tarred wood, at a distance of 150 feet, by solar rays reflected from a combination of flat mirrors. He did this to show the possibility of the legend that Archimedes set fire to the fleet of Marcellus at Syracuse in 212 B.C.

Other early workers were Roger Bacon, an English Franciscan monk, who died in 1294; Solomon de Coux (1576-1626), a French engineer, who, in 1615, invented and described the first machine for raising water by solar heat and the expansion of air; Ducarla; and H.B. de Saussure, the Swiss geologist, physicist, and naturalist, who made (in 1787) the second ascent of Mont Blanc, a great feat in those early days. To de Saussure the credit is due for inventing what is known as the "hot box" (i.e., an insulated air-tight wooden box, black inside, and covered with two layers of clear glass with an air space between them) which has since been such a favorite with other workers. It was he, too, who found that a cover of two sheets of glass gave the best results.

Next in the field was the great English astronomer, Sir John Herschel, who experimented with a "small mahogany box, blackened inside, covered with window glass fitted to size, but without putty, and simply exposed perpendicularly to the sun's rays." He recorded the temperature of the surface soil near Cape Town, South Africa, obtaining a temperature of 240.5 degrees F.

As this temperature far surpassed that of boiling water Sir John made some amusing experiments by exposing eggs, fruit, meat, etc., in the box, all of which he tells us in his report, after a short exposure, were found perfectly cooked, and were eaten with relish by the entertained bystanders.

In 1873 Carl Guntner of Laibach exhibited a reflector intended for use in gathering solar energy at the Vienna Exposition. It was made of sheet metal and possessed the disadvantages common to all sheet-metal reflectors—that to maintain the surface in proper condition when exposed to all sorts of weather, requires careful and costly attention.

The work of the French scientist August Mouchot in this field was certainly of great importance. His experiments are recorded in his book entitled "La Chaleur solaire et les Applications industrielles," 1879; but, as with other early workers he gives extremely meager information of the results obtained.

Mouchot started his solar work in 1860 and took out his first patent in 1861. In the first edition of his above-named work he stated that theoretically, on an average, 86 square feet of reflecting surface are required for 1 h.p. Then to allow for losses, he doubled the area, thus making it 172 square feet. It is to be noted he referred to reflecting surface, not the area of radiation collected, which would almost certainly be a smaller quantity.

In August, 1866, Emperor Napoleon III. of France saw Mouchot's first solar engine at work in Paris. It consisted of two cylindrical concentric copper vessels with domed tops, the water space to accommodate 3½ pints being between them. The boiler was covered by a bell glass and placed at the focus of a reflector. The water boiled in one hour from an initial temperature of 50 degrees F.

—From Smithsonian Report, 1915

FIG. 3—GENERAL VIEW FROM THE SOUTH OF THE SHUMAN-BOYS ABSORBER, MEADI, 1913

After interesting the Emperor, Mouchot received some monetary assistance from the French Government with which he constructed another sun boiler, along the lines of the original one, but larger. This boiler was able to raise steam to 75 pounds to the square inch, and was found capable of running an engine which made 80 strokes per minute under a continued pressure of 1 atmosphere. Later it was changed for an engine with a revolving cylinder,

which worked admirably, putting in motion a pump to raise water, until the pump, which was too weak, was broken.

Next came the versatile engineer and successful inventor, John Ericsson, a Swede by birth and an American by adoption. He made an immense number of experiments, extending over twenty years, with costly apparatus, to determine the solar constant, and later on made apparatus for the practical utilization of solar radiation. All these experiments were made at his own expense, and he tells us they cost him $100,000. The conclusion he arrived at, as given in one of his letters, is that: "Although the heat is obtained for nothing, so expensive, costly, and complex is the concentration apparatus, that solar steam is many times more costly than steam produced by burning coal."

From Smithsonian Report, 1915

FIG. 4—GENERAL VIEW FROM THE WEST OF SHUMAN ABSORBER, TACONY, 1911

W. Adams, deputy registrar, High Court, Bombay, seems to be the sole Englishman who has worked on the practical side of the problem. His work was done in India, and is recorded in his interesting book, Solar Heat (Bombay, 1878).

In two particulars Adams was much at fault. He believed that the solar rays reaching the earth are not practically parallel, in spite of the opposing opinions of the many physicists he quotes. He erred also in believing that the temperature attained at the focus of a lens or mirror is directly proportional to the concentration of the rays. As a consequence, he stated that if a lens 85 feet 4 inches in diameter concentrated the radiation onto a circle one-half inch in diameter the temperature would be 73,400,320 degrees F. This is equal to 40,780,000 degrees C., while the temperature of the sun itself is only 6,000 degrees C., and no amount of such concentration could produce a temperature in excess of this. This error on the part of Adams seems to be due to a confusion of "temperature" with "quantity of heat." Adams constructed several fairly large solar machines, with which he obtained very satisfactory results, his last machine being able to operate a steam pump of 2½ h.p.

He also constructed a solar cooker, which was a miniature of his larger machines (see Fig. 2). The reflecting portion of the machine was formed of eight sheets of plane glass arranged to form a hollow truncated octagonal pyramid 2 feet 4 inches in diameter at the larger end. The food was placed in a cylindrical copper vessel at the axis. With this apparatus, he and others cooked many meals, both stews and roasts, which it is stated were very palatable.

Adams supported the opinion also that the ancients knew something of the utilization of solar energy for the creation of fire. He states:

"When the sacred fire that burned in the Temple of Vesta (The Goddess of the Hearth) became extinct, the ancient Romans used to rekindle it by placing a piece of dry wood in the linear focus of the conical reflector. . . . . To bring fire from heaven, by supernatural aid and a metal reflector was, no doubt, one of the most ancient miracles of priestcraft."

Adams suggested many practical uses for solar heat, curiously, among others, "for the cremation of deceased Hindus and others."

After Adams, M. Abel Pifre, a Frenchman, attacked the problem but the claims for efficiency in the case of his machine are quite improbable, in the face of later experience.

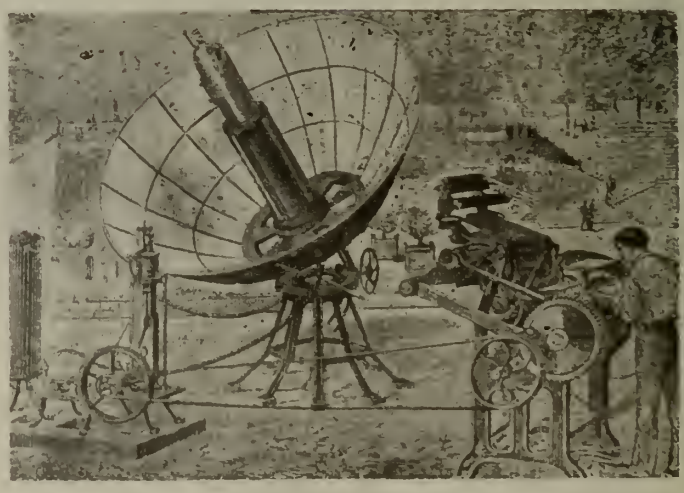
The next noted experimenter was a native of this continent—Langley, the American. His work consisted of many experiments to determine the value of the solar constant, which he gave as 3 calories per square—centimeter—minute.

Next may be noted a plant erected at Salinas, Chile, 4,300 feet above sea level, by J. Harding, for the purpose of distilling water by solar radiation. His plant had 51,200 square feet of glass arranged in sections 4 feet wide, in the form of a very flat inverted V, forming the roof of a shallow water trough. The sun evaporated the water, the resulting vapor condensed on the glass, the temperature in the box being far higher than that of the atmosphere, and hence of the glass. The pure water trickled down the sloping glass and dripped from its lower edge into a small channel on the top of each side of the box. These channels delivered into larger ones, and thus the distilled water was collected. The plant yielded 5,000 gallons of pure water per day in summer, and allowing for interest on capital, upkeep, etc., the cost of the pure water is said to have been less than one-half cent per gallon.

In the United States in late years several sun power plants have been erected, perhaps the most popular of these was that located at Pasadena in 1901. (See Fig. 1). It consisted of a truncated cone reflector, 33 feet 6 inches in diameter at the larger end and 15 feet in diameter at the smaller, with a boiler 13 feet 6 inches long, having a capacity of 100 gallons (U.S.A.) plus 8 cubic feet of steam space.

The all-day average work performed by the engine is given as 1,400 gallons (U.S.A.) of water lifted 12 feet per minute, which is the rate of 4¼ h.p.

The Pasadena plant is said to have cost $5,000 and in 1909 it was perhaps the largest and strongest of the mirror type of solar motor ever built.



From Smithsonian Report, 1913

FIG. 5—PIFRES SUN-POWER PLANT OF 1878, DRIVING A PRINTING PRESS.

H. E. Willsie and John Boyle, jr., started their work in America in 1902. The method they adopted was to let the solar radiation pass through glass and heat water, which in turn was used to vaporize some volatile fluid such as ammonium hydrate, ether, or sulphur di-

oxide, the vapor being used to drive an engine.

Willsie has stated that he believes himself to be the first to propose this two fluid method for the utilization of solar energy, and so far as is known, his claim is correct. Several sun-heat absorbers were successfully built in the United States after this method, and in 1903 patent applications were filed, and later a company known as the Willsie Sun Power Co. was incorporated.

In the spring of 1904 a plant was built by Willsie at St. Louis, which successfully operated, by ammonia, a 6 h.p. engine. Later a similar plant using sulphur dioxide, was built at The Needles, Col. Its results caused Willsie to construct a larger plan which obtained boiler pressures of over 200 pounds, and the engine operated a centrifugal pump, lifting water from a well 43 feet deep (sic) and also a compressor, in addition to two circulating pumps.

A fourth plant, along the lines of the last, was later constructed along the Colorado river which gave equally good results.

In 1907 Frank Shuman, an American, had a plant in operation which developed 3½ h.p. 1,200 square feet of sunshine fell upon a fixed, horizontal water box with a glass top. In the water were rows of parallel horizontal block pipes containing ether, and exposing 900 square feet of surface to the solar radiation. The water became heated and conveyed heat to the under side of the pipes. The ether boiled, and its "steam" drove a small vertical, single-cylinder engine. The exhaust ether vapor passed into an air surface condenser, and the liquid ether from this was pumped back into the tubes of the boiler already described.

Shuman states that this plan ran well even when snow was lying on the ground. At first thought this seems remarkable, but though in winter the number of solar rays falling on a given horizontal area is smaller than in summer, the permeability of the atmosphere is about 20 per cent. greater in winter than in summer, which counteracts the other effect, but of course the loss of heat by conduction from the boiler is greater in winter than in summer.

Shuman later made other experiments and in 1911, with the assistance of some English capitalists, constructed his third absorber at Tacony (a suburb of Philadelphia). The total quantity of solar radiation collected by this apparatus was many times larger than that collected by any previous worker, the total area being 10,296 square feet. In the best run of one hour this plant produced 816 pounds of steam at atmospheric pressure. This is at the rate of 9 pounds per 100 square feet of sunshine, and therefore equivalent to an allowance of 2.45 square feet of sunshine per brake h.p. The maximum thermal efficiency of this absorber was 29.5 per cent.

In 1911 at the request of the Sun Power Co. (Eastern Hemisphere), (Ltd), their consulting engineers (Messrs. A. S. E. Ackermann and C. T. Walrond invited Prof. C. V. Boys, F.R.S., to become associated with the solar radiation work they were carrying on. Prof. Boys suggested some changes in the design of the absorber, viz., that the boilers should be placed on edge in a channel-shaped reflector of parabolic cross section, so that solar radiation was received on both their surfaces, instead of one being worse than idle, as it was when the boilers were placed side on the sun. This design, which is similar to that used by Ericsson, was adopted.

An absorber of this design was then constructed and erected at Meadi on the Nile, 7 miles south of Cairo, in 1912, (See Fig 3). The axis of the reflectors was placed north and south, and could be automatically heeled over from an eastern aspect in the morning to a western one in the evening, so as to follow the sun. Thus the same number of solar rays were caught during the entire day, a small decrease in steam production in the morning and evening being entirely due to the greater thickness of atmosphere through which the rays had to pass at these times. The total area of sunshine collected was 13,269 square feet.

The boilers were placed at the focus of the reflectors and were covered with a single layer of glass inclosing an air space around the boilers. Each channel-shaped reflector and its boiler was 205 feet long, and there were five such sections placed side by side. The concentration was 4½ to 1. The maximum quantity of steam produced was 12 pounds per 100 square feet of sunshine, equivalent to 183 square feet per brake h.p., the maximum thermal efficiency was 40.1 per cent. The best hour's run—Mr. Ackermann tells us in his report to the Royal Society of Arts, (London)—gave 1,442 pounds of steam at atmospheric pressure, hence, allowing the 22 pounds of steam per brake h.p.—a result about 10 times as large as any previously attained, and equal to 63 brake h.p., per acre of land occupied by the plant.

In spite of this review of comparative failures, most scientific men who have given this problem their serious consideration are of the opinion that it is well worthy of the attention of engineers, for even now it is very nearly a solved problem where there is plenty of sunshine and coal costs over $20.00 a ton. It is fortunate, Mr. Ackermann observes, that where coal is dear sunshine is often plentiful, and while coal will no doubt gradually increase in price, the cost of sun-power plants should decrease. Sun-power plants are admirably suitable for pumping in connection with irrigation, for where there is most sunshine there is great need for irrigation, and the slight variation in the quantity of water pumped throughout the day does not matter.

These plants are at present costly to build, involving the erection of expensive equipment, which so far is uneconomical in working, utilizing but a small fraction of the available sun energy. We may however not unreasonably imagine that when the world has become familiar with the moving platforms of the tense cities of the twenty-first century foreseen by Mr. H. G. Wells, it will also have become familiar with the sight of publicly owned sun-power plants of vast dimensions. This will be the sign that the age of coal and oil has forever passed, to be replaced by hydraulic and direct utilization of sun-power until man has subdued other forces of nature that exist at present only in the minds of those among us who delight in dreams.

DESIGN OF FURNACE

To ensure good combustion it is of the first importance to keep the gases in the furnace as hot as possible, until the oxidation is entirely completed; but this fundamental condition is far from being realized in ordinary practice. In setting a horizontal tubular boiler, for example, it is usual to place one end of it immediately over the furnace, so that it is exposed to the direct action of the fire. In this way the gases, which are at a temperature of perhaps 3500° Fahrenheit as they rise from the fuel-bed, are covered, over the entire area of the furnace, by a metal roof or plate that has a temperature of perhaps 350°. In other words, the entire upper boundary of the furnace is maintained at a temperature some two thousand degrees lower than that of the furnace gases. The absorption of heat by this relatively cold surface chills the gases so that sensible portions of them are cooled below the temperature at which they are capable of uniting with oxygen; and if these cooled portions are not already completely oxidized, they are likely to escape up the chimney unconsumed, and a consequent waste of fuel is the result. The waste that is caused in this way can be minimized by properly proportioning the furnace, but it cannot be really eliminated so long as no attempt is made to burn the fuel under scientific conditions.

HOT WATER

Steam is often used for heating water, the steam being either blown directly into the water, or circulated through a coil of pipe submerged in it. The men often fail to realize that the capacity of water for heat is very great, and that a large amount of steam is required to raise the temperature of even a small tank of water through any considerable range. Hence they frequently draw off excessive quantities of steam in the wash rooms, and thereby waste heat. Wastefulness of the same general nature, though usually of smaller magnitude, may also occur when the water is heated in a special tank and delivered to the wash room through pipes; and when hot water is supplied in this way it is advisable to use a spring faucet, designed to close automatically when the man who is drawing the water releases his hold upon it.

Power Plant Management; Coal and Ash Handling

Elimination of Hand Labor an Important Element in Power Plant Operation—Various Methods Employed—Hand Shovelling—Conveyors Essential in a Modern Power Plant

By ROBERT JUNE

Part I

"WHAT do you consider the most important advantage of your mechanical coal handling equipment?" I asked the superintendent of a large manufacturing plant the other day.

His answer, given without a moment's hesitation, was, "Elimination of the large and uncertain labor element. We have twenty 500 h.p. boilers, and at two seasons of the year we require every pound of steam we can get from them, day and night, for weeks at a time. Before we put in our automatic coal handling system we were at the mercy of our coal handlers and passers.

"Time and again the operations of our entire plant were embarrassed, and the work in some departments even brought to a dead stop, by the lack of a full boiler-room crew. We always paid good wages, but the physical conditions under which the men had to work were not good, and on a number of occasions I have been called up at my house late at night, and had to dress and start out in my car on a search for laborers. This was no joke at any time, but when it happened on a cold, rainy night, or with a blizzard for accompaniment, you can imagine the difficulties in getting men to leave their warm beds for any money or other considerations I might offer. On more than one occasion, when I arrived at the plant with my hastily gathered crew, they took one look at the coal piles drowned in rivers of rain and sleet, or else frozen solid, with a forty-mile gale whisking about them, and the thermometer down around zero, and refused point-blank to touch a tool."

"Automatic coal handling has changed all that. Because of its assurance of continuity of operation, the mechanical system we now have is worth several times what it cost us. We would employ it if it cost twice as much per ton delivered to the boilers as hand labor."

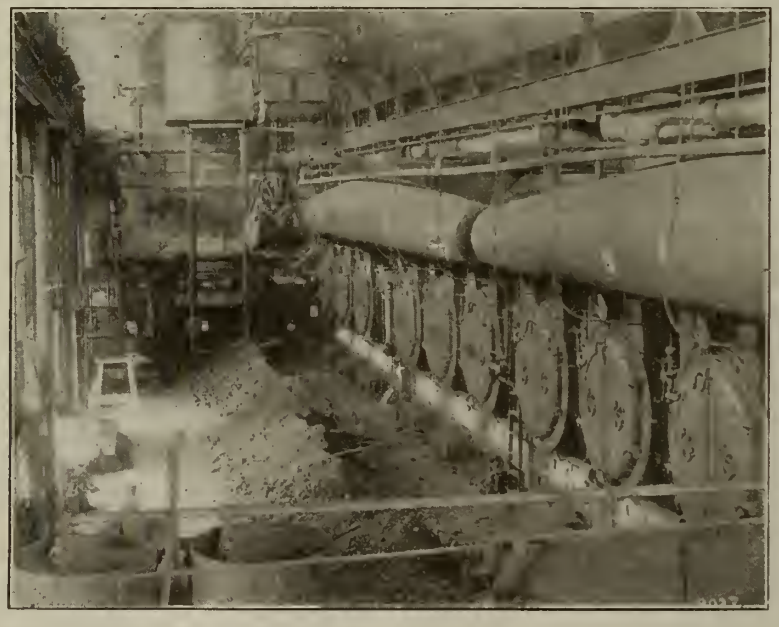
That is one point of view. Another man, manager of a good sized plant, said: "We installed mechanical coal handling because we were able to lay out a system which gave us three times as much storage capacity as we formerly had, and we felt it essential to insure an adequate supply of coal at all times."

A third point of view, typical of many, was expressed by a large operator: "We wanted to reduce handling costs as much as possible, and therefore substituted mechanical means for manual handling. Need I tell you that the savings effected have been very large, particularly during the past two years."

As a rule, one good reason is all a man wants as explanation for an action, hence the failure of the gentleman quoted to mention the advantages which appealed to the others. Upon further questioning, however, each mentioned the additional points as supplementary benefits which they enjoyed.

There does not seem to be any doubt that nineteen plant managers out of twenty, who have installed mechanical handling, are thoroughly satisfied that they made a move in the right direction. Some of them, it is true, would make radical changes in their equipment and layout if they had the work to do over again. The point is, that they would do it over. Dissatisfaction, where it exists, is with the application of the system, not with the principle.

As Reginald Trautschold sums up the situation: "The scarcity of coal has made an adequate coal reserve of the utmost importance to every manufacturer, and its high cost necessitates that the fuel be handled at the plant as economically as possible. This condition had tended to make more general the mechanical handling of coal, for no plant, large or small, could now afford to pay the price of manual handling. The attention thus focused on the question of coal handling has resulted in radical changes in the methods employed to store the coal supply and to feed it to the boilers. So effective have been these changes, that it would be little, if any, exaggeration to claim that to-day the boiler plant for a large manufacturing power plant, exclusive of its steam equipment, could be erected and furnished with adequate coal storage facilities, and equipped with a complete system of conveying mechanisms that handle the coal from the point of receipt at the yards to the furnace grates for less money than the most efficient layout of ante-bellum days. This, too, in spite of to-day's high cost of equipment, materials and labor."



GRAB BUCKET HOIST SHOWN INSIDE POWER HOUSE AND PLACED WHERE COAL IS DISCHARGED FOR FIRING BOILERS. AMERICAN THREAD COMPANY INSTALLATION.

Call In An Expert

Having made out such a strong case in favor of the general handling of coal and ashes by mechanical means, a word of caution is here necessary: When you come to consider the proposition as applied to your own plant, get the advice of a consulting engineer, or engineering firm, specializing in power plant design.

I do not mean to belittle the advice and suggestions of your own works construction engineer, or of the engineering departments of the various conveyor manufacturers, or of the engineers and architects who handle your general building construction. These men are all apt to have mighty good ideas, and they should, by all means, be consulted. But, as they are all general practitioners, whereas you need a specialist, the law of averages is decidedly against your getting as good results from their plans as from those of a man who makes power plant design his chief business.

Various Methods Employed

The delivery of coal to the boilers and the removal of ash are usually the largest items of boiler-room expense. The best method of handling coal and ash in any given plant is that which will do the work at the lowest final cost. I use the term "final cost" because insurance of continuity of operation and adequate coal storage are factors which do not appear in a cost-per-ton comparison of methods, but which may have considerable bearing on what may be termed the "earning power" of the power plant.

View of installation at plant of American Thread Co., Shepard transfer crane equipped with grab bucket hoist which is about to enter power house. This plan provided for future extension as will be noted from the photo.

(That is, it may be cheaper in the end to install a particular type of handling system, which will cost more to operate, but will insure avoidance of monetary losses caused by shut-downs, due to lack of coal or to labor difficulties).

That the problem of proper selection of method is not easy is indicated by the almost numberless combinations of means and devices to be found in American plants. The principal factors, which influence the choice of system, are size and location of plant and cost of fuel and labor. The various systems in use may be tabulated as follows:

1. Hand shovelling, without or with wheelbarrow or car.
2. Conveyors.
   - (a) Screw or spiral.
   - (b) Flight or scraper.
   - (c) Apron and buckets.
   - (d) Overlapping dump buckets.
   - (e) Continuous belt.
3. Hoists.
   - (a) Hoist and hand car.
   - (b) Hoist and automatic cable car.
   - (c) Hoist and trolley: telephrage.
4. Cranes.
   - (a) Railroad with clam-shell bucket.
   - (b) Transfer with clam-shell bucket.
5. Vacuum system.
6. Combinations of above. (So-called "silo" system, etc.).

Hand Shovelling

What are the practical limits of economical hand shovelling? No general answer can be given to this question. Its solution depends upon individual circumstances. It is not necessarily a factor of the number of boilers to be served—for instance, the Burroughs Adding Machine Company, Detroit, finds it economical to employ mechanical coal handling for three boilers, whereas the Mulkey Salt Company, of the same city, serves eight large boilers in a thoroughly efficient manner by hand work. The consideration governing the choice of means in each of these cases was point and manner of delivery, and this is the principal factor to consider.

If coal can be dumped from cars or dealers' delivery wagons into bins or on platforms directly in front of the boilers, it is certain that no cheaper means can be devised for hand-fired furnaces. In such instances, one may handle the coal and ashes and attend to the water level of 200 h.p. With hand-shaking and dumping grates, one man may take care of 300 h.p.

In cases where coal cannot be stored in front of the boilers, but must be hauled by wheel-barrow, cart or hand lorry, the practical economic limit of haul is usually 100 feet, and the economic quantity limit, 20 tons per day. While this is generally true, it is not a hard and fast rule. Thus Professor Gebhart states: "Hand-fired furnaces and manual handling of coal and ashes are usually associated with small plants of 500 horse-power and under, but a number of large stations are operated in this way with apparent economy. A notable example is the steam power plant of the Wood Worsted Mill, Lawrence, Massachusetts, in which 40 return tubular boilers are fired by hand. A tipcart, with a capacity of one ton, brings the coal a distance of 100 to 200 feet to the firing floor, and firemen shovel it onto the grate. Four men are stationed at the coal pile. One man drives two carts (one of which is being filled while the other is gone with its load), sixteen firemen attend to the furnaces, and two men dispose of the ashes."

A good man is capable of shovelling 40 to 50 tons of coal in eight hours when unloading a car, provided it is only necessary to shovel the coal overboard. An average figure for handling coal by barrow and shovel is not far from 2.5 to 3 cents per yard up to 5 yards. Above five yards about 2 cents per ton should be added for each additional yard.

Conveyors

Conveyors, like airplanes, are classified as "tractors" or "pushers," depending upon whether they pull or push the load. A third class are genuine "carriers," since the moving parts bear the weight of the load. Of these general classes, the "carriers" are usually more economical of operation and maintenance. Before deciding, however, let us examine the characteristics of the various types.

Screw Conveyors: These are of the "pusher" type, the apparatus consisting of a hollow shaft, attached to which is a continuous spiral of sheet metal. The shaft is revolved by means of a motor in a trough of slightly larger diameter than the spiral, with the result that as the operation proceeds, material placed in the trough is worked forward.

Screw conveyors may be used up to 100 feet, and in sections of limited length up to an angle of 15 degrees. Speeds, capacities, and horse-power requirements are approximately as follows:

SCREW CONVEYORS—HORIZONTAL RUNS
TABLE I.

Diameter Screw in Inches.	Highest R.P.M.	Capacity Tons Fine Coal Per Hour.	H.P. Required for each 10 Ft. of Length (Coal)	Capacity Cu. Ft. Ashes per hour.	H.P. Required for each 10 ft. of length (ashes)
6	115	6	.5	125	.5
7	110	8	.6	175	.5
8	105	14	1.0	350	.5
9	100	17	1.2	425	.6
10	95	22	1.6	575	.8
12	90	35	2.5	950	1.3
14	85	48	3.5	1200	1.8
16	80	80	5.6	2000	2.8
18	75	110	7.7	2700	3.8

*Page 9—C. K. Baldwin, The Robins Conveying Belt Co., quoted by Prof. Gebhart.

Advantages of this type are low first cost, adaptability, and small space required for installation, but these may be offset by high cost of maintenance, due to rapid and excessive wear and tear, by losses caused by breakdowns at important periods, and by the high cost of power to the operator.

Flight or Scraper Conveyors: These are of three types, plain, suspended flight, and roller flight. The trough is of any section, but is usually built with greater width than height. Flights which conform to the shape of the trough are attached to single or double strands of chains. Material is usually discharged through gates in the bottom of the trough.

The design of the plain scraper provides for the suspension of the flights from the chain, which drags them along the trough, pushing the load ahead. Cross bars, having wearing shoes at each end, are provided with the suspended flight conveyor. The arrangement is such that the flights do not

The Shepard transfer cranes equipped with grab bucket hoists over coal storage pile. Coal is received at end of runway shown in background in barges and transferred to storage. Installation Bridgeport Brass Company.

touch the trough at any time. Differing slightly from the suspended type, the roller flight substitutes rollers for wearing shoes.

As between the three types of flight conveyors, service and maintenance considered, there is not a great deal to choose. The general layout of the plant will usually suggest the type to be employed. In this connection, we will illustrate one or two typical installations of flight and scraper conveyors in the continuation of this article next month.

The power required to operate flight

conveyors may be closely approximated by the following empirical equation:*

$$Hp = \frac{AWLS}{1000} \text{ plus } \frac{BLT}{1000}$$

in which

Hp = the horsepower required at the conveyor drive shaft.

AB = constants as in Table II (see next issue).

W = weight of conveyors per ft. of run, lb.

L = distance between centres of head and tail sprockets, ft.

S = speed of conveyor, ft. per min.

T = capacity of conveyor, tons (2,000 lb.) per hour.

X = 1 for conveyors up to 100 ft. centres, and 2 for longer conveyors.

If the conveyor is composed of portions on different inclines, compute the power for each section separately and add 10 per cent. for each change in direction.

As a general proposition, flight conveyors are low priced and offer an economical and efficient means of handling coal and ash in small plants.

Next month we will discuss other types of conveying apparatus.

The Utilization of Peat and its By Products

This Article, One of Several, Discusses the Origin of Peat, Its Properties, the Extent of Canada's Deposits, and Deals With Methods Which Have Been Devised For Its Manufacture, Not Always Successfully

By L. H. BACQUE

THE peat question, or rather the question of finding some practical way to utilize our resources in peat, has lately come very much to the front. The scarcity and the high price of coal have reached such a point, that the people of several of our provinces have suddenly realized that they are utterly dependent on their neighbors in the United States for their supply of coal, unless something can be done to utilize the material available at home.

Any number of public meetings of every description, of Boards of Trade, Municipalities and even Parliaments, have taken place and the general concensus of opinion expressed at these assemblies has been that something must be done, and indeed, it seems almost unbelieveable that such an excellent fuel as the peat we have in Ontario and in several other provinces, should have lain in the earth, neglected and unexploited, as it has done up to the present.

In twenty-seven bogs alone, which have been located and surveyed by the Federal Government in the province of Ontario, there are 63,000,000 tons available of a good merchantable fuel in the shape of a good quality of peat carrying from 25 to 30 per cent. moisture. That such an amount of valuable material should have been allowed to lay there, unexploited, for such a time, appears almost incredible, yet such is the case.

Numerous attempts, it is true, have been made in the past to manufacture this into fuel, but they have all been dismal failures and peat, as a fuel, is now utterly discredited, which may to a certain extent, perhaps, account for the abnormal situation which we find ourselves in.

Why this has been so, however, is the question one is tempted to ask. The question is readily answered. It is because all these attempts have been made in the wrong direction and with a total disregard of the inexorable laws of nature as exemplified in the peculiar characteristics of the peat itself.

With a persistency hard to understand and probably born of ignorance or indifference, or possibly of both, all efforts to utilize the peat as a fuel have been made with the one object in view, viz.: that of transforming it into a hard, compact fuel, easily to be handled and transported, and presenting as a matter of fact all the characteristics which the peat essentially lacks in its natural state.

The main objective of all these attempts has been to compress the peat in it's raw state and so to drive out the large amount of moisture it contains, while at the same time reducing its bulk to such proportions as would make it as nearly as possible similar to the anthracite coal in such common use in Canada, for domestic purposes.

We may as well state at once that it is utterly futile to hope for successful results in this direction. Mr. A. Lencauchez, an engineer of considerable repute as a peat expert in France, effectually disposes of this subject in the Preface to his work on peat, entitled "La Tourbe"—(Peat). He says:

"Regarding this matter (the compression of raw peat) we must observe that all attempts to compress it have failed and that it could not very well be otherwise, for nothing can take the place of nature and of the molecular contraction provided by a slow condensation lasting ten to fifteen days. The stroke of a press can only dislocate the moist substance of the peat without expelling all the water it contains. Wood which carries 50 per cent. moisture when green, only carries 20 per cent. when dry; but, we ask, could the stroke of a powerful press ever drive out instantly 30 per cent. of this water (if ever it did drive it out), without absolutely reducing to powder, the fibre of the wood? That is the reason why the aimless compression of raw peat must be considered as Utopian."

The event in Canada, as well as in other countries, has proved the truth of this statement.

And not only has it proved impossible up to the present to dry raw peat by compression, but difficulties almost as great have been encountered in all attempts to dry it by artificial means. This is not to be wondered at when one considers some of the peculiar character-

Illustrations Courtesy Department of Mines, Ottawa

PEAT READY FOR THE MARKET. ALFRED, ONTARIO

istics of peat, which are: (1) That when in the raw state it carries from 85 per cent. to 95 per cent. moisture; (2) that it parts with only a small part of this by natural drying, always retaining at least 15 or 20 per cent. water, and (3) that when dried absolutely by artificial means, it immediately reabsorbs it's quota of moisture from the atmosphere as soon as it is again exposed to its action.

Moreover, the excessive amount of utterly useless water to be handled when harvesting the peat is also a serious handicap to be overcome by the manufacturer. If we take 100 pounds of air-dried peat, for instance, carrying 15 per cent. moisture, we find that this material contains 85 lbs. of peat substance and 15 lbs. of water. On the other hand, 100 lbs. of raw peat contain 90 lbs. of water and 10 lbs. only of peat substance. so that to produce 85 lbs. of peat substance, contained in the 100 lbs. of dry peat, we will have to extract, handle and treat industrially, 850 lbs. of the raw material and get rid of:

$$\frac{850 \times 90}{100} - 15 \text{ or } 750 \text{ lb.}$$

of water.

To get one ton of absolutely dry peat, by whatsoever process we dry it, artificial or natural, we must handle 10 tons of the raw material and evaporate or dispose of in some way close on nine tons of water.

The problem, it must be admitted, is not one that promises to be easily solved, nor does the prospect improve when one considers that artificially dried peat is no sooner exposed to the air than it promptly takes up again its percentage of moisture and crumbles away into dust as an immediate result of this re-absorption of water.

Summing up these points, it may be stated in a general way that the manufacturer will always be confronted at the outset with three marked and absolutely characteristic difficulties, viz.:

1. That of harvesting, handling and manufacturing a mass of raw peat containing approximately 90 per cent. water and weighing ten times as much as the finished product to be eventually turned out and marketed.

2. That of evaporating or otherwise getting rid of nine-tenths of this superfluous weight of water by natural or artificial means.

3. And when the peat is as dry as nature will allow it to become, then to further dry and compress it, or make it into coke or briquettes, so as to fit it for any special purposes it may be intended for.

As a corollary of the above, it stands to reason that the most economical way of utilizing peat is that one which will allow the consumer to get the greatest possible heat efficiency out of it, though allowing it at the same time to retain the greatest possible proportion of moisture, and so enabling the manufacturer to produce it at the smallest possible first cost for evaporating this water.

PEAT BOG IN THE COURSE OF EXCAVATION WITH THE AUREY'S EXCAVATOR AT ALFRED, ONT.

Now, before going any further, it may be stated at once that the object of this paper is to show that the most economical, as well as the most practical and elegant solution of this problem from a scientific point of view, will be found to be the gasification of the peat, carrying from 25 to 30 per cent. moisture, by treating it in gas producers, with or without recovery of by-products, and utilizing the gas for power purposes in gas engines, or for industrial and domestic heating purposes.

This much being said, it will be in order to see just what peat is; what its peculiarities are and what are the best and most economical ways in general use abroad to manufacture it into a useful fuel.

Origin of Peat

The geological origin of peat not being relevant to the main subject of this paper, it will be sufficient to state that peat, as it usually occurs in nature, is not properly speaking a mineral, nor is it exactly a vegetable, though it has a vegetable origin. It is a substance which is the product of the destructive fermentation and gradual decay of numerous varieties of aquatic and semi-aquatic plants. Successive crops of the plants grow to maturity, then die and gradually rot away to form deposits at the bottom of lakes or ponds in which the plants grow. In the course of years, these successive deposits accumulate and gradually fill up these ponds, to such an extent that sometimes the ponds are completely filled up and acquire the consistency of solid earth, forming lands upon which trees and other kinds of vegetation begin to appear. Generally, however, the deposits simply take the shape of marshes or "bogs" in which there is more or less water present. At times, there is so much of this water that the peat has to be harvested by means of dredges, similar to those in common use for dredging sand out of rivers and lakes.

Color

In color peat ranges from light yellowish or straw tints, through various shades of yellowish or reddish brown, to a dark brown and even to black, these colors being all darker when the peat is wet. The lighter colors, however, usually change to a dark brown or black color after the peat has been macerated and exposed to the air.

In good peat beds, which have been exposed to the action of the air during the course of their formation and where the peat matter has therefore been thoroughly well aerated, there is a progressive darkening of the peat substance from the upper strata down to those at the bottom of the deposit.

The quality of the peat being indicated to a certain extent by its color, the object of the manufacturer when harvesting it, will be to endeavor to take up an equal proportion of all the strata in the bog at every stroke, to thoroughly macerate the mixture and so to obtain a thoroughly uniform and homogeneous mass, representing as nearly as possible the best average peat obtainable from the cross section of the bed.

Texture

The structure of peat varies considerably according to its origin and varies also in the different strata of one and the same bog.

The top layers of most bogs, for instance, contain a quantity of fibrous matter and partly decomposed grasses and plants and when dry present approximately the appearance of slightly compressed, dried tobacco. On the other hand, the bottom layers of filled bogs are made up of a soft oozy substance of a dark brown or almost black color which, when thoroughly macerated and mixed with the other layers, forms a soft, greasy, plastic substance of considerable density and presenting all the characteristics of potter's clay.

The finer the grain of this substance, and the darker its color, the better the fuel will be as a rule when it is dry.

There are certain kinds of thoroughly well humified fine-grained peat which,

THE DRYING OF PEAT IN OPEN FIELDS BY THE SUN AND WIND. ALSO METHOD OF TRANSPORTING

when well machined, will dry into a dark, almost black, close-grained substance, as hard as wood and which can be carved like ebony.

The nearer this condition a dried machine peat can attain, the better fuel it will make.

In the north-eastern parts of France, where our boys have been fighting a great battle, and in the near neighborhood, this material is made into a very much prized quality of coke which is used for metallurgical purposes. It is much valued for this use on account of the total absence of sulphur from its composition.

In a general way it may be stated that the texture and greater or lesser uniformity of a given peat will depend upon

1. The mode of formation of the bog, whether filled or built up;

2. The general type of plants which have contributed to its formation, and

3. The greater or lesser degree of their disintegration, which is indicated by the color of the material. The more thoroughly disintegrated the material, the better humified it is; the darker its color and the finer its grain, the better the fuel will be.

Water Holding Capacity of Peat

One of the most characteristic features of peat is its great capacity for holding water in various ways. When in its raw state in the bog, for instance, it holds from 85 to 90 and even 95 per cent. water, which it is not easily separated from.

Mechanical treatment will not get rid of any of this water to any extent, the result of very high pressures being to crush the peat substance and destroy it's usefulness as a fuel.

As a rule, this treatment will not reduce the moisture content to less than 70 per cent. and after that point, the peat, if required with a smaller moisture content, must be further dried by either natural or artificial means.

What is known as air-dried peat may be dried by natural means down to 18 to 20 per cent. moisture according to climate, but cannot be dried any more after this point is reached, unless artificial heat is applied to it. This, however, makes the fuel so costly that it should only be resorted to when the fuel is required in the absolutely dry state for a specific purpose, and in that case it should always be used at once before it has a chance to absorb any moisture again, which it will do immediately upon being exposed again to the atmosphere after drying.

Peat is only reduced to an absolutely dry state either when it is required as a fuel to produce high temperatures, and in such cases is used as soon as made, or else when it is intended to be coked or briquetted. In the latter case it must be impregnated with some waterproof binder, if it is to be kept for any length of time before being used.

Composition and Fuel Value of Peat

The formation of peat bogs and the physical processes of this formation take place under such a variety of conditions that it is difficult to give what may be termed even an average standard composition of peat. However, a prominent authority gives the following, around which average compositions will vary, for an air-dried, machine made peat, viz.:

Fixed carbon, 27 per cent.; ash, 13 per cent.; raw tars, 5 per cent.; nitrogenous liquids, 34 per cent.; permanent gases, 20 per cent.; various, 1 per cent.; total 100 per cent.

Another authority gives the following values for an average peat obtained by distillation in closed retorts, of the peat previously desiccated at 200 deg. centigrade, viz.:

Fixed carbon, 30 per cent.; gases by distillation, 36 per cent.; tars, 7.5 per cent.; acid liquids, 14.5 per cent.; ash and sundries, 10.5 per cent.; free nitrogen, 1.5 per cent.; total 100 per cent.

The fixed carbon, tars and gases being the only constituents which will burn, give the peat its heat value and in this connection the composition of the permanent gases themselves will be of interest.

These gases are approximately in the following proportions:

C_2H_4., 2.5 per cent.; C.H., 7 per cent.; H. C. Vapors, 1.5 per cent.; H., 40 per cent.; C. O., 30 per cent.; CO_2, 14 per cent.; Nitrogen, O. and sundries, 5 per cent.; total, 100 per cent.

Or 81 per cent. by volume of combustible gases, and 19 per cent. without any fuel value.

In other words, an average peat desiccated at 200 deg. centigrade, would contain approximately 65 or 66 per cent. of combustible material.

Mr. Lencauchez, of Paris, France, an eminent engineer, of great experience in the use of peats for industrial purposes in the Somme and in Picardy, gives the following as the limits between which peats will vary in that country, viz.:

Fixed carbon, 20 to 34 per cent.; products volatilized by distillation in retorts, 35 to 50 per cent.; ash, 20 to 4 per cent.; hygrometric water, 25 to 12 per cent.; total 100 per cent. each.

The following analysis of Canadian and American peats will show that their composition is very much the same and therefore, that whatever applies to the latter, applies fairly well to the former.

One difference in favor of some of the Canadian peats is that they carry very large percentages of nitrogen, which, as we will see later, is a valuable feature.

American peats. (Analysis U. S. Geol. Survey) Moisture free. Desiccated at 200 deg. C.

Volatile matter	57.98	60.28	56.38
Fixed carbon..	27.75	29.89	36.31
Ash	14.27	9.83	7,31
Sulphur	0.71	0.73	1.07

Canadian peats. (Analysis of the Mines Branch of the Department of Mines, 1913-1914) Moisture free. Desiccated at 105 deg. C.

Fixed carbon	25.	19.	29.	27.	22.	23
Volatile mat.	68.	61.	62.	61.	67.	61
Ash	7.	21.	9.	12.	12.	16
Cal. val.	9100	7500	8900	8100	7900	7900

Referring more particularly to the above, the department gives these peats as carrying percentages of nitrogen varying from 1.5 per cent. to 2.6 per cent., the latter figure being particularly high and giving the peat a striking value not as a fuel, but as a raw material for the manufacture of nitrogenous fertilizers.

Heating Value of Peat

The calorific power of peat will vary, like its composition, within rather wide limits. The ash and the water content are the two factors which will affect it most.

In a general way, it may be said, according to the department data, that this heating power will vary from 6200 to 6500 B. T. Us. for air-dried, machine peat carrying 25 per cent. to 30 per cent. moisture, to 7200 to 7400 B. T. Us. for dry briquetted peat.

Incidentally let us note that these figures show that drying and briquetting peat does not increase its heating value more than 15 per cent. or thereabouts, a fact which must give food for thought to those who advocate the indiscriminate briquetting of peat as a condition "sine qua non" of its success as a fuel.

Specific Gravity of Peat

The specific gravity of peat, like its composition and its heating power, varies considerably according to conditions and runs from .450 to .460 for air-dried, macerated peat to .750 and even 1.0 or 1.05 for artificially dried, compressed briquettes. These figures, however, must not be taken as absolute for, according to the drying and the treatment given to the peat its weight like its composition and heating power, can vary within very wide limits.

General Remarks

In a general way, it may be added that the low specific gravity of this fuel, coupled with its low heating power, have constituted a serious handicap against its adoption as a fuel in this country.

It will take from 1½ to 2 and 3 times the weight, and therefore from 4 to 8 and even 10 times the bulk of ordinary machine cut peats to furnish the same amount of heat as a given weight of coal.

These peculiarities, inseparable as they are from the very nature and physical characteristics of the peat, as well as the misdirected efforts to utilize this fuel by futile attempts to do away with them, have been the cause of all the failures recorded up to the present and the consequent lack of popularity of the fuel.

The proper way of utilizing our peats has never been attempted and seems to have been absolutely ignored from the beginning in this country, and it is the purpose of this paper to show that peat can be advantageously utilized and that in more ways then one, even when in competition with the cheap coals to be obtained in this Province.

PANORAMIC VIEW, ALFRED PEAT BOG

HOT BEARINGS

By M. M.

A wise manufacturer always takes precautions to avoid the bearings in machinery being heated and takes frequent steps to satisfy himself that the men in charge of this matter are really attending to their duties. If this is neglected very serious damage is involved. Some bearings are normally hotter than others and in some cases a bearing may feel uncomfortably hot to the hand and yet may be quite satisfactory, though this is seldom the case in any clay-working plant where the machinery is heavy and runs comparatively slowly.

Among the numerous causes of hot bearings the following are the most important:—

(a) Lack of lubrication, due either to an insufficient supply of oil or grease by the man in charge or to some defect whereby the lubricant cannot reach the part of the bearing where it is required. This defect can be remedied without much trouble.

(b) An unsuitable lubricant, such as using a grease where an oil is required, or a thin oil instead of a thick one. In some cases even a slight increase in the thickness of the oil may make all the difference to the running of the bearings and no pains should be spared to ensure a suitable lubricant being used. It often happens that a cheaper oil or grease may be substituted for the one being used, but the aim should never be to use a lubricant which is sold at a low price, but one which proves to be cheap in use because so little of it is required to keep the bearings in good condition. In many cases the substitution of grease under slight pressure (as in a Stauffer lubricator) will prove more efficient and much cheaper than the use of thick oil. The choice of a lubricant should be based on trials and on actual experience and not on the recommendation of men with little or no knowledge of the conditions.

(d) Dirt in the bearings introduced with the lubricant or in the form of dust. This sets up friction and soon caauses an evolution of heat. The remedy consists in cleaning the bearing thoroughly, using a lubricant free from gritty matter and protecting the lubricating hole in such a manner that no dust can enter the bearing. A light cover will often save a large amount of trouble in this respect, particularly in dusty places.

(e) The clearance in the bearing may be either too large or too small. If the former lubricant will not be kept properly to its work and if the latter there will be an insufficient supply of lubricant owing to the small space through which it has to pass. The remedy in either case is to place the parts of the bearings in such relationship to each other that the correct amount of clearance is obtained.

(f) Lack of alignment will often cause overheating of the bearings, as the machines will not be truly parallel to the driving shaft and the pressure exerted by the belt or gearing will be greater at one part than at another.

(g) Badly made or badly lined bearings usually "work hot" and no amount of lubrication will prevent this. Unless care is taken in relining a bearing the white metal may be left too rough and thus prevent the proper flow of the lubricant or even the total lack of lubrication at certain points because the lining is in contact with the moving part.

When a bearing is overheated the first thing to do is to apply more lubricant and to observe carefully whether this has the desired effect. If not, a thinner lubricant may be applied if the nature of the bearing permits, though the use of thin oil is seldom a permanent remedy for hot bearings. If this does no good, the bearings should be slackened slightly as the clearance may be insufficient to permit the lubricant to flow properly. In some cases it may be necessary to slow down the engine until the bearing cools and at the same time to examine it as far as conditions permit. It is best not to stop the engine or machine entirely as the bearing may then adhere to the journal and it will be impossible to restart it without damage. On no account should a bearing be cooled by pouring water on it. This usually causes such severe contraction that the shell is weakened and may be cracked. If other means of preventing the bearing from being overheated fail, it will be necessary to take it to pieces, examine it carefully and see whether the cause of heating is included in the ones mentioned above. If it is none of these, the case is so abnormal that a specialist will be required to diagnose the cause and provide a remedy.

Talbot Boilers and Engines Made in Canada

Improved Design Results in Saving in Space and Increased Efficiency Over Standard Types of Boilers and Engines—A Description of the Contra-flow Boiler and New Uni-flow Engine

THE developments and improvements that have taken place during the last generation in the manufacture of boilers have been confined very largely to construction details and arrangement of parts, but the principles involved in carrying large volumes of water, with circulation by gravity, has remained the same in all of them, and to some extent the advancement in steam generation has not kept up with the general march of industrial progress; therefore the contra-flow type of steam boiler, with the water spread over a thin film over the surface, represents the last word in the known science of boiler construction. A boiler of this kind occupies about one-seventh the space per H.P. of that required for a Scotch boiler of the same capacity, thus permitting of additional cargo space, or small vessels for stated tonnage. In these oil-fired types of boilers no brickwork is necessary, and with the saving of space it is claimed that they can be operated cheaper than any known power-producer. Automatic control minimizes the labor factor, as one attendant can easily take care of a large group or battery of boilers.

The Talbot contra-flow boilers here described were invented by Paul A. Talbot, president of the Talbot Engineering Corporation, of New York. The Uni-flow engines here illustrated are also of his design.

General Description

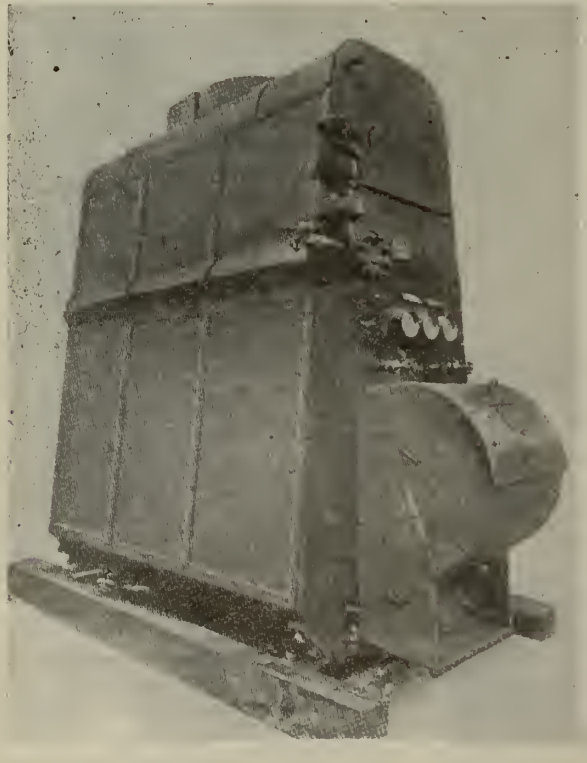
This is essentially a boiler of the contra-flow type, water entering near the stack and leaving in the form of steam near the furnace. The circulation is through water tubes and is forced at a high velocity by means of a pump, doing away with a water drum. By preventing gravity circulation, the steam is drawn directly from the lower tubes, eliminating the steam drum. The boiler is internally fired, and hence self-contained. Feed water and fuel burners are automatically controlled to adjust the boiler to widely varying demands for steam. The boiler should not be confused with "flash" boilers in which the heat-charged tubes furnish steam in direct proportion to the feed supply without regard to the control of the fire. By means of the high velocity, forced circulation and contra-flow principles, the evaporative capacity of the boiler is largely increased.

Any or all of the tubes may be readily removed and replaced without disturbing any manifolds, pipes or connections. Official tests recently carried out in the Navy Yard, New York, included a tube-renewal test of a 100 h.p. boiler. A tube was removed from the boiler under 250 lb. steam pressure and replaced by another tube in 61 seconds, the total period between the time of shutting off the fire and feed water and the time of regaining full pressure and maximum capacity of operation being 3 min. 16 sec.

An idea of the general construction of the boiler may be obtained from Figs. 1 and 2. Fig. 1 shows the front and Fig. 2 the rear of the boiler with the casing removed. Fig. 3 shows complete boiler with its casing. The illustrations are of a boiler having an evaporation of 15,000 lb. of water per hour with ¼ in. of water draft, 20,000 lb. per hour with 1 in. draft and double the normal capacity at slightly above 2 in. draft.

The frame consists of front and rear sections, roughly resembling horseshoes in shape, fastened together at top and sides by lateral ties, and at the bottom by the ash pan and additional ties. The stack ring and upper panel work are supported by framework bent to conform to the curve of front and rear frames. For fastening the boiler in position, feet are provided which are bolted to the main frame through the ash pan. The door frame, of angle cross-section, is fastened at the top and bottom to the main frame and serves as a support for regulating valves shown in Figs. 1 and 3 and described more fully later.

The tubes throughout the boiler are



FRONT OF BOILER WITH CASING

REAR OF BOILER, CASING REMOVED

all alike. As will be seen in Fig. 4, the crucible steel header consists of two sets of overlapping compartments, into one of which is screwed the open-end field tubes, and into the other the generating tubes, there being an annular space between the two tubes. The end of each generating tube is welded together so as to close it. These closed ends are free to expand and are supported in front by perforated sheets of metal. The method

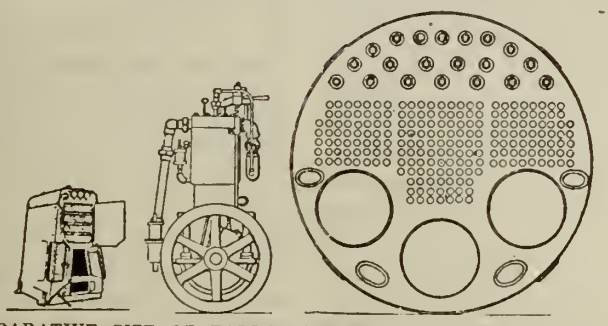


FIG. 3—COMPARATIVE SIZE OF TALBOT BOILER, GAS UNIT AND SCOTCH MARINE BOILER OF EQUAL CAPACITY.

of fastening the tubes into the headers is shown in Fig. 5. Both tubes are threaded with double the standard taper, which makes it easy to remove them. The fit is sufficiently tight to hold a pressure of 1,000 lb. per sq. in., using standard weight pipe.

Five sets of tubes with horizontal headers are placed above the combustion space, and on each side of the combustion space is placed another set of tubes with headers arranged vertically. The rear of the furnace is closed by a wall containing water-circulating passages connecting the tubes on the sides, as shown in Fig. 2.

Between each set of headers is a trap connection, shown in Fig. 2. These traps perform the important function of preventing water from draining by gravity from one header to the next below, until sufficient water is forced into the upper header. The formation of steam prevents the water from siphoning when circulation is at rest and the correct amount of water is thus maintained in each header in readiness for full capacity demands.

Accessibility. There are three doors in the front of the boiler, which, when opened, give access to the free ends of all the tubes. Any tube can be removed by applying a wrench to its end and unscrewing it from its header.

Operation

The circulation of water is maintained by a pump, delivering the feed water to the main check valve at the bottom of the door frame, from whence the water rises in a pipe and passes around the door frame to the regulator valve. The water then passes to the rear of the boiler to the uppermost set of tubes. In order to understand the circulation through the tubes, reference must be made to Fig. 4, which shows a typical header and tubes forming a single section, the path of water through it being indicated by arrows.

Having passed through the first set of field tubes and returned to the inner compartment of the header by way of the annular space in the generating tube, the water returns to the front of the boiler through a similar annular space in next set of tubes and back to outer compartment of the header by way of the inner field tubes. This process is repeated until the water has traversed to the opposite end of the header, where it passes out through a trap connection to the header immediately below. Passing from header to header, the water has a general downward direction to the set of tubes, which is on the left side of the furnace, as seen in Fig. 2. The circulation through all sections of tubes is the same.

Referring to Fig. 2 the steam or water from the set of tubes on the left to the furnace enters a rear wall which is partitioned in order to carry the water at high velocity from one side to the other until it is finally discharged, at the bottom of the right-hand corner, into the set of tubes on the right side of the combustion chamber.

During this passage the water has gradually changed to steam, and it now leaves the last set of tubes through the herringbone steam separator at the back of the boiler and enters the steam pipe, crossing at the front of the boiler where safety valve and steam nozzle are located. The separator drain passes to the front of the boiler where the valve controlling it is located.

The length of water passaged from the point of entering the boiler to the point of leaving it varies with the size of the boiler. The passage in a 1,000 h.p. boiler is 795 feet long, 668 ft. of which is through tubes. The areas through which the water flows also vary with the boiler and are restricted to increase the velocity of flow.

The friction of water and steam by reason of the restricted areas is about 100 lb. at normal load. This friction increases as the load increases.

The velocity through the boilers in which large tubes are used is much greater than when smaller tubes are used. Thus the velocity of the steam in the last stages of the boiler varies from 6,000 to 12,000 ft. per min. depending upon the size of the boiler tubes used. This velocity increases, of course, as steam is formed, so that the velocity in a large boiler is about 500 ft. per min. in the first and 12,000 ft. per min. in the last passages when in the form of steam.

A high rate of evaporation is obtained because of the high velocity of water through the tubes. The tubes which line the furnace evaporate as much as 30 lb. of water per sq. ft. of heating surface, while the average, including economizer and superheating surface, is 8 lb. per sq. ft. rated capacity.

The formation of scale is prevented by the high velocity and consequent scouring action of the water, which keeps the solids in constant motion. The actual velocity great enough to prevent scale is not known, but it has been determined that with a velocity as low as 60 ft. per min. and very poor water, mud forms in the economizer section of the boiler. The water tested was alkali of 27 degrees hardness, such as is found in desert regions. With a normal velocity of 500 ft. per min., such as is used, a minimum velocity of 150 ft. per min. can be maintained at partial loads. It has been found that at very low velocities the deposits have been confined to the water portion of the boiler, where the temperatures are between 100 and 150 deg. Fahr. As the entire heating surface is active and subjected to these high velocities, feed water purifiers are not necessary for this boiler.

The Soot Blower

The soot which forms on the economizer surface of the upper sets of tubes is blown from them by longitudinally directed steam jets situated near the ends of the tubes. Steam is supplied from the main steam pipe, and valves for the control of the jets are on the front of the boiler. The jets have proved a satisfactory method of keeping the surface relatively free from soot. The tubes at the side of the furnace are practically free from soot, and it is probable that if any soot collects on them it eventually ignites. Exterior as

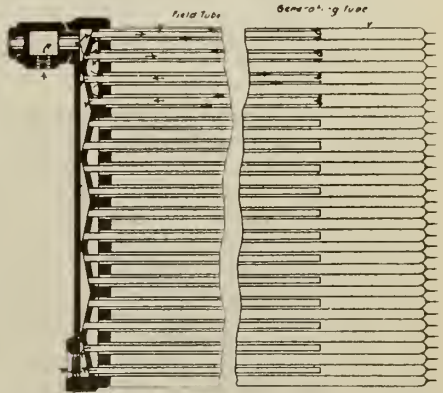


FIG. 4—DIAGRAMMATIC SECTION THROUGH HEADER AND TUBES. ARROWS SHOW COURSE OF WATER CIRCULATION.

well as interior surfaces of the boiler, therefore, are always clean, eliminating the periodic overhauling and cleaning.

Thermostatic Control

The expansion of one of the tubes of the last set at the side of the furnace under the varying temperatures of steam contained within it is multiplied by means of levers, and is utilized as an automatic thermostatic control of both water and fuel supply. Arrangement is made so that the operator may easily and quickly adjust the thermostat to meet the demands. The slightest rise in

temperature of the outgoing steam causes sufficient expansion of the tube to open the regulating valve on the front of the boiler and admit a greater quantity of water, thus lowering the temperature of the steam. In case the operation of the thermostat has not prevented the rise in temperature, as might happen under partial load or insufficient water supply, it will cut off the supply of fuel to the furnace. At low temperatures, the supply of fuel is increased by this same thermostat.

Details of the thermostat. The expansion and contraction of the tube and the movement of the regulating valve are shown by a gauge, which is arbitrarily graduated for convenience in indicating the relative temperatures, and may be calibrated by means of a mercurial thermometer so that the operator may judge from it the temperature of the steam. Thus it might be determined that with the gauge reading 2 3-8, the temperature of the steam is 650 deg. Fahr. Having determined the point for the temperature he desires, the operator can regulate the thermostat to maintain the gauge at this point. This reading is checked occasionally, as changes in the frame, header or tube, due to wear or seasoning, may make corresponding changes in the calibration of the gauge, so that some other point registers the 650 deg. which the operator is trying to maintain. This temperature gauge serves the purpose of the water column of the ordinary boil. The temperature of steam delivered tells operator whether or not the supply of water is adequate, as it is obvious that with too little water, at full capacity, the temperature of the steam will rise and indicate this condition on the gauge. Alarms may be attached, if desired, but are unnecessary, as the fire automatically is shut off before the boiler is damaged. When steam temperature drops, the normal supply of water is attained.

Hand Valve

The action of the automatic valve is fairly close, but due to the fact that the regulator tube is not instantly affected there occur periodic changes in the temperature and pressure. A hand valve is provided for eliminating this action under normal loads. This valve is arranged to shut off completely the supply of water when closed, and is marked with arbitrary graduations from which the operator may determine at what point it should be set for the best results. When the hand valve is closed too much, it is obvious that the supply of water may be so limited that the temperature will rise to a point where the fuel valve will close. When the valve is opened too much, there will be a periodic variation in the temperature of the steam, due to the lag of the controlling thermostat. The point should be determined, therefore, which will allow the regulating valve to be opened all the time, preventing the periodic variation in temperature due to too frequent shutting down of the fuel valve. The accuracy of adjusting this valve determines the accuracy of temperature control under full-load conditions. Experience has shown that on a 25 per cent. load the valve does not require adjustment, but the temperature of the steam will be much less, due to an oversupply of water to a reduced fire. By readjustment of the valve the full-load temperature can be maintained at fractional loads. At less than 25 per cent. capacity a readjustment is necessary to prevent the periodic variation in temperature. The ordinary fireman can easily maintain a constant pressure and temperature by means of this hand valve.

Oil Burner

A steam automizer oil burner is arranged at the front of the boiler near the top of the inflow of air for combustion. The air is heated and carried in a general downward direction by the air duct, a short-metal addition to the front of the boiler having an S-shaped channel. The quantity of the air can be adjusted by air dampers in this duct. Highly superheated steam is used to heat and vaporize the oil and to promote the velocity of the hydrocarbon mixture, which issues from the burner tips. Very heavy Mexican oil, 11 Baume, can be used in this burner. A number of burner tips shoot the flame downward into a firebrick target at the lower rear end of the furnace. This refractory target or oven is designed to distribute the heat uniformly over the entire heating surface. Temperatures of 3,800 deg. Fahr. are obtained within this oven, but as few bricks are used, the upkeep is small.

The intensity of the fire is easily controlled by increasing or decreasing the volume of steam used in automizing the oil. The flame has the effect of a large blow torch, and as the velocity is carried to an extreme, considerable noise is experienced. This is not a detracting feature in marine practice, as it is confined to the fire room.

Furnace Jacket

As heating surface surrounds the furnace on all sides, the insulation of the jacket is easily accomplished. The insulating material is applied in plastic form and fills the entire space between the sheet-metal casing and tubes themselves.

While this system is preferred, the various methods of applying insulating material in boilers having sheet-metal jackets may be used, or brick settings may be installed where space, weight and vibration are not settings for consideration.

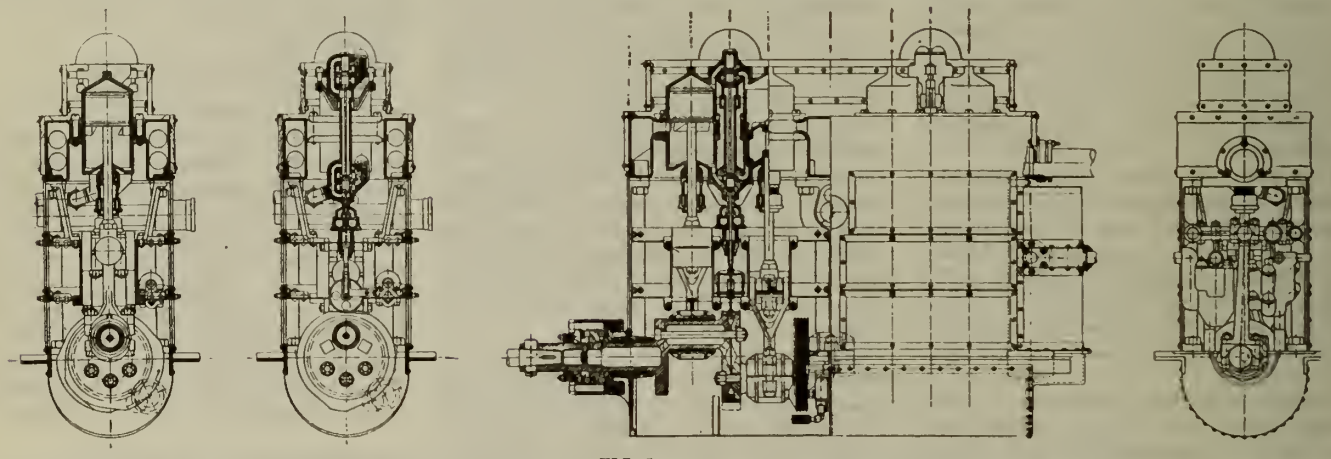


FIG. 5
TALBOT 4-CYLINDER UNIFLOW MARINE ENGINE. WORKING PRESSURE 500 LBS. PER SQ. IN. 1,500 I.H.P. SIZE HAS CYLINDERS 20 IN. x 20 IN. FOR 160 REVS. PER MIN. WEIGHT, 20 TONS. TWO PISTON VALVES SERVE ALL CYLINDERS. STEAM CONSUMPTION 10 LBS. PER H.P. HOUR.

Effect of Forcing

The thermal efficiency of this type of boiler is affected in much the same manner as in boilers of other types, although the drop in the efficiency curve is not so pronounced at higher draft pressures and higher evaporative rates, due to the fact that when forced the economizer surface in the upper part of the boiler is correspondingly increased and the stack temperatures are relatively lower. More water is introduced, and the superheating surface is reduced nearly in proportion as the load is increased.

The Talbot steam power plant is usually installed with the boiler at the side of the engine. In fact, the boiler and engine are one unit, and the plant has the advantage with other oil engine installations of occupying a minimum of space and affording a maximum of steaming radius to vessels equipped with it. The engine proper has four cylinders, which are all of equal diameter and stroke, and it is built particularly for the use of superheated steam. The piston rods and valve stems run in an oil bath

Continued on page 43

Transformer Connections for Power Transmission

Part Two of an Article Descriptive of Various Types of Transformer Connections in Common Use and the Characteristics of the Resulting Circuits

By GORDON KRIBS

2. Star-Star, or Y to Y Connections

IN the Star or Y arrangement each transformer has one terminal connected to a common junction or neutral point—the three remaining terminals being connected to the three-phase lines as shown in diagram Fig. 19.

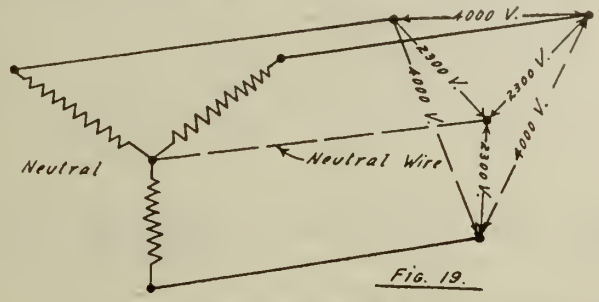


FIG. 19 STAR CONNECTED TRANSFORMERS

In a system using Star-connected transformers, there may be either 3 or 4 transmission or line wires. In case there are three they are all phase or power wires; if four, one of them is a neutral wire, and is connected to the common junction of the transformers. It is often of steel, since it does not carry anything more than a balancing current which in a balanced system is usually small and often of triple the system frequency. In high tension transmission systems the neutral point of a Star connected system is usually grounded, either direct or through a resistance which has a steadying effect on the delivery voltage of the transformers owing to the fact that the electrical neutral point has a tendency to wander from the physical neutral unless tied down by means of a definite ground wire or by reason of the fact that the secondary is delta connected.

In the appended diagram, Fig. 20, the neutral wire is shown dotted, and may or may not be used.

It will be seen that each transformer, both primary and secondary, has one terminal connected to a common point or neutral while the other terminal is connected to the line. This method of connection is not as good for high voltage lines as the Delta-Delta connection or the Delta-Star or Star-Delta to be given later, for the reason that electrical waves of 3, 5, 7 or 9, etc., times the true frequency are liable to be formed—due to magnetizing currents in the transformers and these harmonies, as they are called, are liable to generate destructive high frequency voltages in the circuit. For low voltage lines—this connection is satisfactory. In order to draw a voltage diagram of a Y connected bank of transformers we may proceed as follows:

Let us name the common point in Fig. 20 "X" and each of the other terminals respectively a, b, c.

Now referring to Fig. 21.

Draw A′ X′ vertically representing 2,200 volts—the voltage across the transformer a—x, and draw b X′, and c X′, both equal in length to a X′, but 120 deg. apart so that at X′ we have three angles of 120 deg. each. Each of these lines represent 2,300 volts, being the neutral or common point and the distances a b,—b c,—c a, as measured on the diagram represent the voltage across the lines, which in this case is 4,000 volts.

Since a line is taken off from the free terminal of each transformer it is evident that the current in each line is the same as that in each transformer. The voltage across lines however is seen from the diagram to be 1.73 times the voltage across each transformer, i.e., the voltage across each transformer is only $\frac{1}{1.73}$ or 58 per cent, of the line voltage.

In other words the same ratios which held good for currents in the Delta connection—hold good for voltages in the Y connection.

Unlike the Delta system of connections if a transformer in a Y connected bank of transformers burns out, it is impossible to supply three phase service as may be seen from the diagram Fig. 22.

It will also be seen from the diagram that the phase angle between the transformer voltages is 30 deg. Since at unity power factor the voltage and current in the transformer are in phase, it follows that with a Y connected system, as in a Delta system, there is a phase angle between line voltage and line current of 30 deg.

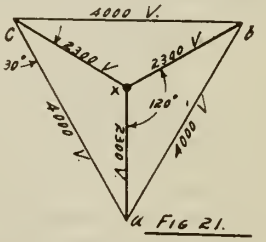


FIG. 21—VOLTAGE RELATIONS STAR CONNECTION

(3) Delta-Star Connection

The Delta-Star connection is simply a combination of the two previous methods in which the primary is connected Delta and the secondary, Star, as in the diagram Fig. 23.

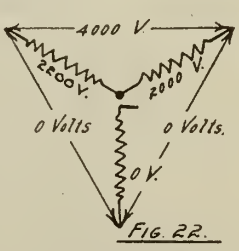


FIG. 22

This system is largely used in stepping down from a medium transmission voltage such as 44,000 volts, 26,400 volts or 13,200 volts to 4000 volts. This latter voltage has lately come into considerable use since standard lighting transformers may be used and yet considerable money can be saved due to the use of the higher voltage in distributing systems and short transmission lines of small capacity. It has the same disadvantage as the straight Star connection in that if one transformer is burned out,

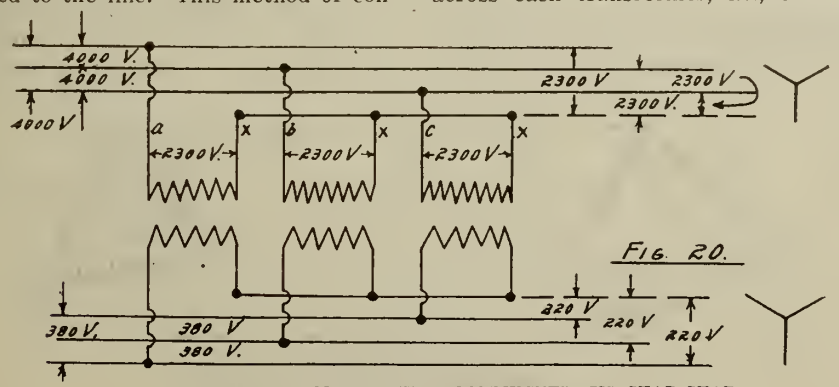


FIG. 20—TRANSFORMERS CONNECTED UP STAR-STAR

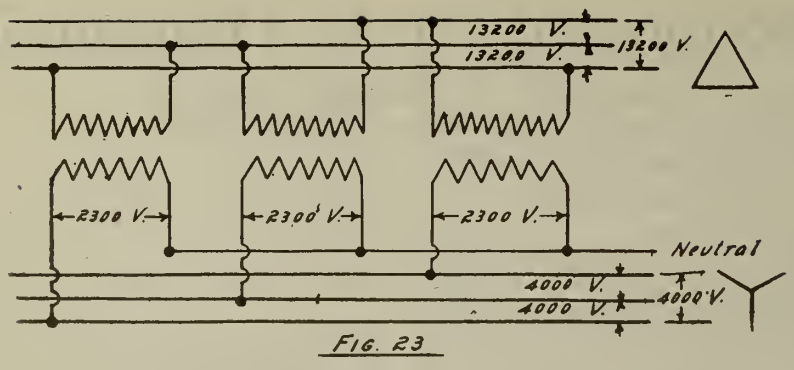


FIG. 23—DELTA STAR CONNECTION

three phase service cannot be given.

(4) Star-Delta Connection

This system of connecting up a bank of transformers is usually used where it is desired to step down extra high voltages such as 60,000 to 110,000 volts to ordinary transmission voltages from 6,600 to 26,400 volts. The diagram (Fig. 24) shows the connections for a three-phase Star Delta bank for transforming from 110,000 volts to 13,200 volts.

The chief advantage of the use of Y connected transformers for high tension work is due to the fact that the current in the H. T. coils is greater and the mechanical strength of the conductor is therefore greater than in transformers built for Delta connection, also the voltage across the terminals is considerably reduced. Thus for a 110,000 volt system, 64,000 volt transformers are used. Furthermore the voltage to ground on the transmission line is only 64,000 volts whereas in the Delta system it would be 110,000 volts and hence there is less strain on the line insulators. On important systems it is necessary to have a spare transformer in case of breakdown to insure certainty of service.

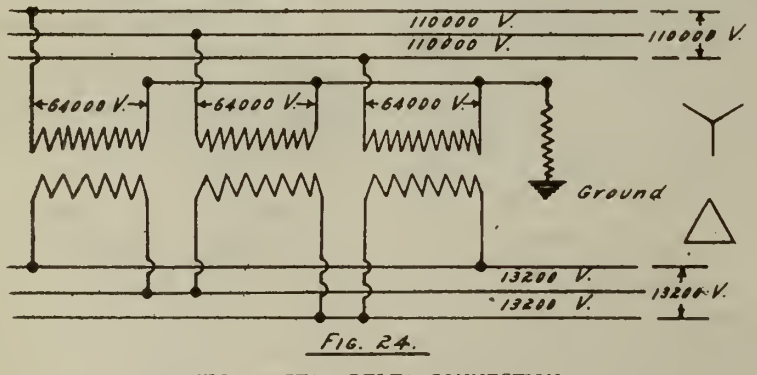


FIG. 24 STAR DELTA CONNECTION

(5) Open Delta

Open Delta, or V connection as it is sometimes called, is used on a three phase system where only two transformers are available or where one of the three transformers of a three phase Delta bank has been burned out. Diagram (Fig. 25) shows two transformers connected in open Delta both primary and secondary.

The voltage diagram of the secondary of this transformer bank is shown in the following diagram (Fig. 26):

The line a b (Fig. 26) represents the voltage across the terminals of transformers A and b c, the voltage across the terminals of transformer B which is 120 deg. out of phase with the voltage a b. The potential difference between terminals a, and c, will also be seen to be 220 volts and thus a true three phase current may be obtained with this combination of transformers.

In a combination of three single phase transformers in delta the combined capacity of the bank is three times that of a single transformer. By cutting out one transformer, we not only reduce the capacity of the bank to two-thirds of the former value, but it is still further reduced owing to the fact that unlike the three transformer combinations the current and voltage waves in the transformers are 30 deg. out of phase.

This may be explained as follows:

Assuming in the first place that we have a Delta connected bank of transformers supplying a three phase load consisting of a Delta connected motor. This may be represented by the diagram (Fig. 27).

As pointed out previously the triangle a, b, c, (Fig. 28) represents the voltage relations in a delta connected system.

Let the sides of the triangle represent the line voltages in magnitude and phase. If we are supplying a load at unity power factor, the load current, is in phase with the voltage. Let us start at the load and work back to the transformer bank. Draw b x, b y, and b z, equal to the load currents and in phase respectively with the voltages b c, a b, and a c. Thus x y, x z, and y z, represent the line currents in magnitude and phase and it will be noted that the line currents are not in phase but are 30 deg. out of phase with the line voltages even though the power factor is unity. In the transformers supplying the power to the line, however, the voltage and the current are again in phase. The currents b x and b z, which in the above diagram were combined to form the line current x z, being again split up into its component parts in phase with the transformer voltages. Now suppose transformer C to be removed, thus forming an Open Delta combin-

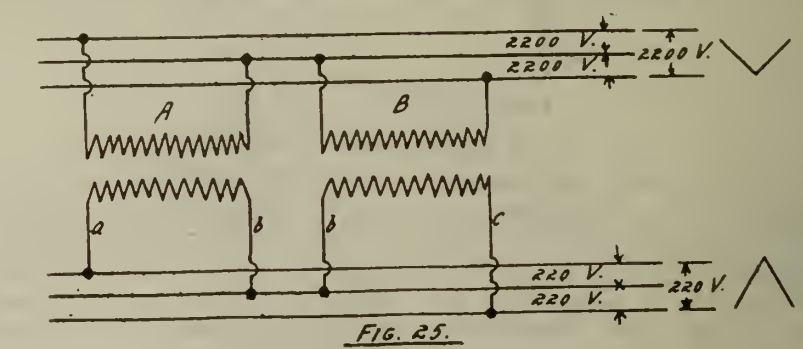


FIG. 25—OPEN DELTA CONNECTION

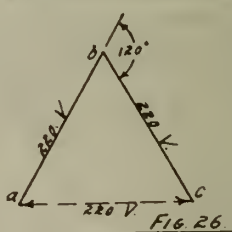


FIG. 26—VOLTAGE RELATIONS, OPEN DELTA CONNECTION

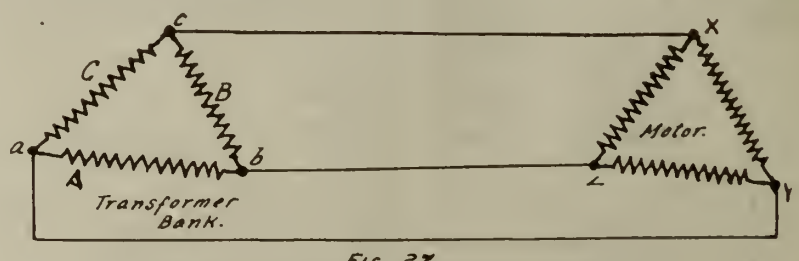


FIG. 27 TRANSFORMER AND MOTOR IN DELTA

ation. The current b z must be carried by the other two transformers in series. Transformer B for instance must carry its own current b x, and the current b z, the sum of these two currents being x z. Similarly the current carried by transformer A is y z. It will thus be seen that the currents in each of

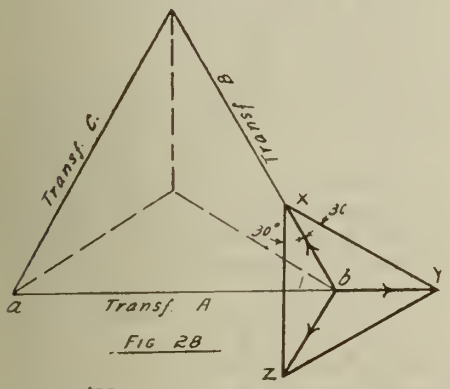


FIG. 28—VECTOR DIAGRAM

these transformers are not only increased by $\sqrt{3}$ or 1.732 times, but are changed so that there is a phase difference of 30 deg. between current and voltage in the transformer. It could not be otherwise, for the transformer currents are identical with the line currents and we have

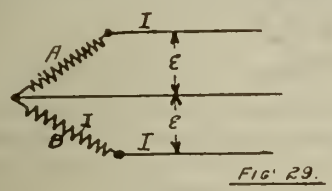


FIG. 29

previously shown that a phase difference of 30 deg. exists between line current and line voltage.

The amount of this reduction may be calculated as follows (Fig. 29):

The current in each transformer is I and is the same as that in the line, also the voltage E of each transformer is the same as that across each line wire.

Thus the capacity of each transformer is $\frac{E\ I\ (K.V.A.)}{1000}$ and the total load being transmitted over the line according to the well known formula is $\frac{1.73\ E\ I\ (K.V.A.)}{1000}$ so that the ratio of the capacity due to this connection is $\frac{2\ E\ I}{1000}$ to $\frac{1.73\ E\ I}{1000}$ 2 to 1.73 or 86 per cent.

Thus the capacity of two transformers in Open Delta is 86 per cent. of the rated capacity of the transformers and is 2-3 × .86 or 58 per cent. of the capacity of the total capacity of the three transformers in a closed Delta bank.

(6) Tee Connection

There is another method, by means of which a balanced three phase load may be taken from a three phase line by using only two transformers. This is called the Tee connection and is shown in Fig. 30.

This connection requires the use of two special transformers. Transformer A must be equipped with 50 per cent. taps—both primary and secondary and have all three leads brought out of the case. Transformer B must be equipped with 86.6 per cent. taps, both primary and secondary, with only two leads brought out.

The vector diagram showing current and voltage relations with the scheme of connections is shown in the following Figure 31.

In diagram (Fig. 31) a b, represents the voltage across transformer A—o c, represents the voltage across transformer B. Thus a b, a c, and b c, represent the line voltages. The line currents as before are 30 deg. out of phase with the line voltages and may be represented by x, y and z. Thus at unity power factor, the current in transformer B is in phase with the voltage while the current in one half of the winding of transformer A leads the voltage 30 deg. while in the other half it lags behind the voltage 30 deg.

The method of arriving at the proper voltage tap for transformer B is as follows:

The voltages across a b, and a c, are equal and 120 deg. out of phase and o a is one-half of a b, or a c. Therefore if o a, is designated as one then a c, equals two, and o c, must necessarily be $\sqrt{3}$ or 1.732 so that the relation between either a c, or a b, and o c $\frac{1.732}{2}$ =86.6 per cent.

The capacity of two transformers connected in T is not equivalent to the sum

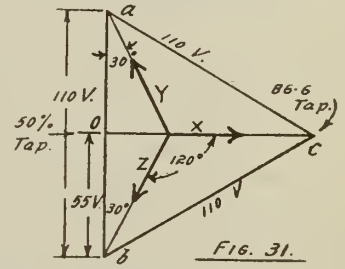


FIG. 31—VECTOR DIAGRAM TEE CONNECTION

of their rated capacities but is smaller since in the transformer A the current is 30 deg. out of phase with the voltage and only 86.6 per cent. of transformer B is used.

The k.v.a. in a three phase circuit is equivalent to $\frac{1.732\ E.\ I.}{1000}$

The k.v.a. in a T connection is $\frac{2\ E.\ I.}{1000}$ so that the transformers in a T connection will only carry 86 per cent. of their rated capacity providing they are similar transformers.

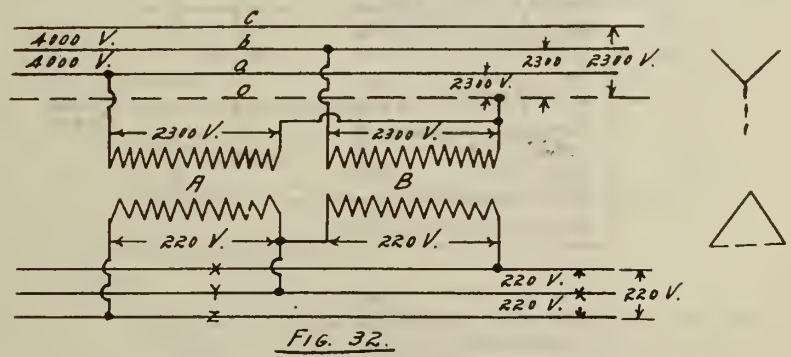


FIG. 32—OPEN Y, OPEN DELTA CONNECTION

(7) Open Y—Open Delta Connection

This is another connection which is coming into use particularly on 4,000 volt lines (2,300 volt Y) for use on small loads where the use of three transformers is not warranted. This connection, unlike the previous three phase connections, does not produce a balanced load on the line—in other words all the power from this combination is taken from two phase wires and the neutral. It is necessary to use three combinations of like capacity connected in rotation in order to secure a balance and all balancing current is carried by the neutral. Fig. 32 shows the scheme of connections.

It will be noted that in this connection, no power is taken from one of the primary lines.

The vector diagram of this connection is shown in diagram Fig. 33.

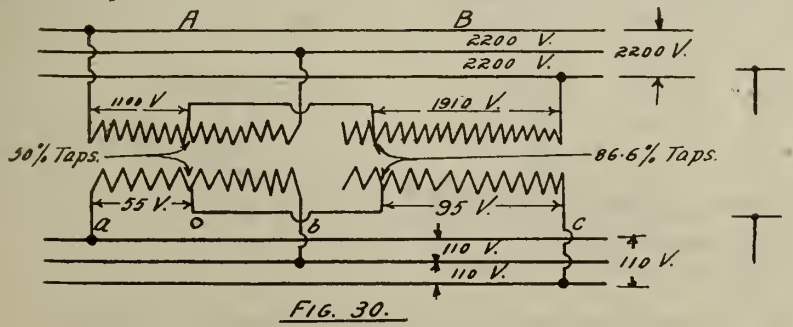


FIG. 30—TEE CONNECTED TRANSFORMERS

The voltage across the primary of the transformers is represented by o b, and o c, each equal to 2,300 volts and with 120 deg. phase relation. The line voltage b c, is 4,000 volts. The voltage induced in the secondaries of the transformers is in phase with the primary voltage, but in transformer B is in the opposite direction. On o c, mark off o y, equal to 220 volts and produce b o, to z, making b z,=220 volts. The voltage y z, is also equal to 220 volts and since these voltages are in 120 deg. phase relation we have a balanced three phase voltage on the secondary. As the current in the open Delta secondary is 30 deg. out of phase with the voltage, the capacity of this combination is 86 per cent. of the rated capacity of the two transformers or 58 per cent. of the capacity of three transformers connected Delta or Star.

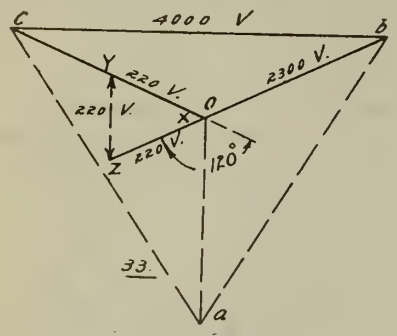


FIG. 33 VECTOR DIAGRAM, OPEN Y, OPEN DELTA CONNECTION

(8) Booster Connections for Three Phase Circuits

As pointed out previously in the case of single phase circuits, transformers may be connected in a three phase circuit for either bucking or boosting the line voltage. In a three phase circuit in order to get balanced voltage three transformers are necessay. These may be connected either Delta or Y as shown in Fig. 34.

Two transformers may be used as boosters on a three phase system which, however, introduces a slight unbalancing of voltages.

This method is shown in Fig. 35.

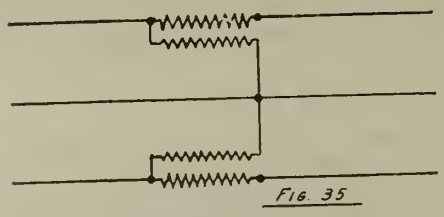


FIG. 35—BOOSTER CONNECTION

(D) Two Phase—Three Phase Connections

It is possible by means of two transformers to transform from two or three phase and vice versa. The system of connections ordinarily used for this purpe is called the Scott connection, although there are other schemes which can be used. The diagram of connections is given in Fig. 36 in which power from a three phase 2,200 volt circuit is stepped down to 220 volts and at the same time changed to two phase. Two transformers only are used, the Scott connection being very similar to the Tee connection.

For a Scott connection, the three phase side of the combination, whether primary or secondary, must be provided with special taps, one transformer being provided with a 50 per cent. tap while the other is provided with an 86.6 per cent. tap. It will be seen that the H. T. terminals of transformer A are connected to two of the three phase mains, and one terminal of transformer B is connected to the middle tap of transformer A and the 86.6 per cent. of transformer B is connected to the remaining three phase main.

The four secondary terminals are connected each to one of the four wires in the two phase mains. It is possible to effect a two phase—three phase transformation by means of auto transformers, the ratio of transformation being one to one. This will only work on a four wire two phase system in which the two phases are not interconnected. Suppose that power is supplied two phase and we wish to transform it into three phase.

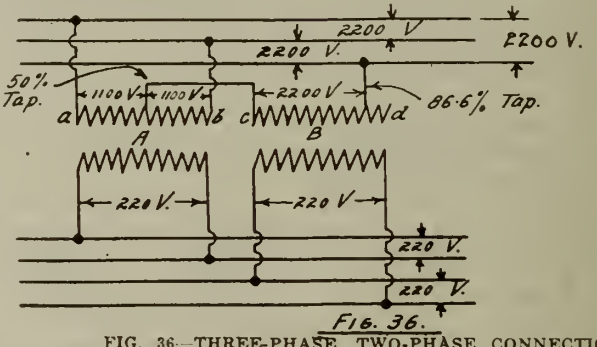


FIG. 36—THREE-PHASE, TWO-PHASE CONNECTION

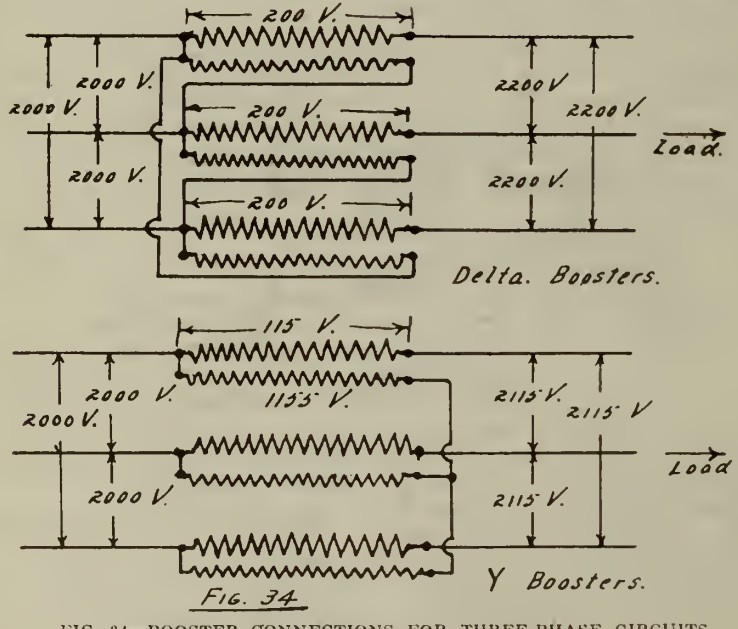


FIG. 34—BOOSTER CONNECTIONS FOR THREE-PHASE CIRCUITS

The diagram (Fig. 37) shows the manner of working this connection and diagram (Fig. 38) shows the voltage relations in this combination.

Two phase voltages are at 90 deg. phase relation with each other. If we impress one phase of a 2,200 volt two phase circuit across a b, and the other phase across c d,—c, being the middle point of a b, then the lines a b, and c d, in the above figure properly represent the voltage conditions both as to magnitude and phase relation. Now it is apparent that if a point e, be taken somewhere on the winding c d, such that a e, and b e, are equal to a b, that we would have a balanced three phase voltage, each voltage being at 120 deg. phase

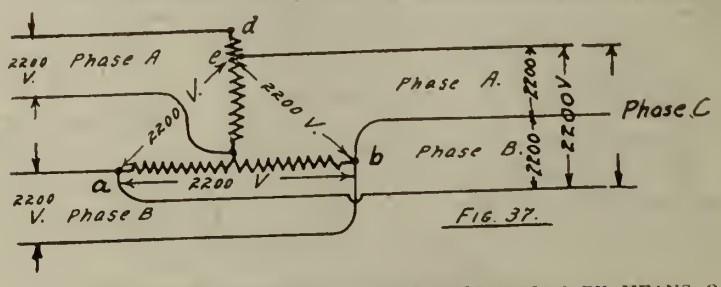


FIG. 37—TWO-PHASE, THREE-PHASE TRANSFORMATION BY MEANS OF AUTO-TRANSFORMERS.

relation with the other voltages. The exact location of the point c is found as follows:

a b, is equal to a c, or c d, and a c, is one half a b, therefore if a c, is equal to one, a c, must equal two and c e, equal

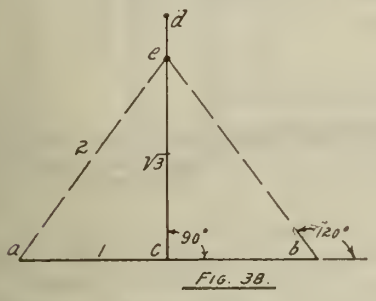


Fig. 38.

FIG. 38—VECTOR DIAGRAM, SCOTT CONNECTION

to $\sqrt{3}$=1.732, therefore the relation of the portion of the winding c e, to the whole winding c d, is 1.732 to 2 and $\frac{1.732}{2}$ =86.6 per cent. So that it is necessary for the winding c d, to have an 86.6 per cent. tap.

The relation of the current to voltage in the transformers in the Scott connection are similar to that of the T connection and hence the capacity of two transformers connected Scott is 86 per cent. of their rated capacity.

It is apparent that the Scott connection will work equally well in the reverse direction, i.e. with three phase power supplied will transform with two phase.

TALBOT BOILERS

Continued from page 68

and packing trouble is practically eliminated by using a special form of water cooled stuffing box. No cylinder oil is used within the cylinders, and long tests covering several years have proved that the wear is even less without the use of cylinder oil than with it in engines operated on wet steam.

Engine Control

The control is effected by an oil operated piston, both the reverse mechanism of the engine and the throttle valve being operated from any position in the boat where the control station is located or from various positions if more than one control station is installed. Four small pipes carry the oil from the piston at the control station to the oil piston on the throttle valve and reverse gear on the engine. This control is effected very much easier than any gas engine control yet devised, as no manual effort is required, there being no clutches, etc. The engine itself reverses and the control mechanism is perfectly balanced so that practically no power or effort is necessary in controlling the engine. The steering gear on our latest battleships is controlled in substantially the same manner as controlling the Talbot steam power plant.

The Canadian Letters Patent and exclusive rights to manufacture, sell, install, etc., Talbot contra-flow steam boilers and Talbot uni-flow engines, have been secured by C. L. Dixon, late works manager and production engineer of the P. Lyall and Co. munition plants. Mr. Dixon is now president and general manager of the Montreal General Tool Co., which firm is now manufacturing this new class of power equipment.

SOME POWER PLANT NOTES

By James E. Noble.

WHERE a water column is blown down the glass will show a higher level when the valves are closed. Some firemen who have not studied engineering and who do not ask questions have doubtless wondered why this is. The answer is easy. Hot water is lighter than cold. Before the glass is blown out the water has had time to cool and contract; after being blown out the glass is filled with very hot water.

Experiment has proven that if two tubes, one containing water at a temperature of 80 degrees Fahrenheit and one containing water at a temperature of 340 degrees, corresponding to an absolute pressure of 55.94 pounds are equal in diameter and enough water at the lower temperature is put into one tube to raise the water level 30 inches, and an equal amount of water, by weight, placed in the other tube at the higher temperature, or the temperature raised in the first mentioned tube to the high temperature, the level will be about three inches higher.

One thing which many plant owners do not seem to know is that ashes are a mighty bad thing to cover iron pipes with, unless black or galvanized wrought iron or steel pipes are laid in glazed tile pipe with cemented joints, or properly insulated from moisture in some other way, ashes placed around them will soon cause them to corrode. If hot water or steam is passing through the pipes the corroding process will be more rapid than if the pipes were cold. Go around among the outlying small plants and I venture to say that in many of them it will be noticed that ashes are dumped around on the ground under which wrought iron or steel pipes are laid. When these pipes corrode into holes they are removed and renewed. Perhaps the owner will rail against the makers of iron pipe, call them rogues and grafters, etc., and proceed to fill up the trenches containing the renewed pipes with a mixture of ashes and soil, mostly ashes. Dry ashes seem to have no injurious effect on pipes but add moisture and the "eating" starts.

The following point may have been overlooked by a few. In a cold water pump, and sometimes in a hot water pump the valves will last for many years. In time the valve stem holes get worn, or enlarged, so much that there is a great stoppage of water. This will be noticed generally in the greater speed of the pump to deliver the same amount of water as originally.

If the valves are taken out and the valve stem holes reamed out to a true circle, and pieces of brass tube placed on the valve stem, from the head to the thread, and the valves then placed in the stem, which is screwed back in place as usual, it will be noticed that the water delivery has been greatly increased.

RADIATION SHOULD BE PREVENTED

The loss of heat by radiation from boilers and their settings, and from steam pipes, may be very serious indeed, unless care is taken to keep it down to as small an amount as possible. In some parts of the country it is common to see boilers standing out of doors, with no protection, even in winter, except the roof over them,—the sides of the boiler shed often being entirely open to the weather, with little or no provision for shielding the boilers and piping from the cold out-door air. This is exceedingly bad practice, not only on account of the waste of fuel that it entails, but also because the chilling action of the air upon the heated metal gives rise to severe strains that shorten the life of the boiler, and sometimes lead to immediate rupture. Stationary boilers should always be properly housed in and covered, and portable ones should be enclosed by suitable coverings that will protect them from direct exposure to the air. Pipes conveying steam should also be effectively covered with heat-insulating material, to reduce the radiation and condensation as much as practicable. The loss of heat from the brickwork of the settings is best prevented by care in designing the settings.

OTHER STEAM WASTES

There are many other ways in which heat is lost about a steam plant through the waste of steam, and the engineer should always be looking for them, and he should remedy them at once when they are important enough to require attention. Steam jets discharging into the furnace of the boiler are sometimes used for improving combustion, and there is often no proper appreciation of the large amount of steam that is consumed in this way. Steam jets are also occasionally used for improving the draft, but except in locomotives, where it is impossible to provide the requisite draft by other means, this practice is too wasteful to be recommended. Tube cleaners that are operated by steam may be very wastefully used, and in applying these and other devices that consume steam, the fact that steam costs money should never be forgotten by the man in charge.

SAVING DRIPS

A great deal of heat is lost by the improper disposal of the water of condensation that is formed in radiators, pipe coils, and other steam-using apparatus. Drips of this kind can easily be returned to tanks, from which they can be pumped into the boilers and used as feed water.

Oil and Coal Compared for Steam Generation

How a Coal-Burning Setting Was Adapted to the Burning of Crude Oil With Considerable Advantage—Economical Operation Was Found to Result From the Change

By G. H. HOYLES

THE above heading may be of much interest to our northern engineers and works managers, as it is to others farther south, where oil is more plentiful. Recently it had great importance to a large munition plant in the middle West, incidentally to myself.

We were in the unfortunate position of not being able to obtain a guaranteed supply of coal at a reasonable price and quality, which compelled someone to get busy along other lines. We were using fuel oil as a heating medium for our heat treatment furnaces, which were on a large scale, compelling us to provide storage capacity for 80,000 gals., with pressure pumps, etc., for same. After several weeks' delay it was decided to use fuel oil under the boilers.

The battery was composed of two "Erie City" return tubular, 250 h.p. each and one B. & W. The Erie City boilers were eventually selected as the easiest to convert. The same type of burner as we were using on our heating and normalizing furnaces, with a few alterations we made in our machine shop, was fitted to boiler fronts.

The original bridge wall was taken out with the grate bars. A special floor was built (see sketch). The front end was at level of fire hole plate, extending back one-third the length of boiler, on an angle of 25°. This floor was constructed with openings for free air regulated by original ash pit doors, of a total space of 650 square inches, after quite a lot of experimenting.

Fire brick was used, obtained from an old boiler setting, which had been dismantled previously. Supports for the floor were made from 4-in. T iron; each end let into the side walls.

The burner, 1 for each boiler, was fitted to boiler front, 8 inches above fire-hole door. A hole was cut 6 inches diam. to allow front section of burner to enter, which, with the four 5-8 in. bolt holes used to bolt burner to boiler front, was all the cutting required.

The nozzle of burner, which had its oil outlet at same angle as floor, 25 degrees, was fan-shaped on a 2½ radius and 3 in. wide, with an ⅛ in. opening. This was ultimately reduced to 2½ x 1-32.

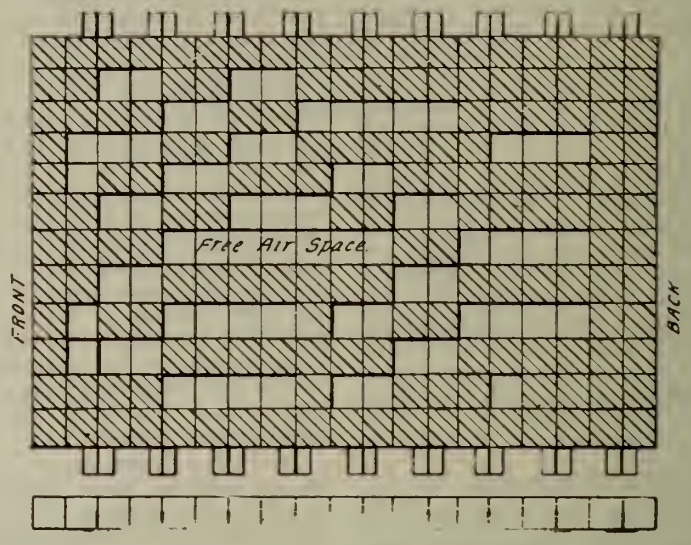
Oil of 18,045 B.T.U. per lb. was used at 80 lbs. pressure, with a 1 lb. air pressure supply delivering air through a 3 in. diam. pipe around the nozzle; end of 3 in. pipe was 2 in. behind end of oil pipe, so as to drive oil forward in a fine vapor. This air supply was dispensed with, excepting when boilers required forcing for any reason.

On a 6-hour run, with 110 lbs. steam, and supply pipes empty and ready to be filled from supply which had been weighed, 14 lbs. of water (also weighed) per lb. of oil, were evaporated to steam at 110 lbs. Temperature of feed water was 198 degrees average. The steam was used for a large heating system, all on the ground floor, returns flowing to boiler room.

This was considered a great improvement on what it would have cost for coal, allowing market price for coal and oil at that time, Nov. 15th, 1918.

It was afterwards decided to place the same type apparatus in a large works which the same firm were contemplating farther east.

Should like to hear how this compares with other experiences along same lines, as in a few years I firmly believe there will be much more oil used than is used at present time.



DESIGN OF CHECKERWORK BRICKWORK

OPEN BOILER-ROOM DOORS

In the summer season it is often necessary to keep the boiler-room doors open, in order that the room may be comfortable for the attendants; but in the winter, especially in our northern latitudes, care should be taken to prevent the entrance of unnecessary quantities of cold air, because this increases the loss of heat by radiation from the boilers and piping. It must not be forgotten, however, that it is always necessary to admit to the boiler room a quantity of air sufficient to compensate for the air that enters the ash-pits and goes up the chimney or stack. The draft will be impaired if the doors and other openings into the boiler room are all kept tightly closed, because the pressure in the boiler room will then become reduced by the action of the chimney until the flow of air into the ash-pits may be checked to a notable extent. Air is sometimes drawn from the boiler room by fans, for warming other parts of the plant. This is poor practice, for several reasons. The air of the boiler room is often charged with dust and ashes, and moreover as the fans act in direct opposition to the chimney, they are likely to check the draft very seriously unless the doors and other openings into the boiler room are left wide open.

COVERINGS FOR PIPES AND BOILERS

The coverings that are used to check radiation from pipes and boilers should have good heat-insulating properties. Non-conducting coverings should be of such a nature that leaks from pipes or from the roof of the boiler house will not damage them seriously, and they should not be made of materials that are likely to char from heat. In selecting them, attention should be given, not only to the cost of the material, but also to its heat-insulating power, as determined by experiment.

Coverings upon pipes that convey steam or hot water under pressure should be applied in such a way that they can be removed readily for repairs or inspections, particularly where the pipes enter fittings of any kind. In the event of a leak at these places, it will then be possible to examine the pipe and make the needed repairs at materially less expense than would be involved if the covering were put on without regard to this contingency.

Our Question Box

Question.—How does the water circulate in a Robb-Mumford boiler?

Answer.—The boiler consists of two cylindrical drums; the bottom drum contains the furnace at one end and numerous small flue tubes at the other, all of which are surrounded with water and connected together by water legs; the lower drum is inclined about one inch per foot, which promotes the circulation of water. In operation the water and steam bubbles circulate upwards and to the rear of the lower drum, passing up the rear neck (or water leg) to the upper drum; they then circulate down the front neck to the lower drum. The upper drum is called the steam drum.

Question.—What is the difference between a single-ended and a double-ended Scotch boiler?

Answer. — The single-ended Scotch boiler has a furnace at one end only. The double-ended Scotch boiler has a furnace at each end, and resembles two boilers placed back to back. The double-ended boiler is lighter, cheaper, and occupies less space than two single-ended boilers.

Question.—In what respect does a flush-tube vertical boiler differ from a submerged tube?

Answer.—This refers to a vertical boiler. When the tubes extend to the upper head of the boiler their upper ends passing through the steam space above the water line, it is called a flush-tube boiler. In a submerged-tube boiler the tubes do not extend above the water line and there is a smoke-box between the upper tube sheet and the chimney.

Question.—What is a wet-bottomed fire-box boiler?

Answer.—A boiler in which the furnace is entirely surrounded by water. It is a common construction in semi-portable constructions.

Question.—What is the object of the mud-drum of a Babcock and Wilcox boiler?

Answer.—The mud-drum collects a considerable portion of the solids contained in the feed water and is blown off at intervals.

Question.—I notice with many fire-box boilers that the inner side of the furnace sheets are liable to crack at the lap joints. Is there any reason for this, and is there any remedy?

Answer.—The sheets are liable to crack at this point owing to the difference in temperature between the fire side and water side of the point which sets up local stresses. Bevelling the furnace side of the lap and using countersink rivets occasionally remedy this fault.

Question.— Is there any difference in strength between concave and convex heads?

Answer.—The convex heads are stronger, design being similar.

Question.—What is the Adamson ring joint?

Answer.—A joint formed in a built up furnace flue by flanging the sections and riveting them together with a finished ring between them.

SOME OLD TIME RECIPES AND POWER PLANT RECIPES

As a rule, the engineers in charge in office buildings and institutions have to attend to repairs on the plumbing, heating, and other such work. The following information will prove of value to many readers, and it is information not generally known.

Years ago I used the receipt below for making a powder to cement together marble slabs which had been broken; many such slabs are used around water closets and other places. Up to date I have not seen any article better, or as easy to make.

Make a saturated solution of alum by dissolving as much alum as possible in some water; soak some plaster of paris in it; then bake it hard and dry in an oven, and grind it to a powder.

To use it take the needed quantity of the powder and mix it with water, like plaster, and apply it to the edges of the broken marble or slate. It sets very hard and it can be given a high polish; also, it can be made any color desired by using mineral colors in the powder. It requires quite a few words to describe this wrinkle, but it requires very little work to make the powder. One broken slab repaired will pay for the little trouble of making the cement many times over.

Another good thing I used in former and present days is a disinfectant. Why use such horrible smelling stuff, such as chloride of lime, or expensive chemicals, such as caustic soda? One pound of nitrate of lead, which is a very cheap material, will make several barrels of fine disinfectant.

To make a small quantity, take half a dram of nitrate of lead and dissolve it in a pint of boiling water; also dissolve two drams of common salt in 10 quarts of water. Mix the two together and when it is settled, pour off the clear liquid, which is a saturated solution of chloride of lead.

Some of this liquid poured down a water closet, sink, or drain, or onto any decaying or offensive objects, will at once sweeten the fetid atmosphere. A cloth saturated with the liquid and hung up in a room will produce the same result.

No doubt many of your readers have come across the street vendor who sells "Magic solder." It is used by holding a candle under a hole in a tin or copper utensil, which has been scraped clean around the hole on one side, and rubbing the solder over the hole, filling it up. The solder is simply a mixture of two parts tin, one part lead and one part bismuth. However, a slightly different mixture, namely, 1 part tin, 1 part lead and 2 parts bismuth, is a solder melting at a temperature of 200 degrees Fah. and makes an excellent agent for soldering automatic sprinklers, using venice turpentine or white rosin as a flux. This solder will neither harden or weaken with age. In using the solder on sprinkler heads it is best to use a blow torch, as the use of a copper soldering iron on this solder is apt to slightly change the melting point.

And last, here is a mighty simple, but good tip.

Do not continually keep sweeping the dust cement from a cement floor. Give such a floor a brushing over with boiled linseed oil and convert your dusty cement floor into a dustless one.

JAMES ELLETHORN.

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The Future Fuel

A COUNTRY rich in water power will have an enormous advantage over those not so fortunate when coal becomes scarce in the distant future, but waterpowers in themselves will not be able to supply the demand for energy and other sources will have to be called into play. The power of the wind and tides might well be used and greater than these, solar energy. The deserts of the tropics will become vast power generating areas and possibly manufacturing centres drawing their raw materials from the near-by countries.

One other form of energy which may become available in the dim future exists in all matter and the possibilities latent in the atom made known to us through radio-active substances are vast indeed but almost hopeless in accomplishment so far as the present is concerned.

The problem of the world's future supply of energy is a fascinating one in many ways and it is altogether likely that before a great many years it will become more serious than fascinating.

The coal resources of the world are by no means inexhaustible and in fact are being rapidly depleted in many areas at the present day. Our present methods of using coal are wasteful in the extreme and it is only a matter of a few years probably until enormous steam plants are established at the mines in conjunction with coking plants wherever possible. Our methods of heating will likely undergo considerable modifications also and the central heating plant will likely be quite common. This plant will also squeeze the last mite of power out of the fuel before turning the steam into heating mains. The present trend in steam power plant design clearly indicates that much higher steam pressures will be in common use before long, that is pressures ranging from 300 lbs. to 750 lbs., or even higher.

Buying Second Hand Equipment

ACCORDING to an item in the Humboldt (Sask.) "Journal" of recent date a new boiler is needed for the town plant, and the engineer in charge of the plant also recommends that a condenser should be added to the equipment.

In fact, the situation is that the plant will soon have to be shut down for repairs unless a new boiler is added.

The town council has heard the situation outlined, and has been informed that a condenser should increase the efficiency of the plant some twenty-five per cent.

Prices have been secured on new boilers that run from $2,650 up, and a condenser, it is said, would cost around $4,000. Of course, there are variations from these figures.

But the council has wind of an outfit that can be secured in Saskatoon for much less money. The boiler is said to be on the market for $500, while the condenser is to be had for $800. And so it is that the heart of the town goes out to the Saskatoon outfit.

Of course, there would be an immediate saving. Between the figures quoted for new and used outfit there is a spread of $5,350. But what of it? It may be that the Saskatoon outfit is a regular bargain, in good shape, and put on the market under exceptional circumstances. If so, then the town stands to gain.

But why should a place of any size go into the market for second-hand equipment for a municipal power plant? Buying a second-hand boiler and a second-hand condenser is, as a general thing, doubtful policy. That states the case mildly. If the tubing has defects which come to the surface after put in use again, the difference in price can soon be absorbed in the re-tubing of the equipment.

Humboldt would be much better advised to send their specifications directly to a list of responsible firms in Canada, and ask for quotations on a new outfit of lines that are known to be good.

Councils often make mistakes of this sort. They imagine that a boiler is a boiler, and a condenser is a condenser. The fact that the thing has boiled before or condensed before is not taken into consideration.

The belief grows with men who have an expert knowledge of such affairs that it is good policy and good financing to go into the machinery or power transmission market with a requisition for new material that carries with it the backing and guarantee of the people who make it.

The Operators' Point of View

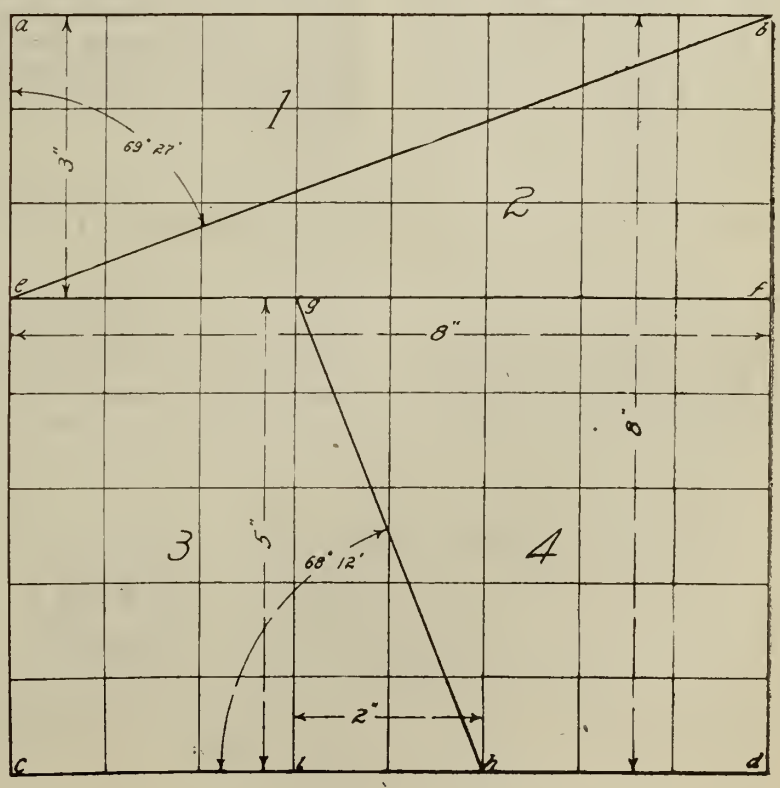
SOME HINTS ON THE OPERATION OF WOOD-FIRED BOILERS

AMONG sawmill plants located in the country or on a timber limit, and where the fireman lives or boards in a house close to the mill, it is sometimes convenient for him (if he is using slab wood for fuel) to allow the fire to burn to coals when getting near closing time, and, with the water shut off (first making sure it is high enough in the boiler so that he can afford to) let the heat of the fire all go to making steam for the engine; then, when leaving, after closing down for the day, turn on the injector and let the boiler fill up while he is away to tea. This economizes wood by making it unnecessary to fire quite so hard for a time before stopping, and also avoids waste of escaping steam (from the safety valve) as a result of heat produced by a bed of wood coals existing on the grates after hours. Obviously, this is only practised where the proportions of boiler and injector are such that the attendant will have plenty of time to eat and return before the boiler becomes too full. Generally the injector pipe enters and takes steam from the dome, and if the attendant is unexpectedly delayed, the boiler may become filled up into the said dome, thus necessitating more blowing down before raising steam again than is necessary for sediment only. To avoid this occurring, if the injector pipe is tapped into and takes steam from the top of the boiler, instead of from the dome, and if a long thread, say 3 or 4 inches, is cut on the inner end of the piece of pipe entering the boiler and this pipe then screwed into the boiler as far as it will go, the injector cannot then fill the boiler further than to near this pipe, for then water will begin coming down the injector steam pipe and the injector will begin to work spasmodically—putting much water out at the overflow. Wet steam is bad for an injector, as it tends to wear the jets, therefore this spasmodic action should not continue any longer than can be avoided. The remedy? Attach to the steam valve of the injector an adjustable sprocket rim with chain guide and chain. To the chain attach a vessel capable of hoiding water, and have a pipe bringing water to it from the injector overflow. As the vessel gets heavier with water it will descend, thus closing the valve. The adjustment should be such that the vessel will come to rest on a support just as the valve closes and before it jams. If this valve and the check valve are in good condition and proper strainers on the water supply pipe to prevent fine dirt reaching and lodging under the check valve, then the remaining valves may safely remain open until the said attendant arrives. This device is not meant as something to be called into use regularly; it should, like the plug in the crownsheet of locomotive type boilers, be ready to act if occasion so demands, yet occasion should not be permitted to demand it. Where the slab wood was from timber which did not burn well, I have known firemen to help themselves considerably by thus utilizing the injector during the noon hour as well as after closing for the day. If this gets past the W.P.B., probably old hands accustomed to coal will consider this bad practice, but I am not advocating this method for plants using coal. Years ago I fired where either coal or wood could be had, the company had a supply of each. I asked for coal and got it during my entire stay. The man who worked on the same job, but the opposite shift, preferred the wood, asked for it, and got it. I have seen men accustomed to coal take charge of steam outfits burning wood, and when they banked their fire they would leave their furnace doors open. With wood, the furnace doors should be shut as much as possible at all times while there is a fire on, whether the fire is banked or not, and if the fire is banked to hold for hours the ash pit doors should also be closed tight (unless the wood is wet or otherwise very bad, in which case the draft is regulated accordingly), but the furnace doors should, in any case, be left shut. This is correct practice with wood, but you know how long a coal fire would remain in the desired condition if banked in this manner. With the difference in fuel can reasonably come an occasional difference in methods of operating. Circumstances alter cases.

J. E. McCORMACK.

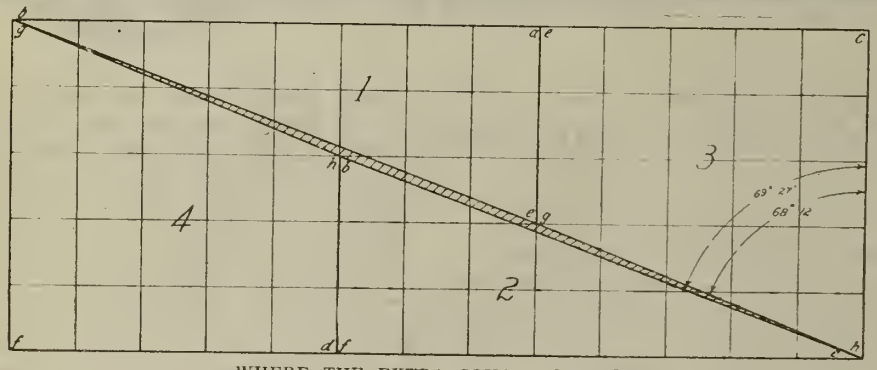
AREA—64 OR 65 (?) SQ. INCHES

One of our readers has again brought up the mythical problem of making "something out of nothing," namely, that of obtaining an additional unit of area by the rearrangement of a certain num-



SQUARE TO BE DIVIDED

ber of units. The query is, that if a square is composed of 64 square inches, 8 inches on a side, and the same is cut as indicated in Figure 1, and then arranged into a rectangle 5 inches wide by 13 inches long, that an area will be obtained equal to 65 sq. inches, or a "gain" of 1 sq. inch. This problem has been given much publicity, largely as a result of the query arising from those who may see the re-arranged pieces placed in position, with a slight change in the angle, so that the figure has the appearance of an unbroken rectangle containing 65 sq. inches.



WHERE THE EXTRA SQUARE IS GAINED

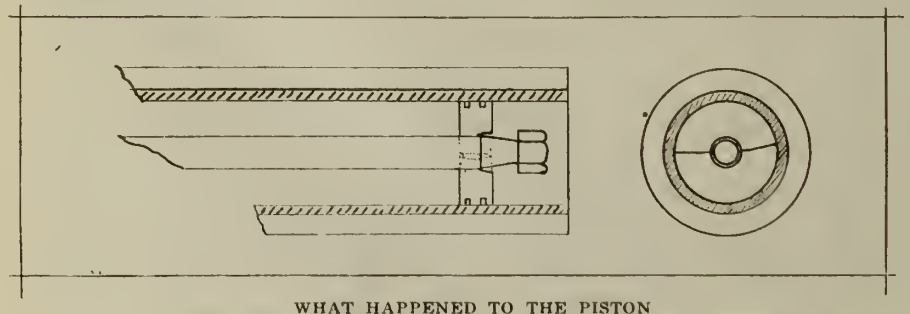
The original square of 64 sq. inches, is divided as shown in Figure 1, The sections 1 and 2 are identical and each forms a right triangle 8 x 3 inches; the sections 3 and 4 form two equal trapezoids, the parallel sides of which are 3 and 5 inches. It can therefore be readily seen that as the total area is 64 sq. inches, no possible arrangement of said sections will produce an area greater or lesser than the initial area. Figure 2 shows the rearranged sections that provide the area of "sixty-five"? sq. inches. When these pieces are cut out and placed together the diagonal line from b to h can be brought close together so that a casual glance will give the impression that an extra sq. inch has been "found." Or when this is drawn to puzzle the minds of the uninitiated the diagonal can be drawn from one corner to other. It will be seen however,—and can easily be proven with a drawing board and pencil,—that, when the sides b—c and f—e are parallel, there is a long narrow space produced along the diagonal as shown in Figure 2. The area of this slit can be calculated and proven to contain the sixty-fifth sq. inch.

The length of the diagonal e - b, Figure 1, can be found by extracting the square root of the sum of the squares of the two sides; $\sqrt{3^2+8^2}=8.544$ inches. The length g-h is found in the same way, g-i-h being the right triangle. $\sqrt{2^2+5^2}=5.385$ inches. The approximate length of the diagonal in Figure 2 will be 8.544 + 5.385=13.93 inches. The angle c-h-g equals 68 degrees 12 minutes and the angle a-c-b equals 69 degrees, 27 minutes. Therefore the acute angle of the diagonal space in Figure 2 is 69 deg. 27 min., minus 68 deg. 12 min., or 1 deg. 15 min. The zinc of this angle is .02181 and therefore the parallel portion of the narrow space will be .02181 x 5.385=.117 inches approximate. The area of the two tapered ends will then be 5.385 × .117=63005 inch, and the parallel section in the middle will be 3.159 x .117=.3696 inch, and the total area of the space will be .63005+.3696=.99965 inch. The slight variation from the exact sq. inch is due to the elimination of decimal places. It will be seen from the foregoing that the increased area is one of imagination only.

A DAY OF REST IN THE POWER PLANT

By T. H. FENNER

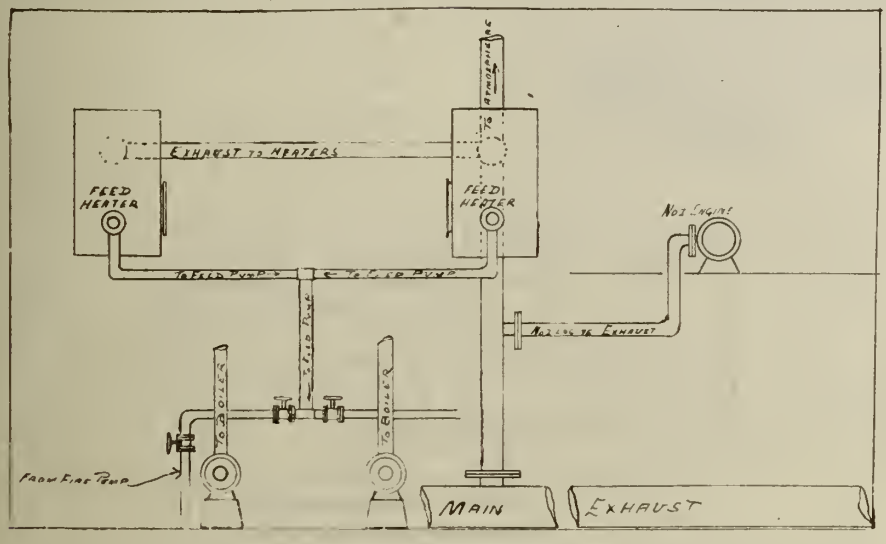
A SERIOUS and expensive breakdown occured to an 11"×9"×14" high speed tandem compound engine under my charge in a peculiar manner. The accident occurred on a Sunday, when the regular engine room attendant was not on duty. As a matter of fact, no one was in the engine room at the time, the fireman on duty in the boiler room being under orders to come up and look at the oiling arrangements from time to time. To understand what happened we must have a glance at the boiler room, where the cause of the accident originated.


WHAT HAPPENED TO THE PISTON

The feed pumps took their water from overhead open heaters, of the Webster type, discharging through economiser to boilers. There was also a direct discharge to main feed leader direct, by passing the economiser, and also a direct discharge to an auxiliary header, as shown. The suction pipe from heaters to pump came down to a T between the two pumps, and branched off to each pump. There were also two independent suctions on each pump connected to hot and cold wells. On one of these suctions a connection had been made from the discharge of the fire pump for washing out boilers, and an emergency boiler feed. A branch was tapped off the auxiliary header at each boiler to connect the valve of the turbine hose for washing out. When washing out the fire pump was used, discharging through the feed pump suction, through the pump, and auxiliary header. The boiler room staff had stringent orders never to touch this fire pump valve, the engineer on duty in the power house being the only one authorised to make the connection. The reason for this care was apparent, as if the valve from the fire pump was opened and the suction from the open heater left open at the same time, the discharge from the fire pump would have clear access to the heater and from this to the whole exhaust system.

The day that the accident happened being a Sunday, in the ordinary course of events nothing would have been running. However a 50 h.p. armature had burned out on the Saturday morning, and the millwrights and electricians had been working Saturday afternoon and Sunday morning and were ready to try the motor after dinner Sunday. This would mean, if the repairs were O.K., about ten minutes running. Being anxious to know if everything would be alright for Monday morning, I decided to go down to the factory myself. The regular day engineer had been instructed to come in after dinner to run the engine as required, but as he had not shown up I started up myself, made the switchboard connections, and saw that the forced lubrication was alright. I told the fireman where I was going, and warned him to come up at intervals of not more than ten minutes, and look at the engine. I expected to be all through before he came up twice. However, some minor troubles developed in connection with the motor and shafting. A man was sent over to the engine room to see how things were and he reported everything alright. We got ready to start the motor again, and it started up this time perfectly, but after running about five minutes the motor started to slow down and the lights to dim. I started for the engine room on the run, but about half way there was met by the fireman, who informed me in quite a disinterested way that No. 1 engine had "gone to h—." He also volunteered

the information that there was a lot of water in the basement. Arriving in the engine room, I saw a tangle of oil pipes, and the broken crank case lying on the floor, and at the same moment an ominous cracking broke on my ears. Coupling this with the fireman's statement of the leak in the basement, I made a rush for the feed pump, finding what I expected, the valve from the fire pump open, and the heaters and exhaust system flooded. The leak in the basement was the excessive overflow from the heaters backing up the water seal from the sewer. The next thing was to look at the water gauge to find the water just bibbing in the bottom nuts of the glasses on the two boilers that were working. I began to reconstruct things a bit in my mind, and then proceeded to



PIPING LAYOUT

catechise that picture of injured innocence, the fireman. The evidence being so complete, he could not deny opening the valves, but hedged a bit about the reason. However, I had a good idea of that, too, and on putting it up to him, he admitted the soft impeachment. He began the course of events by neglecting to watch his gauge glass, and when he did look, found the glass full, but how much more he knew not. However, he promptly stopped the feed pump, neglecting to shut the checks on the boilers. He then resumed his paper, being anxious to see how Foch was making out. Presumably he found the news to his liking, for when he next looked the water was about half glass. He congratulated himself on his excellent judgment in stopping the pump, and thought it would be all right now to start it up again. Here he struck a snag. The boiler checks not being dead tight, when the pump stopped some leakage occurred from boiler to pumps, resulting after a while in the pumps and heaters getting good and hot, too hot to handle water. Deciding that here again was a case for a good man to use his own judgment, he decided to pump some water through from the fire pumps, achieving the double purpose of feeding the boilers and cooling off the lines and pumps. He started up the fire pump, opened the discharge through the feed pumps, and left the main suction open. The water in the boilers did not rise, but it did somewhere else, and his ears were soon assailed by numerous strange noises. At the same time his gauge glass lamps started to lose their brilliancy, and it crept into his mind that something was wrong. He went up to the engine room just in time to hear a crash, and had then decided to go and get advice. His view of the matter was that it was decidedly unjust to spoil any poor man's Sunday by involving him in a series of untoward happenings that kept him in a state of nervous tension. Not having time to discuss the matter fully I went to ascertain the damage. I found both the crank pin and crosshead gib straps sheared off, the brasses themselves broken in several pieces, and all the oil piping twisted and broken. The cast iron crank case was also broken, though this was a detail. This was the outer damage. Next thing was to look for the internal troubles. The H. P. cover was removed and an attempt was made to move the piston ahead.. It was apparent at once that something was jammed, and jammed hard, as the hammer rebounded as though from an anvil. It was decided to take the nut off the end of the rod, and a spanner was brought for the purpose, but at the first application the end of the rod and the nut came away together, and it was evident that the rod had been ready to break. We then found that the piston came off the taper surprisingly easy, and after removing the piston from the rod a tentative tap with a hammer was tried on the end of the rod with the same result as before. The next step was to open up the L. P., and this achieved, the trouble was at once evident. The L. P. piston was cracked across, the crack being open from ⅛ in. to 3-16 in., and the piston had been forced over the taper into the parallel part of the rod, jamming on the walls of the cylinder. The only way it could be removed was to drill holes all round the boss and break a piece out, letting the piston come down on the rod, and relieving the pressure. The piston was then taken out in halves. The repairs necessary were new piston rod, new low pressure piston, new connecting rod end brasses, gibs, straps, cotters, and bolts complete, and oil piping, guards, etc., all of which was done at the factory.

Cause of the Trouble

What had happened was as follows: The water from feed pump had backed up through open heaters till they filled up to overflow level. The overflow took care of some of the water, but the level still rose till it came to the exhaust steam opening. Entering this it dropped down to the main heating exhaust and travelled along to the building. Presumably about this time the engineering genius in the boiler room, finding he was getting no water in the boilers, speeded the pump up a bit. There was some back pressure on the engine by now but the water had not yet reached the level of the cylinder. However, shortly after it did, with the results as named. When the final smash occurred the engine was just coming to the back centre. She must have been considerably slowed down from her normal 260 R. P. M., and was probably running about half that. The L. P. piston met a solid wall of water, and the energy of the fly wheel was enough to force the rod through the piston, splitting the piston and jamming everything hard and fast. The fly wheel still possessed considerable energy, the whole of which was applied to move the crank ahead, against the resistance of the immovable L. P. piston. The weakest parts were evidently the straps in crankpin and crosshead, and these parted. The fly wheel evidently made a few revolutions after this, as the connecting rod was thrown back near the front cover, and pieces of the bearing boxes were in the crankpit and on the floor, while the oil piping gave mute testimony of what it had gone through. The shock of the sudden stop on the H. P. end of the rod had to be absorbed by the piston nut, and this had evidently been too much for it. The metal had given, and the piston had loosened in the taper and was ready to let go at the first movement. This shows what can happen through one man's carelessness, and the guilty one should be susceptible to a more drastic punishment than being discharged as in these days being discharged holds no terror for the average fireman.

UNIFORMITY OF PRACTICE

It is conducive to economy to have the boiler-room practice as uniform as possible in all respects. The water level should be kept at a fixed point, except when it is temporarily lowered by opening the blowoff from time to time. The steam pressure should also be maintained at a steady value, and an approved routine should be established for every detail in the room. When this is done the work will go on almost automatically, and in the best way possible. Any errors or omissions on the part of the attendants will also be more quickly observed.

Progress in New Equipment

3-WIRE METERS

AT the present time, when great attention is being given to conservation and standardization, the new direct-current, 3-wire, service type watthour meter, just placed on the market by the Sangamo Electric Company, Springfield, Ill., is attracting much attention.

This meter consists simply of 2 standard 2-wire elements placed side by side in a common base and registering their K.W.H. on a common recording train, so that the sum of the revolutions of the 2 elements will be properly added and indicated on the K.W.H. dial of the meter. This is effected by means of a very simple but ingenious differential gearing within the recording train, so that no matter what load there may be on one element as compared with the other, the total revolutions of the two elements will be accurately added and recorded. Even with one element fully loaded and the other one without load, the registration is as accurate as though each element were recording on a separate train.

This arrangement of meter elements and train is not new, but has been given a thorough and successful test on similar ampere-hour meters built for use with storage batteries on submarine vessels of the U. S. Navy during the past two years. The only difference between these very successful ampere-hour meters for submarines and the present 3-wire D-5 service type meter, is in the fact that the driving elements in the ampere-hour meters have permanent magnet fields instead of shunt energized fields of the watthour meter.

As will be seen from Fig. 2, each element of the new 3-wire meter is a standard 2-wire element including the light load adjustment, the arrangement of damping magnets, and in the case of meters over 10 amperes capacity, the arrangement of internal or external shunts. As shown in diagram, Fig. 3, and from the arrangement of the elements it will be apparent that this meter achieves for the first time the requirements of a true 3-wire direct current meter; that is, one which will measure and record accurately the load on either side of a 3-wire distributing system, no matter whether the other side is entirely dead. For example, if the fuse in one outer line of the system is blown or purposely withdrawn, the element connected in the other side will record ac-

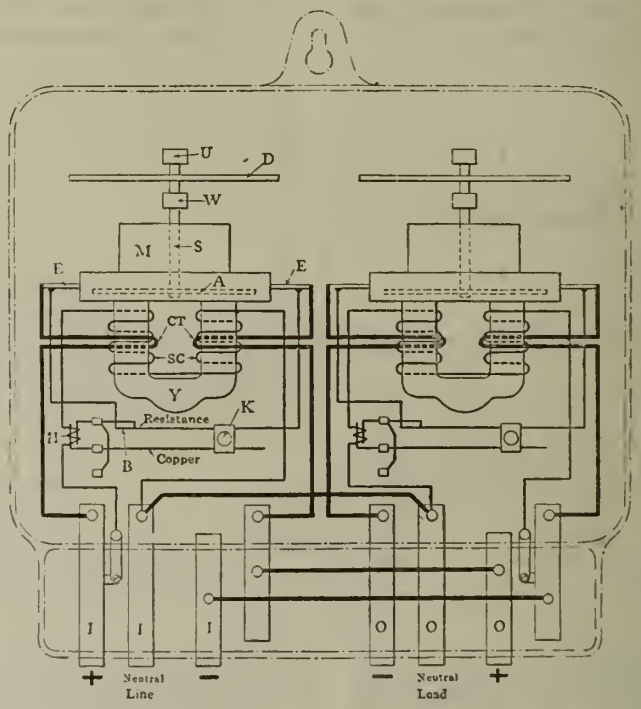
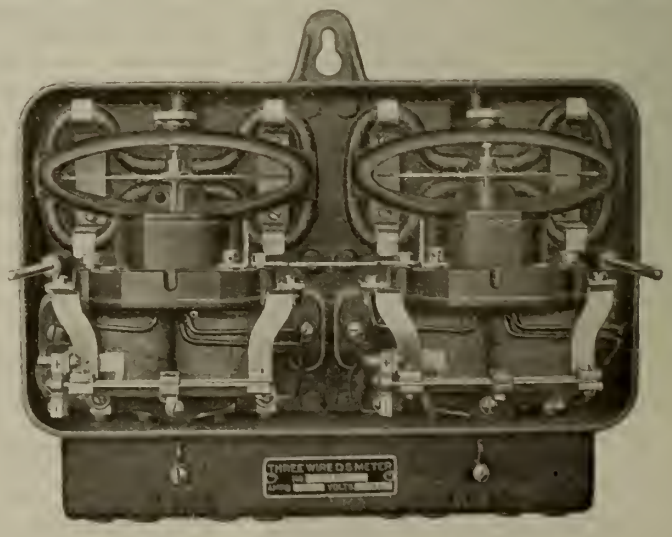


DIAGRAM OF CONNECTIONS

EXTERNAL VIEW



SHOWING ARRANGEMENT OF MECHANISM

curately the load on that side, as its potential circuit and measuring circuits are entirely independent of the side which is open. If the neutral fuse is blown or withdrawn, the two potential elements remain in series across the outer lines so that the meter will continue to record any load that may pass through it between the outer wires with the neutral open. Under widely unbalanced conditions of voltage between the outer lines, this meter will record with a degree of accuracy which is impossible with any former 3-wire direct current meter having a single potential element connected either between one outer line and the neutral, or between the two outer wires. As shown in the diagram, the elements are so connected through an ingenious interchange of connections within the terminal box itself that the load wires from and to the line pass in and out of the meter in regular succession; no crossing over or interchanging of leads being required.

The recording train is held on a bracket connecting the two motor elements, shown in Fig. 2 with the train removed, and absolutely correct meshing of the two worm wheels on the train, engaging with the two elements, is obtained by a system of locating rear bearings of the worm wheels similar to that used in the standard 2-wire meter. The train is held in position by a simple locking device operated from the top front so that it may be readily removed for purpose of inspection and calibration of the elements.

In calibrating, each element is considered and tested as a standard 2-wire meter without respect to the other element. For this reason, an absolutely perfect balance of the two elements may be secured in minimum time and effort by the tester.

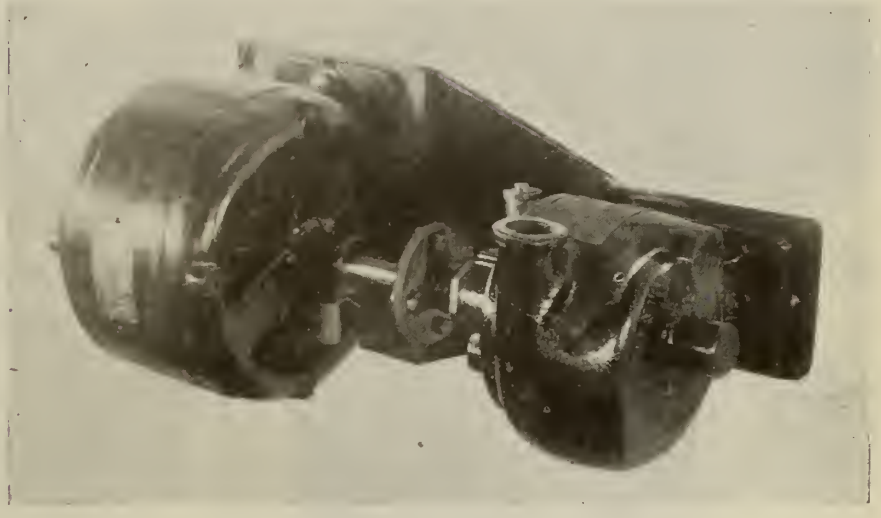
A NEW FULFLO PUMP

The Fulflo Pump Company, Blanchester, Ohio, has placed on the market a line of direct connected motor driven pumps. These pumps are designed for use in connection with high-class motor driven machine tools, oil circulating baths and for supplying batteries of machines with cutting oils or compound.

They are all centrifugal in type, but retain their prime without the aid of valves or other mechanical means, each pump being provided with a priming chamber and having both intake and outlet located at the top, which makes it impossible for the pumps to lose their prime. The impellors are of the semi-enclosed type, and are supported by a bearing at either end of the impellor shaft. The thrust is on the suction side of the impellor and is taken care of by a hardened steel thrust collar on the impellor shaft which thrusts against the nose of the bronze bush supporting the impellor shaft on the suction side of the pump. The thrust at this point is very slight as most of it is taken up by the coupling between the pump shaft and the motor shaft.

The main pump bearing also forms the pump gland and is of cast iron. The lubrication of this bearing is taken care of by a sight feed oiler which feeds into a pocket completely surrounding the bearing.

The shaft is of hardened and ground steel. The packing used is the flexible metallic type and is guaranteed not to cut the shaft. The life of this pump is exceptionally long as the impellor, the only internal pumping part, does not depend on any contact fits for its pumping efficiency. Standard pumps have cast iron bodies, covers and impellors, but may be furnished in brass or bronze when so desired.

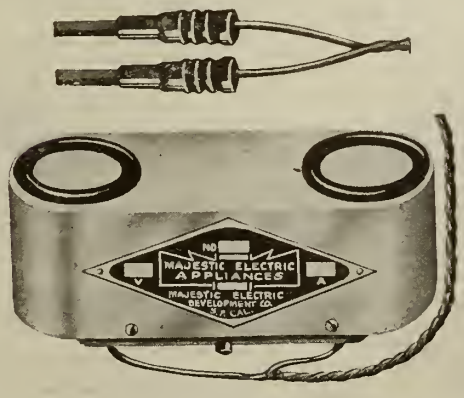


NEW FULFLO PUMPING UNIT

THE MAJESTIC DETERMINATOR

Doubt always causes loss. In every case of doubt there is a loss of time, and in most case of doubt the loss of time is accompanied by a more or less serious loss of money. The foregoing applies with more force to electrical work than to any other, as most of the expensive and dangerous burnouts are caused by doubt—doubt as to whether the current is A. C. or D. C.

When motors, transformers or any instrument operated by electricity are to be installed, the first thing necessary is to find out what class of current the building is supplied with, and for this use the Majestic Electric Development Company, San Francisco, have developed the Majestic determinator. Formerly there were but two ways of determining the character of the current supplied: first, by "feeling the juice," which should never be done, as it is always extremely dangerous. Second, by asking the central station, which puts them to considerable trouble and places an unnecessary responsibility upon their shoulders, which they are not willing to assume. This method is uncertain, as the central station may be supplying that particular building with both alternating and direct current.



DETERMINATOR FOR A.C. AND D.C. CIRCUITS

The Majestic determinator is an instrument as simple in operation as it is certain. To operate it, all that is necessary is to place the plugs to the wires or terminals, press the button at the bottom of the determinator, and if the current is direct, the letters D.C. will instantly appear within one of the circles at the top of the determinator; if the current is alternating, the letters A.C. will appear within the other circle. The brilliancy of the light back of the letters A.C. or D.C. tells whether the voltage is 110 or 220.

The plugs attached to the determinator are knife blade type and are so constructed as to render short circuit or shocks impossible.

With this instrument, all open fuses and circuit breaks may be accurately determined. Broken wires or coils, as well as bell and lighting circuits, may be accurately tested with it.

Every wirer, trouble shooter, electrical engineer, superintendent of buildings, or, in fact, anyone having anything to do with electricity, may use one of these instruments to advantage.

The Majestic determinator has no delicate or moving parts or fuses, therefore, is not liable to get out of order. It is 4 inches long, 2 inches high and 1½ inches wide, weighs 7 ounces.

This device is being manufactured and marketed by the Majestic Electric Development Company, 656-658 Howard street, San Francisco.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$32 00	$.....
1¼ in.	36 00	.....
1½ in.	39 00	32 00
1¾ in.	39 00	32 00
2 in.	45 00	32 00
2¼ in.	48 00	34 00
2½ in.	50 00	40 50
3 in.	58 00	45 00
3¼ in.	.....	52 00
3½ in.	70 00	54 00
4 in.	80 00	67 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$5 50	$6 00
Tank plates, 3-16 in.	6 50	6 25

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 60%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$4 75
Steel bars, base, Toronto	5 00
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	4 55
Steel bars, base, Montreal	5 05
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28	$ 7 00	$ 7 00
Sheets, Black, No. 10	6 50	6 90
Canada plates, dull, 52 sheets	8 50	8 10
Canada plates, all bright	8 50	9 50
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	8 20
Premier, 10¾ oz.	....	8 50

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19¼
Palacine	22½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Canital	49¼
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers ..... list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass ..... add	20
Machine screws, o. and fil. hd., brass ..... add	25
Nuts, square blank ..... add	$1 50
Nuts, square, tapped ..... add	1 75
Nuts, hex. blank ..... add	1 75
Nuts, hex. tapped ..... add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	0 35
Solder, guaranteed	0 40
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	5 20
White lead, pure, cwt.	16 20
Red dry lead, 100-lb kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A. ..... list plus	20
Emery Cloth ..... list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D." per lb.	0 03
Rosin "G." per lb.	0 03½
Borax crystal and granula	0 14
Wood alcohol, per gallon	1 80
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless	0 55
Tubing, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	20
Peerless	21
Grand	19¾
Superior	19¾
X L C R	18½
Atlas	18½
X Empire	17¼
Ideal	17¼
X press	16
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets ..... list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts ..... add	40, 10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. ..... add	$7 00

METALS

	Montreal	Toronto
Lake copper	$23 00	$24 00
Electro copper	22 00	23 00
Castings, copper	22 00	21 00
Tin	65 00	65 00
Spelter	9 00	8 50
Lead	7 25	7 00
Antimony	9 00	10 00
Aluminum	40 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided	$0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb extra.

STRAIN
YOUR OIL

Use Twin Oil Strainers and insure a continuous supply of clean oil for your burners.

Fuel oils commonly contain some solid matter which must be removed from the oil before it can be used with any degree of satisfaction. To do this, it is necessary to use some kind of a strainer, so why not use the Twin—a strainer that can be cleaned without shutting off the supply?

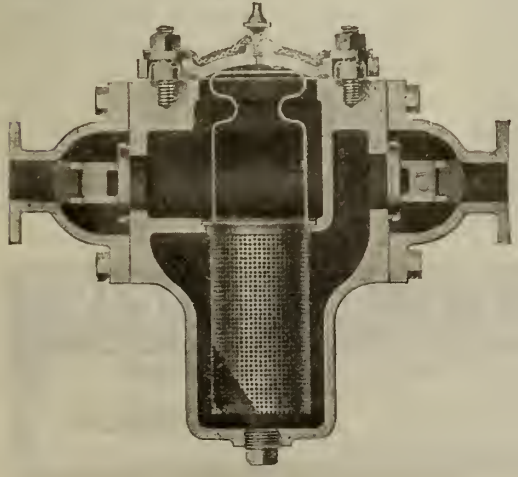
THE TWIN OIL STRAINER

gives the same service as two single strainers, but it is more convenient to operate, it requires less space for installation and it does away with all extra valves and piping necessary to connect up. These are the features that led to its being used in Submarines and Destroyers now being built for the United States Navy and in cargo boats now being built for the United States Merchant Marine.

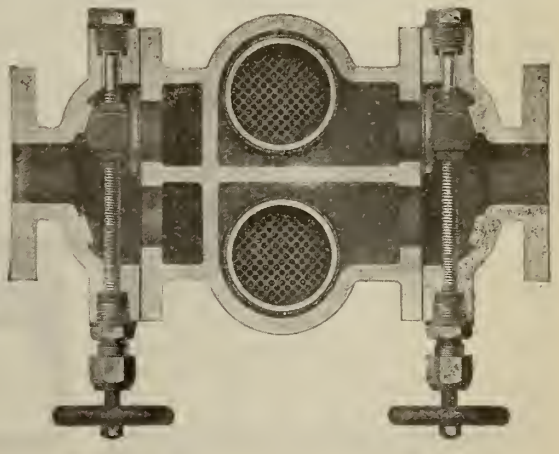
Sizes range from 1 to 5 inch. (2½ inch and larger sizes have flanged connections). Basket mesh 1/64 inch or larger. See Bulletin "AA" for details.

ELLIOTT COMPANY, 443 Diamond St., Pittsburgh, Pa.

The oil enters the Strainer at the left and empties into and passes through the straining basket, then up and out at the right. All solid impurities are retained in the straining basket.



When a basket is clogged, the valves are shifted to direct the flow of oil into the clean basket, which is in reserve. The compartment containing the dirty basket is then opened up, the basket removed, cleaned and replaced, and held in reserve until the basket then in service needs cleaning.



Terry's Commercial Manager Visits Canada

Very few manufacturers in the metal and engineering trades are as well known, or serve such a diversified class of trader as the house of Herbert Terry & Sons, Ltd., Redditch, England.

From a one man genesis in 1855 the business has grown, until to-day it employs between 1,200 and 1,400 workpeople, and embraces more than 60 highly-organized departments. Both technically and financially the firm has a high reputation, also being successful in maintaining cordial relationship between employer and employee.

The firm is producing every known kind of metal spring and numerous other light metal articles. A big line of goods for motor garages, lock springs, flexible shafting, etc., are included in the lines which will be shown by Mr. Ernest Clarke, the commercial manager of the firm, who is visiting Canada for the purpose of demonstrating his firm's ability and desire to serve Canadian manufacturers and traders.

Mr. Clarke is able to quote for any kind of spring needed and to give much valuable advice based on his technical knowledge of the business.

Mr. Clarke can be addressed at any of the offices of The MacLean Publishing Co.—Advt.

BOOK REVIEW

Steam Engine Troubles by H. Hawkens, $2.50—The Norman W. Henley Publishing Co., New York.

A practical treatise on the troubles which are common to the operation of various types of steam engines. With the great number of different designs of engines in use it is a somewhat difficult matter to determine the reason why things go wrong with certain parts and to prevent trouble and to remedy it when it does occur. In the present work the troubles which the principal parts of steam engines are subject to are described, good design is contrasted with bad, the most suitable material for certain parts and the best construction is pointed out. The advantages and disadvantages of many designs are discussed. The directions given for correcting existing evils are easily understood. The principal considerations in the building of foundations, setting of templets and lining up an engine are given with a complete account of how to erect an engine. Directions are given for lubrication valve setting and testing, also how to locate trouble with an indicator, and what adjustments are to be made on new engines and maintained on old ones. Speed regulations are also treated of and simple rules for calculating safe pressures of main bearings, stresses in flywheels, strength of cylinder walls, etc., are given which enable an engineer to find out whether the engine he runs is constructed on sound principles or not. The various parts of an engine such as cylinders, valves, piping and separators, throttle and emergency valves, pistons, frames, bearings, connecting rods, etc., are dealt with in detail, a separate chapter being devoted to each one. This work should prove quite welcome to those having the operation of stationary engines in their charge.

Graphical and Mechanical Computation, by Joseph Lipka, Ph.D., John Wiley and Sons, Inc., New York; the Renouf Publishing Co., Montreal. Price $4.00.

A book written as an aid in the solution of a large number of problems which the engineer, as well as the student of engineering, meets in his work. In the opening chapter the construction of scales is developed and leads to a discussion of the principles upon which the construction of various slide rules is based. The second chapter develops the principles of a network of scales, showing their application to the use of various kinds of co-ordinate paper and to the charting of equations in three variables. Engineers have recognized for a long time the value of graphical charts in the lessening of the labor of computation. Among the charts devised none are so rapidly constructed, nor so easily read as the charts of the alignment type. Chapters III, IV and V give a systematic development of the construction of alignment charts; the methods are illustrated by charts for a large number of formulae. It is the writer's hope, as expressed in his preface, which we quote, that the simple mathematical treatment employed in these chapters will serve to make the engineering profession more widely acquainted with this time and labor saving device. Many formulae in the engineering sciences are emperical, and the value of many investigations is enhanced by the discovery of laws connecting the results. Chapter VI is concerned with the fitting of equations to emperical data. Chapter VII considers the case where the data are periodic, as in alternating currents, sound waves, etc. Where emperical formulae cannot be fitted to experimental data, further computation can be made by interpolation, differentiation, and integration by the methods developed in the last two chapters. Numerous illustrative examples are worked throughout the text and exercises are given at the end of each chapter. While a preliminary knowledge of mathematics is essential to the complete understanding of the subject matter of this book, it places in the hands of the designing engineer a powerful means of simplifying the calculation of problems arising every day in structural, hydraulic, power plant, mechanical and electrical engineering. The treatment adopted throughout is concise and well arranged.

Electro-Metallurgy, Electrolytic and Electro-thermal Processes, By Eric K. Rideal, Bailliere, Tindall and Cox, London.

The rapid development of applied chemistry in recent years, accelerated by the recent war, has brought about a revolution in all branches of technology. A series of books, of which the present publication is one, is being prepared by the publishers as an aid to the further development of industrial chemistry throughout the British empire. This series will give a general survey of the particular portion of the science dealt with and each volume is complete in itself. The present volume is divided into eight main sections dealing with electrolysis in aqueous solutions; electrolysis in fused electrolytes; the electrolytic preparation of the rare metals; electro-thermal processes; carborundum and oxysilicides of carbon; the carbides; electro-thermal nitrogen fixation by metals and metallic compounds, and iron and the ferro-alloys.

In an introduction to the above sections the problems relating to the ample supply of power necessary for electro-metallurgical operations are dealt with and interesting figures relative to comparative costs of power production by present methods, hydro-electric, coal, gas and oil are given. In Great Britain, where waterpowers are scarce and coal plentiful, the cost of producing power by the latter would seem to be sufficiently low to warrant the establishing of electro-chemical plants using it as fuel. The metalliferous resources of the British Commonwealth are also dealt with in the introduction.

In the section devoted to electrolysis in aqueous solutions the winning and refining of copper is thoroughly taken up and special mention is also made of the use of colloid addition agents in electro-

CONDENSED ADVERTISEMENTS

FOR SALE — CANADIAN WESTINGHOUSE Motor—Type C. Constant speed, 100 h.p., 225 ampere per terminal, 2 phase. Full load speed 580, alternating 720. Box 150, Power House. (p3h)

PREPAYMENT METERS FOR SALE 60 FERranti 5 and 10 amp., 110 volt, types B & C, geared for 7 to 10 cent rate, in first-class condition. Will accept 55 per cent. present cost new meters. Address Hydro-Electric Power Commission of Ontario, 190 University Ave., Toronto.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

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(Canadian Representative)

lytic work. The other metals treated of in this section are zinc, cadmium, gold, silver, nickel, lead, antimony, bismuth, tin, cobalt and cobalt nickel alloys. In general this section may be said to be an exhaustive summary of present day practice.

In the section devoted to fused electrolytes, the preparation of sodium potassium, lead zinc, aluminum and other metals is dealt with. A portion of the book which is of considerable interest deals with the preparation of the rarer metals which are finding increasing application in modern industry. The section on electro-thermal processes deals with the smelting of and reducing of the metallic elements from their ores and also with the preparation of graphite and other electric furnace products.

Carborundum, carbides and the fixation of atmospheric nitrogen are also considered and an important part of the contents is related to the iron and steel industry.

As a reference aid to the metallurgist engineer or chemist interested in electrometallurgy this publication should find considerable usefulness and the excellent bibliography which is incorporated at the end of each section is of considerable assistance to those wishing to make further investigation.

The value of the work is greatly enhanced by the incorporation of much material in the nature calculations as to energy requirements for electrolytic and electro-thermal processes.

Forging, by John Jernberg, The American Technical Society, Chicago

The art of blacksmithing is an ancient one and for centuries was the only method-working profession. Very little improvement has been effected in it up to comparatively recent times. In the last few years the adoption of new types of steel has made considerable advancement necessary in the art of forging and also in the allied art of heat-treating. The author states that this book was written for the bringing up to date of the machinist's knowledge concerning the art of forging in its more modern aspect. One chapter describes mechanical details, materials and equipments, and goes into the various types of forges, furnaces, annealing ovens, and power tools which are used. Forging operations are next taken up and the major portion of the book is devoted to this particular subject, welding, upsetting and other forging operations being all dealt with. Heat treatment and its effect on the physical properties of steel is an important subject and is covered in a simple and able manner.

CATALOGUES

Buckeye Products Company, Cincinnati, Ohio, have issued their general catalogue number 7. This book contains 400 pages and is a reference work on foundry tools and appliances. Practically everything which is necessary to the successful operation of a foundry may be found in the pages of this book, and a list of reference books is included which may be purchased through the Buckeye Products Company.

The Morse Chain Company, Ithaca, New York, for which Jones & Glassco, Montreal and Toronto, are the Canadian agents, have issued publication Number 16, entitled "A Chain of Evidence." This publication is one of a series and deals particularly with the small power drive. The book is replete with illustrations and is of interest and of useful reference for those who have to deal with the transmission of small amounts of power.

The Crouse-Hinds Company of Canada, Limited, Toronto, have issued a four page folder called "Condulet Suggestions 64." This folder describes the use of their condulets and the arranging or the charging of storage batteries on the train lighting sets. In the installations the condulet is mounted on a concrete pedestal which both facilitates a plugging and insures against the condulet being frozen in or covered with snow during the winter.

The Goldie & McCulloch Co., Galt, Ont., have recently issued a catalogue on rotary jet condensers and vacuum pumps. This firm have obtained the rights to the Rees-Roturbo pumps and condensing equipment and this catalogue deals with the various types of condensing equipment which they are prepared to supply. Condensers in general are treated of. Condenser plant economies and the economy of high vacuum are shown. The Rees-Roturbo jet condenser is treated of in detail, its design being gone into thoroughly, and features of installation being dealt with in a very thorough manner.

The Graton and Knight Manufacturing Company, Worcester, Mass., have issued a very complete catalogue descriptive of the lines of belting which they manufacture. The first few pages are taken up in the description of the plant and of the various portions of the hides which go to make up the finished belt. The various grades of belting are taken up next and each one of the different classes manufactured by the Graton and Knight Company are described in detail. Various types of belt drives are treated of and much valuable data is given regarding the proper calculation of belting problems and the care of the belts themselves.

The Bureau of Mines, Washington, have recently issued Technical Paper 191 dealing with central station heating. Briefly stated, the paper sums up the manifold extravagances of utilizing about 15 per cent. of the heat valve of the fuel, allowing the remainder to go to waste, mainly in the condenser cooling water. This percentage is true of the most efficient plants of to-day. A method that promises at once to increase the community value of such stations is worthy of consideration and the central station heating offers a favorable solution. The development of central station service is dealt with, methods of computing costs and rates to be charged are also gone into thoroughly.

The LONG Patent Steam Trap

Automatically drains jacket kettles, separators and steam mains. Nine hundred to 1,500 feet of one-inch pipe isn't beyond its ability. Also used with splendid success in drying room systems.

Only One Movable Part

Works against 1 and 200 pounds of pressure—no possibility of freezing. Has two outlets so it can be installed in any position.

Circular gives full particulars.

Write to-day.

J. T. LONG
84 Adam Street
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If your dealer does not sell it, write direct 1

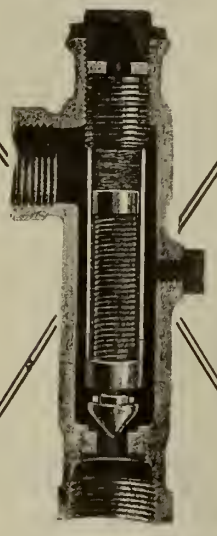
NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242-244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

No Delay No Bother
No Trouble
Ready for
Immediate Delivery

STEAM TRAP
SARCO



Is as readily installed as it is quickly supplied. No pit—no foundation—no expensive preparation. Because of its simple form and unique construction SARCO can be placed

Any Place Any Position
Any Angle

whether the pressure be low or high—2 lbs. or 200 lbs.—can be applied to your pipe line as easily as a coupling or an elbow—along the stretch, in the bend—*anywhere—any point needed.* SARCO is an efficient steam trap as easily inserted as a cork in a bottle. Do you wonder that several hundred thousand SARCOS are in use!

You won't wonder if you accept our offer of a trap on 30 days free approval.

Sarco Company, Inc.
Woolworth Bldg., New York City

Ellicott Square, Buffalo
New Telegraph Bldg., Detroit
Drexel Bldg., Philadelphia
Monadnock Block, Chicago
Williamson Bldg., Cleveland
Healey Bldg., Atlanta,
and representatives in all principal cities.
Canada, Peacock Brothers, Montreal.

The Goldie and McCulloch Co., Galt, Ontario, have issued a very attractive catalogue on the Rees Roturbo pump, for which they have secured the manufacturing rights for Canada. The Rees-Roturbo pump has proven highly efficient and is widely used in Great Britain, Canada, and the United States, the high efficiency and self-regulating features proving particularly attractive. The literature, which has recently been published by the above mentioned firm, goes into the design of this pump very fully, and makes very interesting reading, the fundamental principle of the pump itself is very clearly explained. and the manner in which the problems connected with variation of head in either the suction or delivery are dealt with is clearly shown. The various types of single and multi-stage pumps are featured and dimensions and other information given concerning their design.

WESTINGHOUSE NEW ANNUAL CATALOGUE

The Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., has issued a complete catalogue in which all of their electrical supplies are listed. In compiling the catalogue every effort was exercised to make it of the greatest convenience to purchasers.

The catalogue is made up of 1,264 pages of description pertaining to the products of the company and a score of other pages contains a complete cross index, and index to style numbers, and a table of "Approximate Cost Multipliers," which enables one to figure the approximate cost of all supplies listed.

Although the book is called a catalogue, it contains a vast amount of information of a technical and engineering nature. Practical suggestions for the use of many kinds of apparatus for the transmission and utilization of electric power are given.

It is planned to issue this catalogue annually. The publication of this catalogue is quite noteworthy, as it is the first book of such a nature published by an electrical concern having the wide diversity of products sold by the Westinghouse Company.

NEW PUBLICATION

The double-helical speed-reducing gear, as used for stepping down from the high speeds of steam turbines to speeds suitable for ships' propellers, direct-current generators, large centrifugal pumps and fans, rope and belt drives, etc., was first introduced about twenty-five years ago by the late Dr. De Laval. This type of speed-reducing gear has subsequently been developed and refined by the several companies bearing his name, particularly for large size units, by the De Laval Steam Turbine Co., of Trenton, N.J.

That company has now issued a 32-page catalogue describing standardized geared turbine units for marine service. The gain in fuel economy of the steam turbine over the reciprocating engine is stated to be approximately 25 per cent. The geared turbine weighs about half as much and occupies less than a third of the cubical space required by the engine. It is also more accessible and easier to repair, the expense for supplies and attendance is considerably less.

The new publication describes the details of construction of turbines and gears and also various turbine-driven auxiliaries, including lighting sets, circulating pumps, boiler feeders, etc. A new development is the centrifugal pump for the continuous purification of the oil used in the turbine and gear bearings and on the gear teeth.

DESULPHURIZATION OF BENZOL FOR MOTOR USE.

It is now possible by using a new method of desulphurizing benzol to make it more effective in competition with sulphur-free petrol. The portion of sulphur present as thiophene—about 30 per cent. of the total can be eliminated by washing with concentrated sulphuric acid, such as is required in the making of pure products, and the real difficulty is to get rid of the carbon bisulphide, which remains unaffected by the washing process, and of which the crude spirit contains on the average about 0.96 per cent. After numerous experiments a process was finally evolved and embodied in a patent by which the benzol is washed with caustic soda solution at a temperature just short of its boiling point. Sodium thiocarbonate water, and sodium carbonate are formed in the following proportions:—

$$6\ NaHO - 3\ Cs_2 = 2\ Na_2CS_3 - 3\ H_2O - Na_2\ CO_2$$

The caustic soda is prepared in the usual way from soda-ash and lime, but of higher strength than usual—aiming generally at a density of 26 deg. Twaddell, corresponding to approximately ten per cent. of NaOH. The charge of benzol forerunnings is blown into the mixer, which is a cylindrical tank fitted with an agitator having a series of arms radiating from a central shaft, a small reflux condenser (to return any vaporized benzol) and a heating coil. Steam is turned on full for about ten minutes, the agitator started. and the caustic run in. The agitation is kept up for about two hours. by which time the caustic has become exhausted; the contents of the mixer are then allowed to settle for some twenty minutes and the spent liquor is run off. The following particulars give details of a washing:

First wash—Caustic soda. 715 gallons. 27.5° Tw., 10.74 per cent of NaOH. Sp. Gr. after run 0.892. CS_2 3.57 per cent. — 59.55 per cent. reduction.

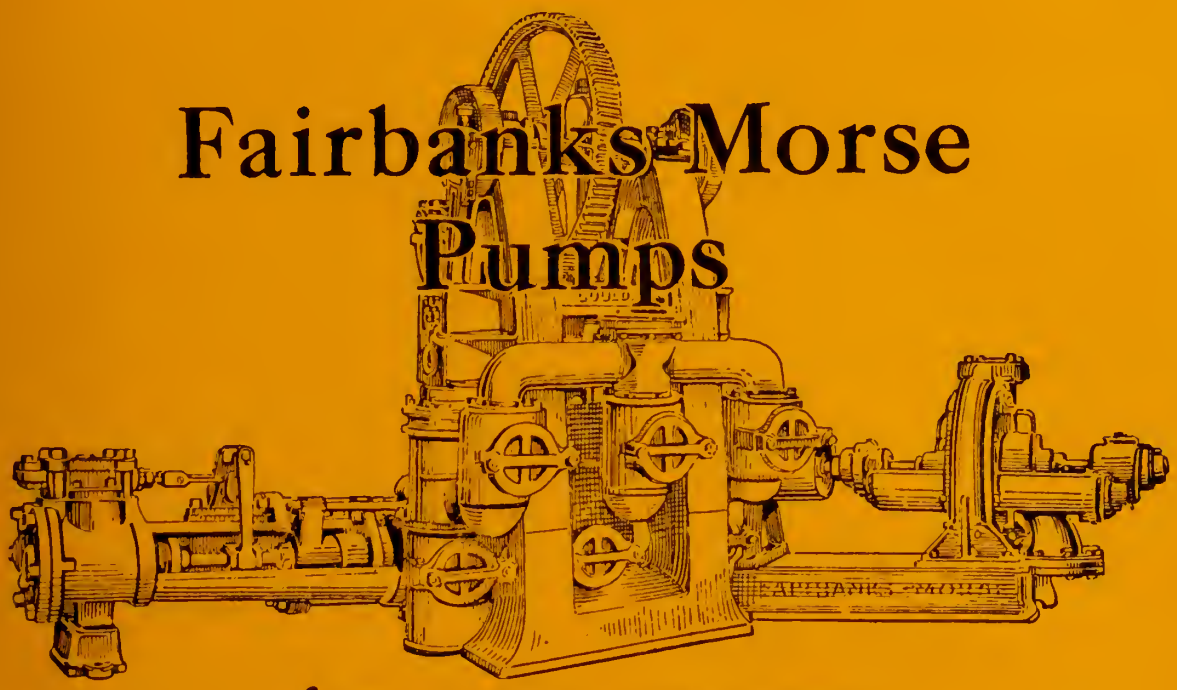
Forerunnings charged to mixer. 1,241 gallons. Sp. gr. 0.907. CS_2 8.83 per cent.

Second wash—Treated spent liquor from first wash, 550 gallons. Sp. gr. after run 0.885. CS_2 3.57 per cent. reduction. Total CS_2 removed 95.51 per cent.

The liquor from the second wash is again revivified. and used for partly washing a succeeding charge.—M.E.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Fairbanks-Morse Pumps



for every purpose

The same high standard and efficiency that characterize the Canadian Fairbanks-Morse engines and other mechanical equipment are found in each of the models of Fairbanks-Morse pumps.

No matter for what purpose you may desire a pump, there is a Fairbanks-Morse style to meet your requirements.

Enquire of the nearest Branch.

"Canada's Departmental House for Mechanical Goods."

The Canadian Fairbanks-Morse Co., Limited

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Toronto	Hamilton	Windsor	Winnipeg
Saskatoon	Calgary	Vancouver	Victoria

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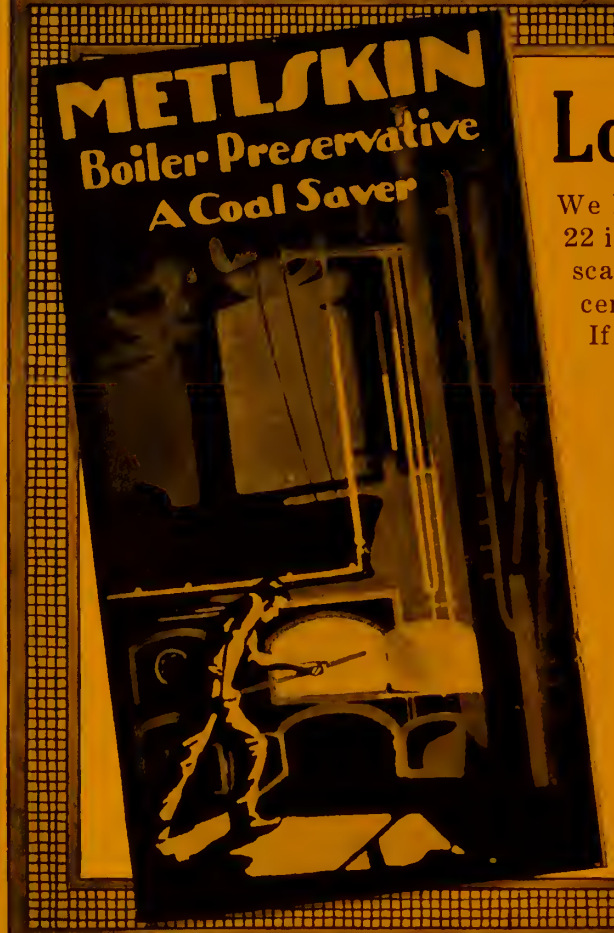
EVERYTHING MECHANICAL



Loss—Questionnaire

We have recently issued a summary sheet (5½ x 22 inches) which will serve to show you just what scale, pitting, and corrosion are costing your concern in the shape of fuel loss and boiler repairs. If you want a copy we will gladly send it

Without Obligation

It is for your own use and need not be returned.

A bit of effort and your own figures may disclose some startling facts about your boiler-room costs.

Send a post card to-day to the C. F.-M. Co., Ltd., or to us.

Metlskin Co., Inc., Rochester, N.Y.

Canadian Distributors:

Canadian Fairbanks-Morse Co., Limited

Halifax St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Saskatoon Calgary Vancouver

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR

I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

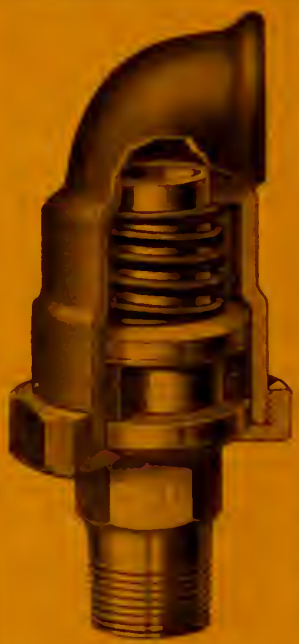
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y.

General Sales Agents:
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda
SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
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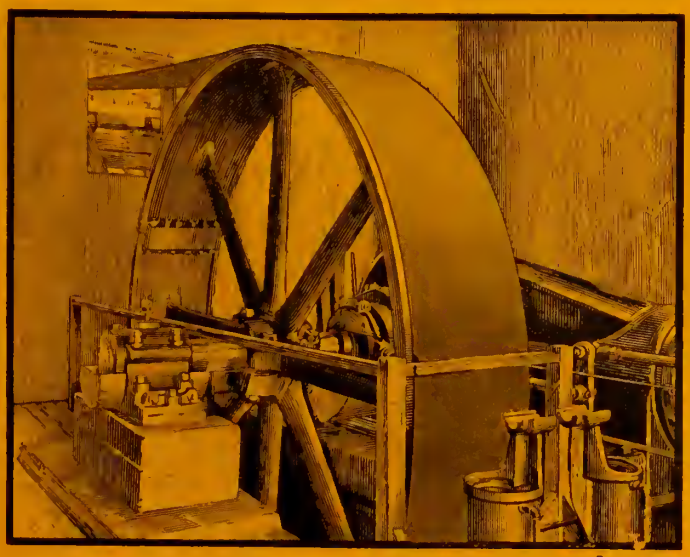
General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

GRATON AND KNIGHT



GRATON AND KNIGHT

Nature's Contribution to Power

30-inch Neptune Double Belt, 91 feet long, driving mill of J. C. Halsema Mfg. Co., Jacksonville, Fla. This belt has been in operation five and one-half years, and is in as good condition as when first installed. It has given satisfactory service at an overhead charge of $2.17 per week, or a cost of five mills per horsepower per week

It's the right material in the right place. Nature provided that material, worn originally on the back of a steer. A steer hide is *naturally* tough, strong, pliable, elastic. All of those characteristic virtues are retained to the right degree in Graton & Knight Standardized Tanning. That tanning is done to meet fixed requirements.

Leather stands hard usage. It has a hull-dog frictional grip. It keeps on taking the punishment of main drives and the side-slapping of shifters—and then comes back for *more*. Good belting must have tractable pliability. It must be firm. It must stretch and come back when required. It must be easy to slice and repair. Nothing beats leather for these characteristics. No belting beats Graton & Knight Standardized Series Leather Belts.

Every Graton & Knight Brand isn't recommended for *every* drive. The work to be done determines the belt to be used—that is the G. & K. Standardization idea. Power transmission requirements are confined to a few classes. There's a standardized belt for every class. The Neptune Double referred to above is one of them. It's the Standardized Belt for use wherever dampness or water is present or where belting is subjected to exposure and rain, snow and other unfavorable climatic conditions; and for excessive loads.

Many of the best belted plants ask us to specify the belting for every *pulley drive*. Try the plan yourself. Then, when buying, call for "Graton & Knight—Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for information about Standardization as applied to Belting.

THE GRATON & KNIGHT MFG. COMPANY, WORCESTER, MASSACHUSETTS, U.S.A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packings, and Specialties.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES.

Canadian Graton & Knight, Ltd., Montreal. Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria.

Tanned by us for belting use.

GRATON & KNIGHT Standardized Series LEATHER BELTING

Do you know that we have a thoroughly organized engineering department devoted to the interests of all belt users? We have—and it is one of the best in equipment and resources, in the country. You are invited to send us your problems for solution. The only fee involved is your good will.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

DURABLA

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Sold on a Service Basis

DURABLA COMPRESSED ASBESTOS FIBRE SHEET PACKING is guaranteed to meet every flange condition in your plant, making a permanently tight joint wherever a gasket is required.

One Standard Material for all Gasket Work. *Prompt Shipments of All Orders*

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Valves and Asbestos Packed Cocks

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EVERYTHING MECHANICAL

Consider the Convenience of Packing Any Size Valve From One Spool of

TRADE MARK
"PALMETTO"
Reg. U.S. Pat Office
TWIST PACKING

(Just unstrand to the desired size)

The lubricant in each strand of high tensile strength gives "PALMETTO" long life in service, making it a packing of

Economy and Great Convenience

Small stuffing boxes need the right packing, because the amount of packing is small and is more likely to burn out or harden.

Send for free working sample to test for yourself.

GREENE, TWEED & CO.

Sole Manufacturers

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CANADIAN FAIRBANKS-MORSE
EVERYTHING MECHANICAL

No Buckling
Split Tubes
Nor Leaky Heads

Because in this Alberger Heater expansion stresses are positively overcome by the use of a divided tube head which takes care of the unequal elongation of the tubes in the various passes.

With this
ALBERGER MULTI-HEAD HEATER

your hot water cost will be cut down. You will be saved steam repairs—fuel—space. You will need no extra storage tank because the water will be heated to the required temperature as fast as it is withdrawn.
You will need less fuel because the small diameter helically corrugated seamless pure copper tubes insure very rapid heating; they have been proven to transmit 50% more heat than any plain tube heater of similar size.

Send for Bulletin No. 201.

ALBERGER HEATER COMPANY
BUFFALO N.Y. U.S.A.

General Sales Agents: Canadian Fairbanks-Morse Company, Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria.

Capacities range from 200 to 200,000 gallons per hour.

Voorhees Rub-Steel Valves

"The Valve with a Backbone"

Are without an Equal for

Deane of Holyoke Condensers

or Suctions on Paper Machines

Softest high-grade rubber as seating, supported by an inseparable **steel core.** Spring guides and brass bushed stud-holes as above, if desired, or plain faces.

Not a cheap valve, but positively smoothest in action and longest lasting.

This construction in Four Grades for **every** known pumping service.

The Canadian Fairbanks-Morse Co., Ltd.
Sole Distributors for Canada

THE AMERICAN DEAD WEIGHT GAUGE TESTER

Simplifies Gauge Testing

Especially adapted to shop and engine room testing.

Check your own gauges.

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Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited
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AMERICAN STEAM GAUGE & VALVE MFG. COMPANY
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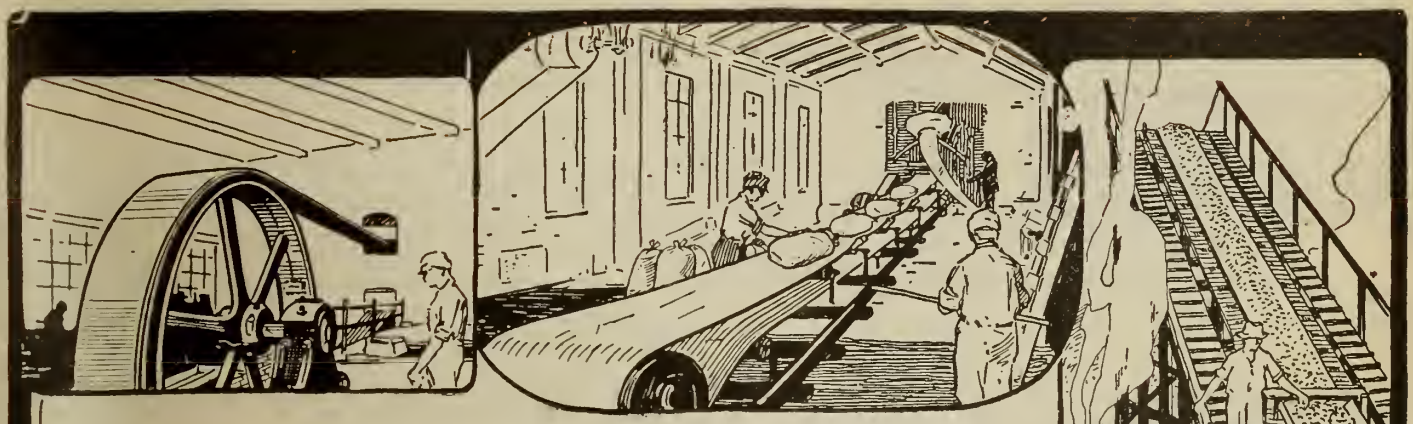


Dominion Rubber System Belting is Better Belting for Every Purpose

There is yet to be found a process, condition, use or industry in which belting is required that the Dominion Rubber System's belting engineers have not successfully and efficiently served with some type of our Belting.

If you have a problem for which there is no parallel, our technical experts will undertake to solve it without charge, and produce, if necessary, a special type of belt to satisfactorily meet your requirements.

Nearly every factory, mine, quarry, paper or flour mill, grain elevator or railway shop, is using our Belting as a satisfactory part of its equipment—some of the largest users specify it exclusively.

Our **Dominion Friction Surface Belting** will out-serve, at lower cost per horse-power, any belt made—because it is built up to the highest quality standard—by the oldest, largest and most highly specialized rubber organization in Canada.

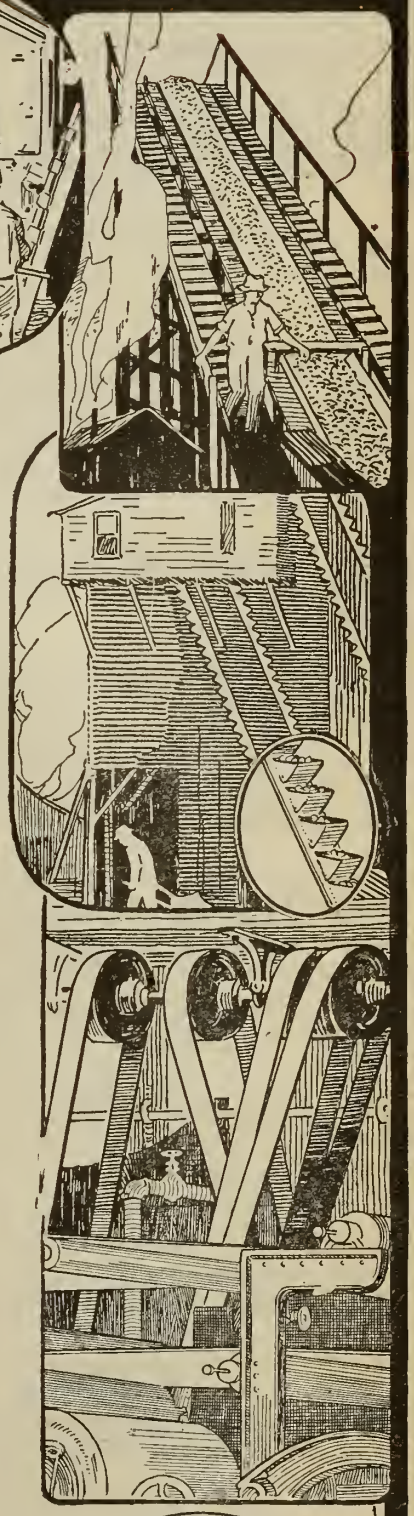
An important factor in the service of Dominion Rubber System Belting is in placing the right type of belt where it will produce maximum efficiency—this is primarily due to our Dominion-wide service branches, through which the free advice of our belting engineers is available to every user of belting.

As one of these service branches is within 'phone distance of you, put it up to our experts to get you out of any difficulty that concerns belting.

Service Branches

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Kitchener, North Bay, Fort William, Winnipeg, Brandon, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria.

17



CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Becoming a Bigger Man

WHAT is the difference between some men you know and others known to you? Why are some men earning $3,000 a year and some $30,000? You can't put it down to heredity or better early opportunities, or even better education. What, then, is the explanation of the stagnation of some men and the elevation and progress of others?

We are reminded of a story. A railroad man, born in Canada, was revisiting his home town on the St. Lawrence River. He wandered up to a group of old-timers who sat in the sun basking in blissful idleness. "Charlie," said one of the old men, "they tell me you are getting $20,000 a year," "Something like that," said Charlie. "Well, all I've got to say, Charlie, is that you're not worth it."

A salary of $20,000 a year to these do-nothing men was incredible. Not one of the group had ever made as much as $2,000 a year, and each man in the company felt that he was a mighty good man.

Charlie had left the old home town when he was a lad. He had got into the mill of bigger things. He developed to be a good man, a better man, the best man for certain work. His specialized education, joined to his own energy and labor sent him up, up, up. To put it in another way: Charlie had always more to sell, and the world wanted his merchandise—brain, skill and ability. Having more to sell all the time, he got more pay all the time.

Charlie could have stayed in the old home town; could have stagnated like others; could have been content with common wages. In short, Charlie could have stayed with the common crowd at the foot of the ladder. But Charlie improved himself and pushed himself, and this type of man the Goddess of Fortune likes to take by the hand and lead onward and upward. Almost any man can climb higher if he really wants to try. None but himself will hold him back. As a matter of fact, the world applauds and helps those who try to climb the ladder that reaches towards the stars.

The bank manager in an obscure branch in a village can get out of that bank surely and swiftly, if he makes it clear to his superiors that he is ready for larger service and a larger sphere. The humble retailer can burst the walls of his small store, just as Timothy Eaton did, if he gets the right idea and follows it. It is not a matter of brain or education so much as of purpose joined to energy and labor. The salesman or manager or bookkeeper or secretary can lift himself to a higher plane of service and rewards if he prepares himself diligently for larger work and pay. The small manufacturer, the company director, the broker—all can become enlarged in the nature of their enterprise and in the amount of their income—by resolutely setting themselves about the task of growing to be bigger-minded men.

Specialized information is the great idea. This is what the world pays handsomely for. And to acquire specialized information is really a simple matter, calling for the purposeful and faithful use of time. This chiefly.

One does not have to stop his ordinary work, or go to a university, or to any school. One can acquire the specialized information in the margin of time which is his own—in the after-hours of business. Which means: If a man will read the right kind of books or publications, and make himself a serious student at home, in his hours—the evening hours or the early morning hours—he can climb to heights of position and pay that will dazzle the inert comrades of his youth or day's work.

IF business—BUSINESS—is your chosen field of work, we counsel you to read each week THE FINANCIAL POST. It will stimulate you mentally. It will challenge you to further studious effort. It will give you glimpses into the world of endeavor occupied by the captains of industry and finance. With the guidance of the POST, and with its wealth of specialized information, you, a purposeful man, aiming to go higher in life and pay, will find yourself becoming enlarged in knowledge and ambition, and will be acquiring the bases and facts of knowledge which become the rungs of the ladder you climb by.

It is the first step which costs. But this cost is trivial—a single dollar. We offer you the POST for four months for a dollar. Surely it is worth a dollar to discover how right we are in our argument. If you have the will to go higher in position and pay, sign the coupon below.

THE MACLEAN PUBLISHING COMPANY, LIMITED,
.—143-153 University Avenue, Toronto.

Send me / us THE FINANCIAL POST for four months for one dollar.

Money to be enclosed / remitted

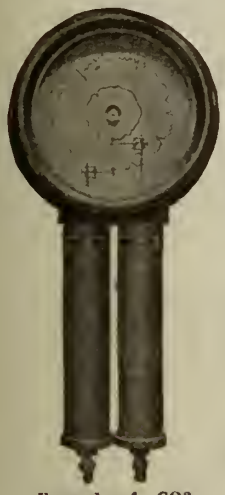
Signed .....

P.H. .....

UEHLING WASTE METER

COMBINED

CO_2 AND TEMPERATURE RECORDER



Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO2 indicator at the Boiler Front holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

CO2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company

2008 Empire Building — New York City

Structural Steel and Steel Plate Work

of every Description

Smoke Stacks, Storage Tanks, Pressure Tanks, Boiler Breachings, Bins, Hoppers, Feed and Fresh Water Tanks, Cranes, Uptakes, Shaft Bearing Seats, etc.

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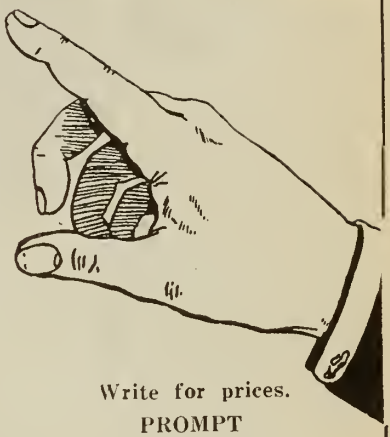

Write for prices.

PROMPT DELIVERIES

Sherbrooke, Que.

Don't buy that New Electrical Apparatus Just Yet

WE can supply you with high-grade apparatus that has been slightly used and discarded through no fault of its own, at an **immense saving in cost.** For instance, in many cases we take over entire plants simply because of changed conditions such as increased capacity, change of system, etc.

EVERYTHING IS OVERHAULED AND REFINISHED BY US AND **GUARANTEED** AS GOOD AS NEW, BOTH ELECTRICALLY AND MECHANICALLY.

Our catalogs of offerings should be in the hands of every power plant superintendent each time they are gotten out, and it will be worth while for anyone interested in this class of power plant equipment to be on our mailing list to receive all offerings.

Nearly all of the principal power, lighting and street railway plants in the United States are our customers.

WRITE FOR OUR LATEST CATALOG of **Power House Equipment, Street Cars, Motors, Hoists, Compressors, etc.**

MACGOVERN & COMPANY, Inc.

General Office: 114 Liberty Street, New York

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In Canada's Biggest Industries

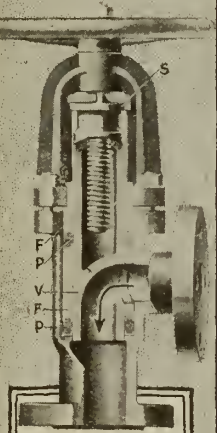
Where absolute certainty must be counted upon at all times, no chance can be taken with equipment.
In the big industries, especially, must every detail be efficient—the blow-off valve as well as the boilers, pumps and engines.

So, when the big Canadian corporations such as the following instal Yarway (formerly Simplex) "Seatless" Blow-Off Valves, their choice becomes an endorsement of the very highest character.

Canadian Explosives Co., Ltd., have 11.
Dominion Iron & Steel Co., Ltd., have 20.
Canadian Pacific Rly. Co. have 24.
Bathurst Lbr. Co. have 8.
Montreal L., H. & P. Co. have 24.
International Eng. Wks., Ltd., have 13.

And there are many others, With the Yarway (formerly Simplex) "Seatless" Blow-Off Valve there can be no sudden opening and closing to injure tubes; the operation is simple, certain and safe; the valve does not leak; it requires but little attention as there are no weak places such as seats or discs to cut and scar; even the packing lasts for years. You can verify each of these claims by testing the Yarway on one of your boilers for 60 days. Return it if not satisfactory.

Write to-day, stating size of line, and whether screwed or flanged, angle or straightway.



Operation: In closing valve shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

Yarnall-Waring Company
7604-20 Queen Street
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YARWAY
Seatless Blow Off Valve
formerly the
SIMPLEX

Established 1834

Look for the registered
TRADE MARKS

"WORLD"
OR
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As a guarantee of Quality

T. McAVITY & SONS
LIMITED
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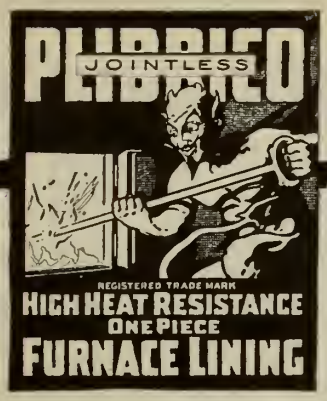

Saves Coal

By stopping up costly leaks in old boiler furnace linings or by making a complete new *jointless* gas tight lining.

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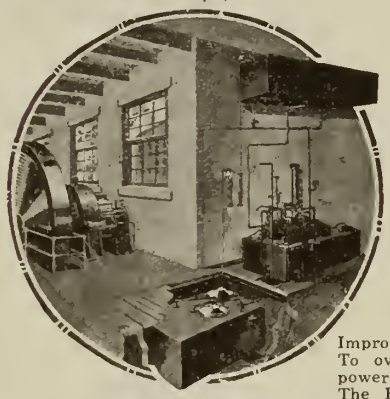
Economy of Power



6 F TYPE OIL FILTERING AND CIRCULATING SYSTEM

With the

BOWSER ESTABLISHED 1885

OIL CIRCULATION and FILTERING SYSTEMS

Improper lubrication causes friction. To overcome friction and carry the power house load, extra power is used. The Bowser System stops this waste of power by providing an unvarying supply of oil for the bearings at all times.

You can see how Bowser will save for you—save power, save shutdowns, save repairs, add to the life of your machinery, increase your production.

Bowser Engineering Department at your Service.

S. F. Bowser & Company, Inc.

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Sales Offices in all Centres *Representatives Everywhere*

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

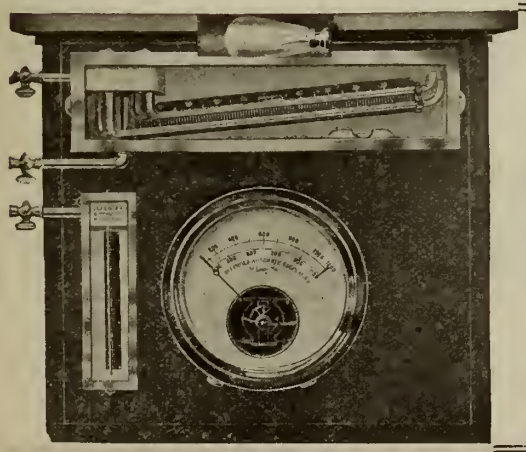
Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes



Boiler Room Efficiency Instruments

NO MORE GUESSING IN YOUR BOILER ROOM

THE DEFENDER SYSTEM (READS)

Draft, Temperature and CO_2 on each Boiler. Determine the Draft over the fire and at the last pass of the Boiler and the drop in Draft through the Boiler—that gives the highest percentage of CO_2 in the Flue Gas and the lowest Flue Gas Temperature.

This gives the highest Boiler and Furnace Efficiency. The Defender Catalogue No. 10, which is just off the press, shows a very complete line and price list of Combustion Appliances and Damper Regulators for the Boiler Room.

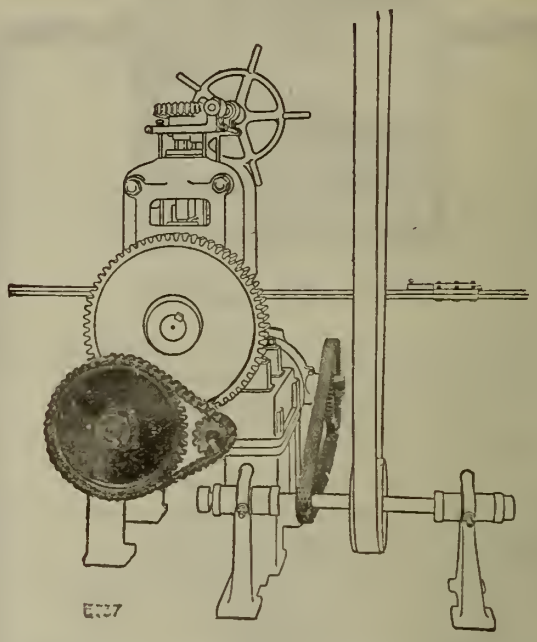
The Defender Automatic Regulator Co., 709 Pine St., St. Louis, Mo., U.S.A.

"THE COVENTRY" CHAIN DRIVES

THE ideal drive for all kinds of power transmission. In the case of the rolling mill illustrated, considerable power, large reduction of speed ratio, even flexible torque, silence and short centres are required. Note short distance between centres in front chain drive.

THE
COVENTRY
REGISTERED TRADE MARK

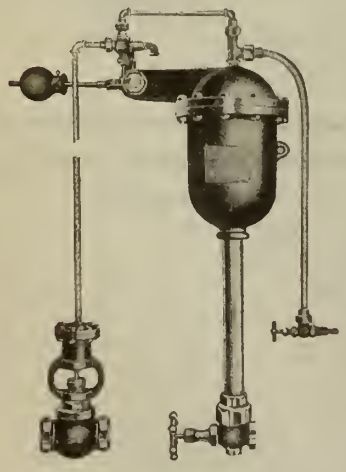
THE "COVENTRY" CHAIN Co., LTD.
COVENTRY, ENGLAND
Cables: Chains, Coventry. Codes A.B.C., 4th and 5th Editions, and Western Union



Rolling Mill for producing stream line wire for aeroplanes. Diameter of rolls 9", rolling speed 20.0 per minute.

THE
VIGILANT

Regardless of Load or Firing



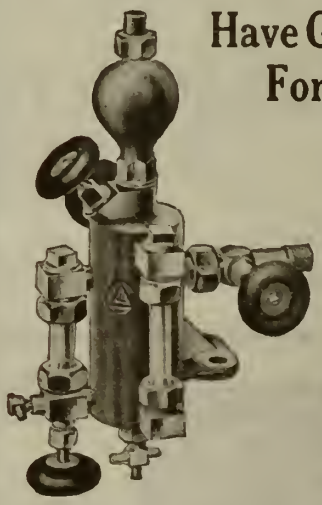
THE VIGILANT AUTOMATIC FEED WATER REGULATOR will keep your boiler water within a ¼ inch of Middle Gauge. It saves coal, reduces risk of boiler explosions and saves time, labor and worry.

Pleased to have you write for catalogue and literature about the "Vigilant."

The Chaplin-Fulton Manufacturing Company
28 Penn Avenue - - Pittsburg, Pa.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



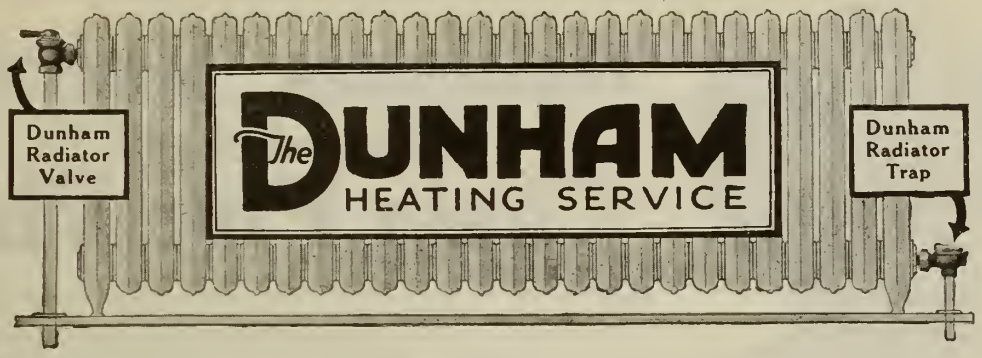
Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.



A Timely Service --- and the Company behind it

The public wants better steam heating service—more comfort per ton of coal. This Company is in a most favorable position to meet this demand through its co-workers—the architects, heating and ventilating engineers, heating contractors and builders—to whom it offers practical co-operation that will increase their prestige as well as their volume of business.

Any man who uses, specifies or installs steam heating equipment will find it advantageous to learn more about Dunham Heating Service—the product of 15 years' knowledge of steam heating in all its phases.

C. A. DUNHAM COMPANY, LTD., Toronto, Ont.

Halifax Ottawa Vancouver Montreal Winnipeg Calgary

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction.* Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs.* Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.

American-Marsh Centrifugal Pump.

Williams' "Vulcan"
Drop-Forged
Chain Pipe Vise

MADE entirely of drop-forgings and wrought steel, these Vises are unbreakable, compact, rapid in action and positive in gripping pipe. They are attachable **anywhere**—any handy bench, post, or other support will answer. Remember, Williams' Chain Pipe Tools have been **Standard** for nearly half a century—they are all backed by our absolute and unconditional guarantee of service.

Vises in 3 sizes for ⅛ to 8-inch pipe.

Descriptive Booklet on Request.

J. H. WILLIAMS & CO.

"The Drop-Forging People"

78 Richards St., Brooklyn, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, British Columbia and Alberta

Western Office and Warehouse: 78 So. Clinton St. Chicago, Ill.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

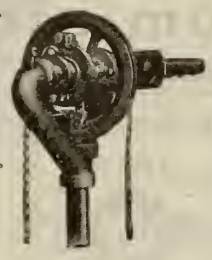
Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

SAVE 4 to 8 PER CENT FUEL

COST MORE AND WORTH MORE

STANDARD OF THE WORLD

Where Shall We Look For Profits?



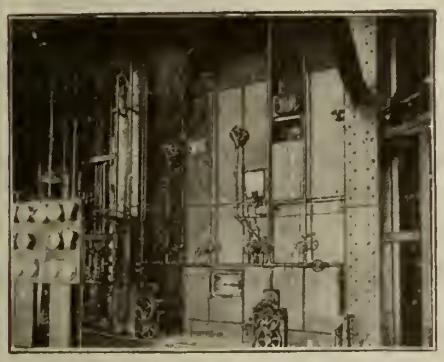
Taxes are high. Labor is high. Keen competitive conditions are being re-established. The trend of prices at which commodities can be sold is downward.

Yet business must be conducted at a profit!

How can this be accomplished? Only by increasing operating efficiencies.

In particular, the cost of producing power CAN and MUST be reduced. Equipment essential for this purpose is Diamond Soot Blowers.

In the average plant Diamond Soot Blowers will effect the following economies:



Diamond Soot Blowers at Plant of Buffalo General Electric Co.

1. Fuel; a saving of 4 to 8 per cent.
2. BOILER EFFICIENCY; an increase of 4 per cent.
3. LABOR; a saving of many hours per day.
4. LONGEVITY; an increase in the length of service of boiler tubes, through the prevention of corrosion.
5. STEAM; a saving of 25 to 75 per cent. of steam used for cleaning.

Such savings as these show up handsomely in your annual profits. If your plant is not equipped with Diamond Soot Blowers, ask for Bulletin No. 119.

Diamond Specialty Company

Windsor Ontario

MADE OF CALORIZED STEEL

HOMESTEAD
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They Stay Tight

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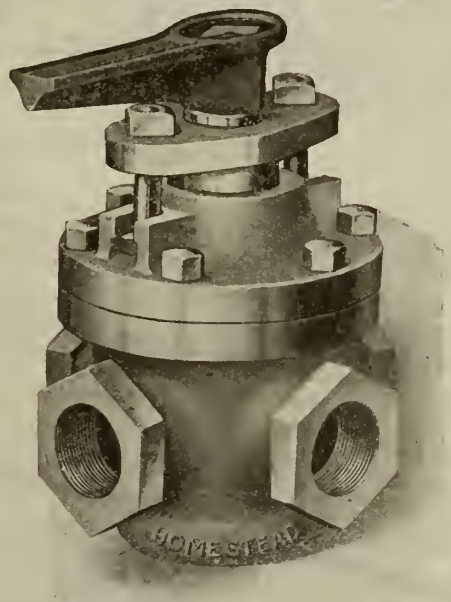

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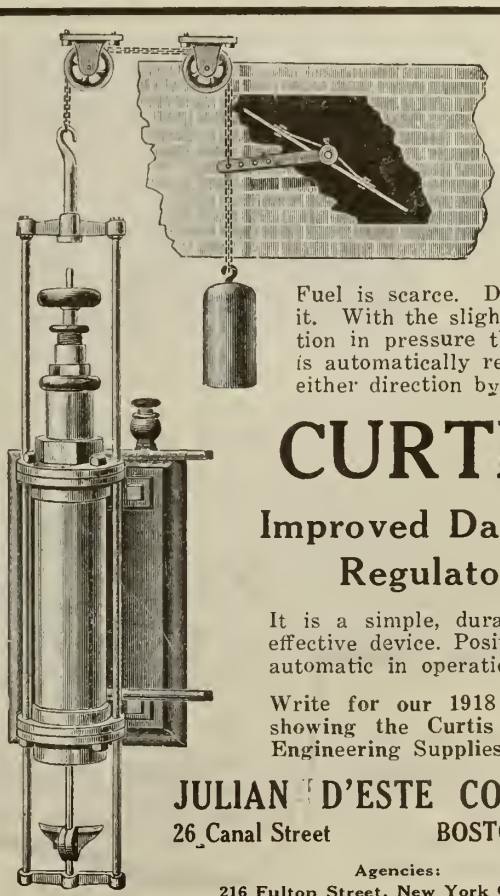

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922 POWER Vol. 48, No. 23

Coal Saving by the Scientific Control of Steam Boiler Plants*

By D. Brownlie

THE author has been associated for about ten years with the investigation on scientific lines of the working of every description of steam-boiler plant, and in the present article it is proposed to give the average figures for 250 typical steam boiler plants, with the object of supplying accurate data as to the tremendous national economy that can be effected by tha adoption of acientific methoda in the boiler-house.

In the burning af coal for the generation of steam, the loss because of lack of scientific methoda is hardly realized and, apart from the national point of view, offers to the individual firm a means of most substantial economy in running expenses.

It is not possible to find out what is the exact amount of coal used for the production of steam for purposes other than power, there being, for example, no statistics available showing the number of steam boilers at work in Great Britain.

The author proposes therefore to assume, until further information can be obtained by a proper engineering census of the country, that the total amount of coal used for steam generation in the United Kingdom is between 75 and 100 million tons per annum, being 60 to 70 million tons for power production and 15 to 30 million tons for purposes other than power, corresponding to 40 per cent. to 53 per cent. of the total coal used, and is of the opinion that the 250 boilers to be dealt with in the present article are really representative of all the boiler plants of the country, and the results of such a very large number of exhaustive investigations carried on continuously during ... enable us to judge with ... rine" boiler, 2 "vertical" boilers, and 3 "patent" boilers difficult to classify. It would be most interesting to know the exact number of each type of steam boiler at work in the country, although there is no doubt that the chief type in use is the "Lancashire."

Amount of Fuel Used—The average shows 20.9 lb. of fuel burnt per square foot of grate area per hour, referring, of course, to the average amount burnt per hour per working day, and not to the amount for any particular hour. This figure is considerably below what is possible on a boiler plant run on modern lines, which would burn something like 25 lb. to 30 lb. per square foot grate area per hour with the average quality of fuel. The boiler plants of the country are working under very easy conditions in this respect, and much more fuel could be burnt per boiler. Figures for fuel consumption depend largely on the quality of the fuel. Thus a good quality washed coal of, say, 13,000 B.t.u. and 7 to 8 per cent. ash could easily be burned economically at the rate of 35 lb. per square foot per hour, whereas purely refuse coals would only give ... Coke of good quality can be burnt ... per square foot grate ... 15 pounds.

... to the efficient ... some other ... works.

Economizers—Out of the 250 plants, 155 were fitted with economizers, the other 95 plants having no means of utilizing the waste heat from the boiler flues.

Taking the 155 plants fitted with economizers, the average saving is 11.4 per cent. of the coal bill. The highest figure found was 19 per cent. on a cotton-mill plant. The ordinary figure obtained on a well-managed plant is 15 to 20 per cent. saving, depending on the conditions.

Estimation of CO_2—Out of the 250 plants, 225 ... not ... recei...

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G. A. SCHULTZ,
Chief Engineer.

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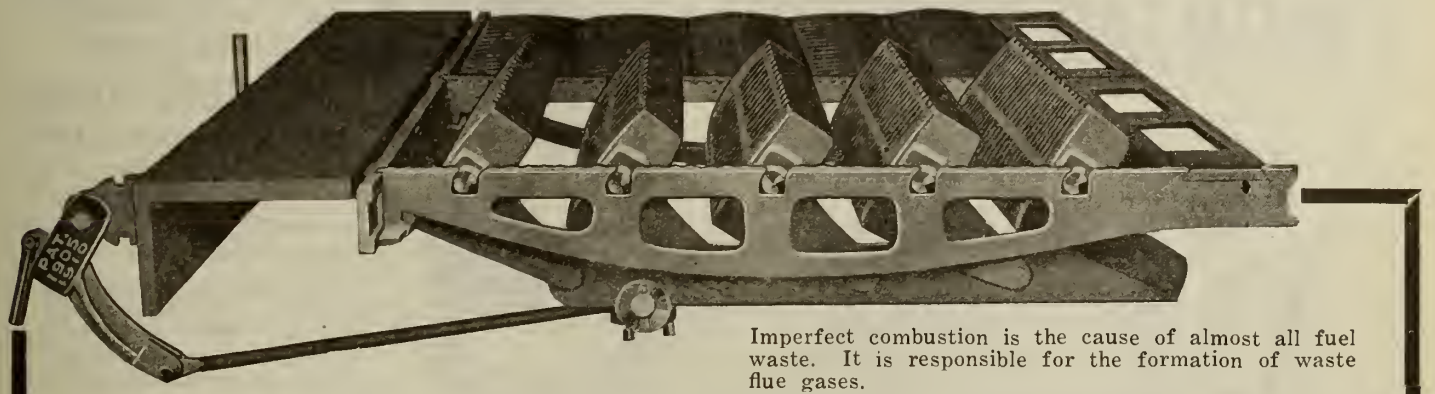

Imperfect combustion is the cause of almost all fuel waste. It is responsible for the formation of waste flue gases.

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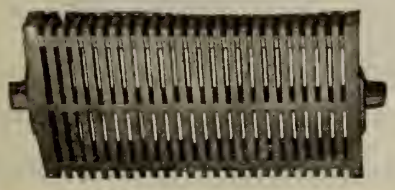

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Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

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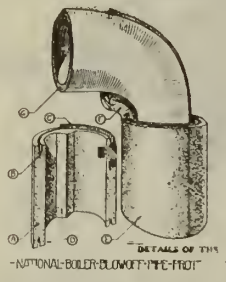

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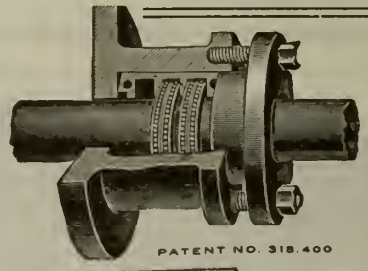

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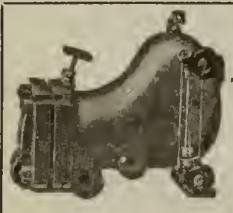

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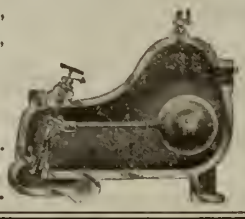

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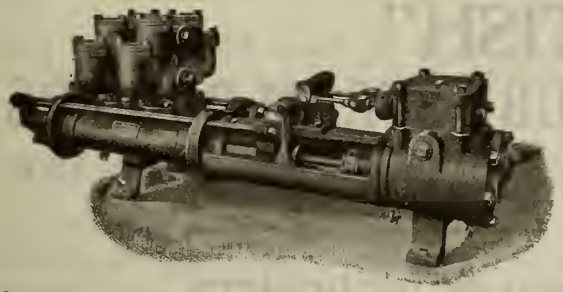

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The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID,
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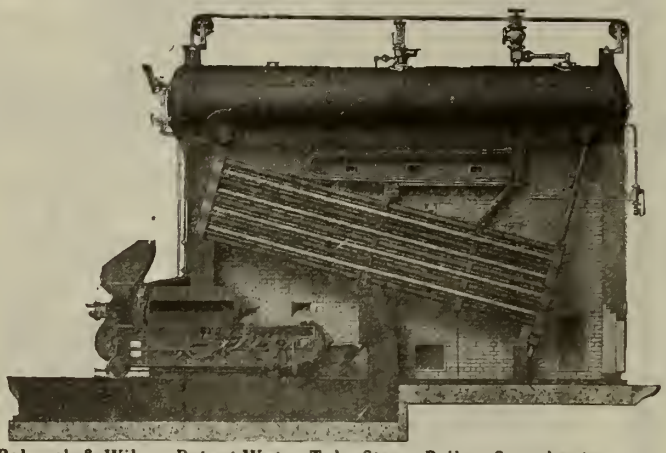

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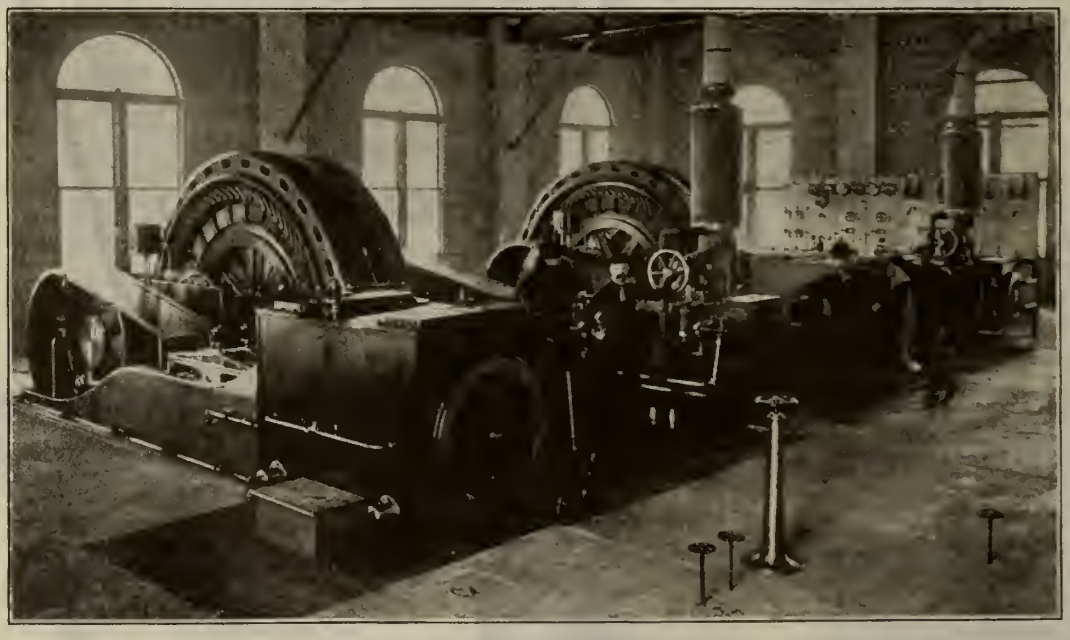

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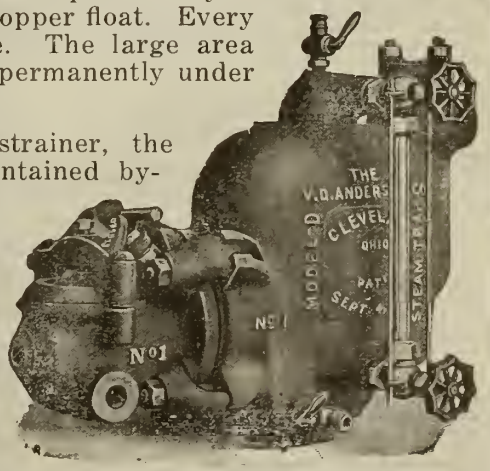

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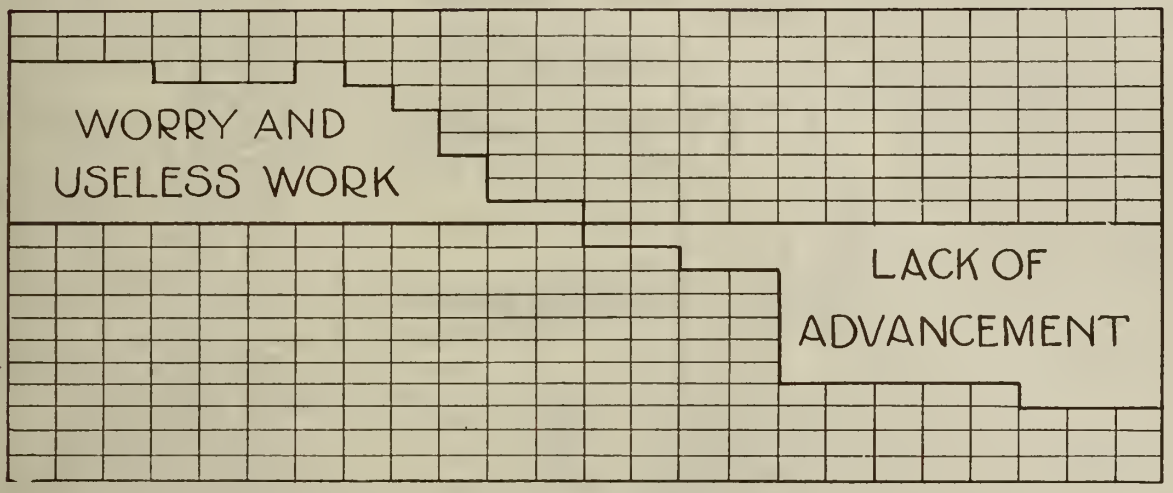

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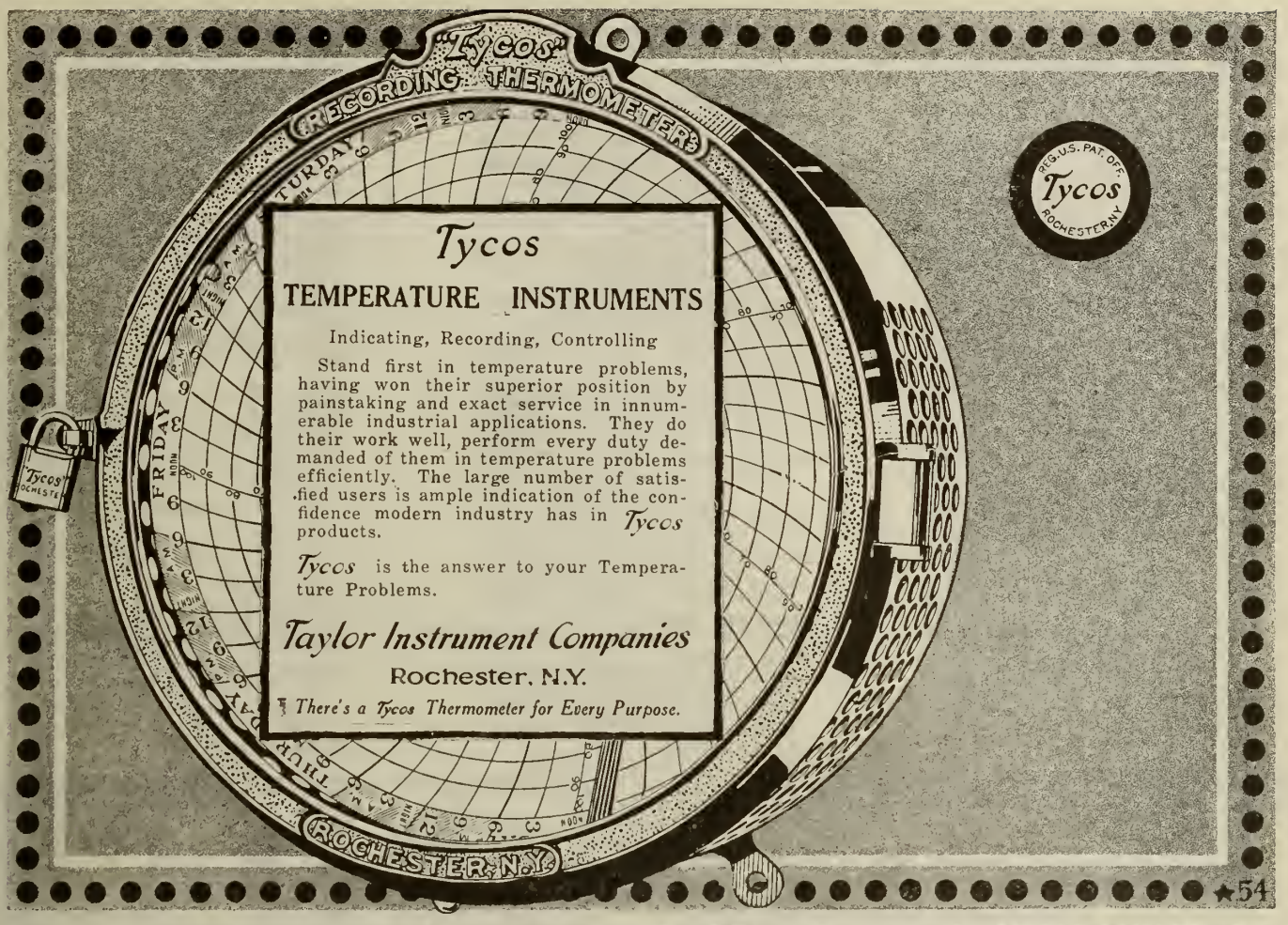

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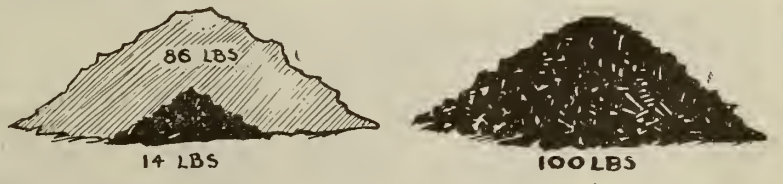

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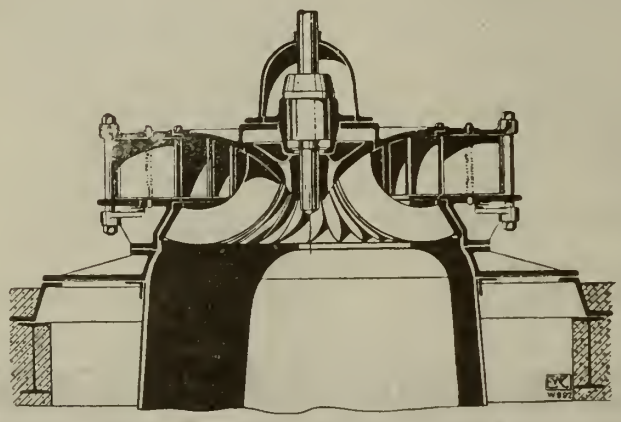

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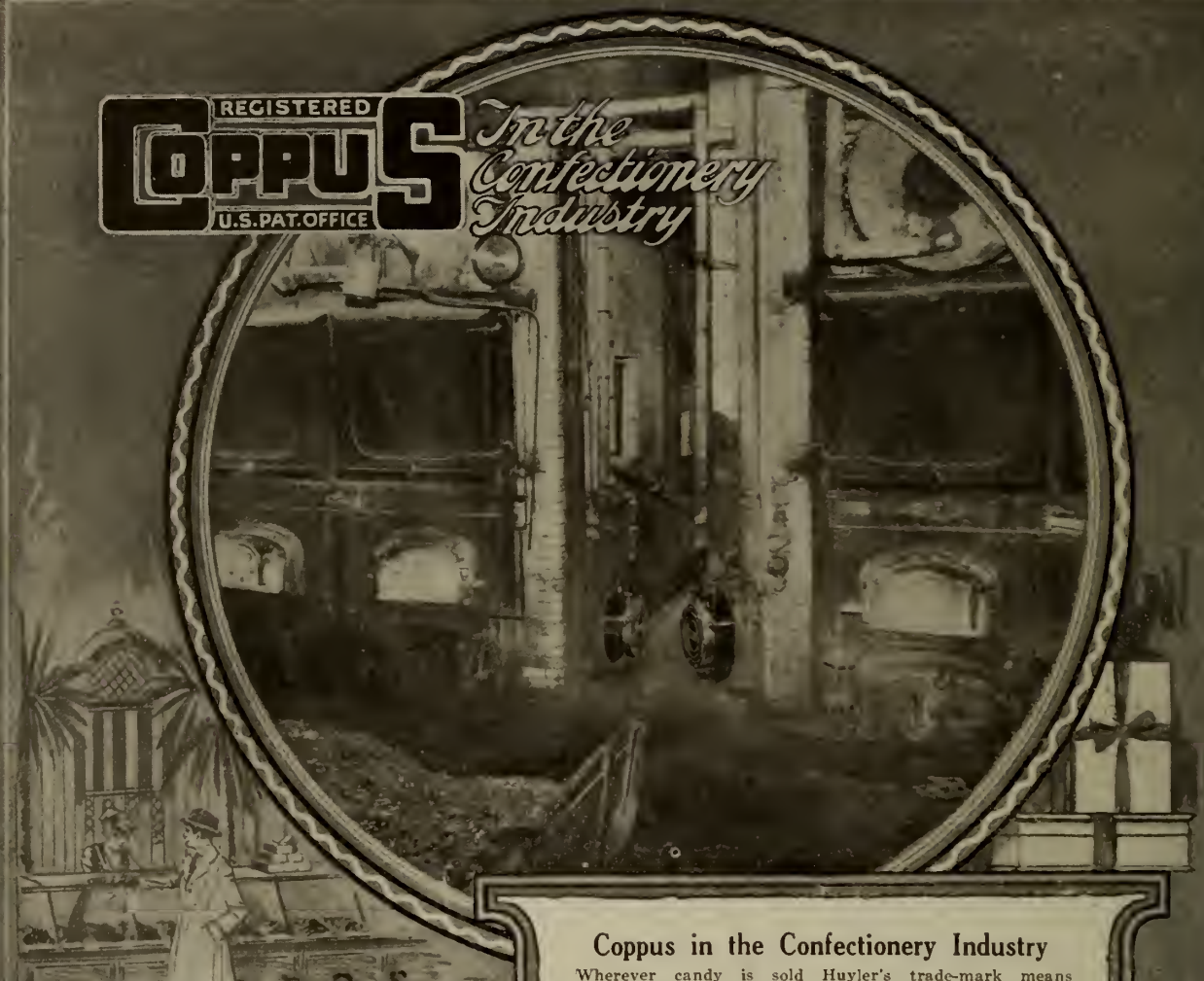

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COPPUS TURBO BLOWER

BOILERS

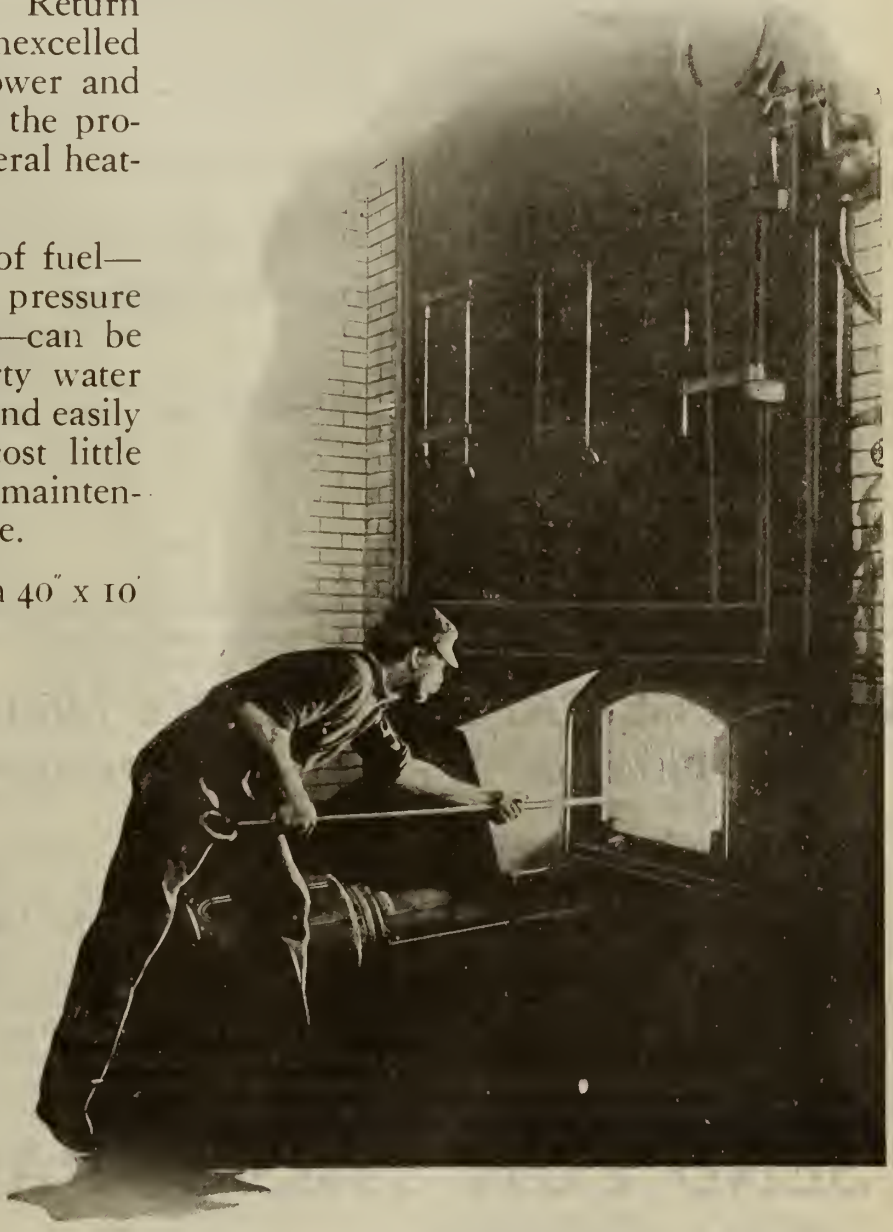
Waterous Horizontal Return Tubular Boilers are unexcelled for use in municipal power and pumping plants and for the production of steam for general heating purposes.

They are economical of fuel—carry a big reserve steam pressure for use in emergencies—can be used with hard and dirty water and are readily cleaned and easily taken care of. They cost little new,—their upkeep and maintenance expense is negligible.

We build all sizes from 40" x 10' to 72" x 18', and supply them complete for any installation, whether for power production or for heating systems.

Our numerous installations in Provincial and Municipal institutions throughout Canada vouch for the quality of our product.

Boilers in stock.



Waterous

BRANTFORD, ONTARIO, CANADA

Entire Plants and Equipment For Sale

O'BRIEN MUNITIONS, Limited and ENERGITE EXPLOSIVES

RENFREW, ONTARIO

THIS is probably the most attractive offering ever placed before Canadian manufacturers, and one that is worthy of your most careful consideration.

The Geographical location of the Town of Renfrew and uniformly permanent construction of the plants themselves, which are situated just a few minutes' walk beyond the Town limits, makes it an opportunity that comes but once in a lifetime.

Plenty of cheap electric power, town water on all parts of the property, excellent labor conditions and completely equipped Industrial Railway connecting all parts of the Plants. Canadian Pacific and Grand Trunk Railway sidings bring shipping and receiving facilities up to a maximum of efficiency. Free from Town taxation.

To those interested we will be glad to forward ground and building blue prints, inventory of Plant Equipment, including machinery of all descriptions, together with complete office and housing furniture, etc., all in first-class condition.

Tenders will be received for any part or all of these plants' equipment, as well as the land and buildings thereon erected. We are not setting a price on this "Manufacturing Opportunity." Write for full particulars, investigate and—

Make an Offer.

Highest or any tender not necessarily accepted.

M. J. O'BRIEN, LIMITED **RENFREW, ONTARIO**

FOR YOUR CONVENIENCE MAIL THIS COUPON

M. J. O'BRIEN, LIMITED,
RENFREW, ONT.

[] Entire Plant Equipment,
[] Buildings and Land.

Mark in space provided what you would be most interested in. This will facilitate supplying you with full information promptly and without obligation.

Name ..... Street .....

City ..... Province .....

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Plibrico One-Piece Plastic Firebrick
For Boilers, Burners, Smelters.

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SHELL BAR GRATES
Anti-Clinker—Revolving
Enables you to use cheaper fuel.

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Washable, Enamellike Coating.

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Damp-Proof for Acid Tanks, etc.

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Noiseless Trucks, Gears, Etc.

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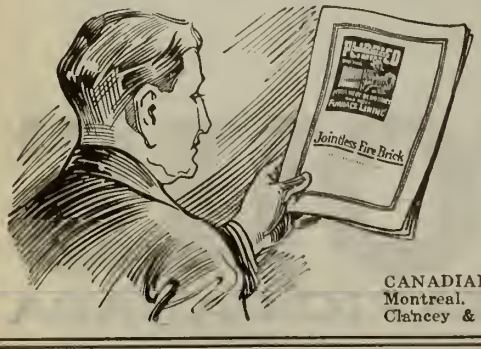

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Contains instructions on setting all types of boiler furnaces and brass and metal furnaces. Gives full directions on how to build and maintain tight furnace linings.

Every engineer and plant operator should have a copy for reference.

Send for your copy to-day.

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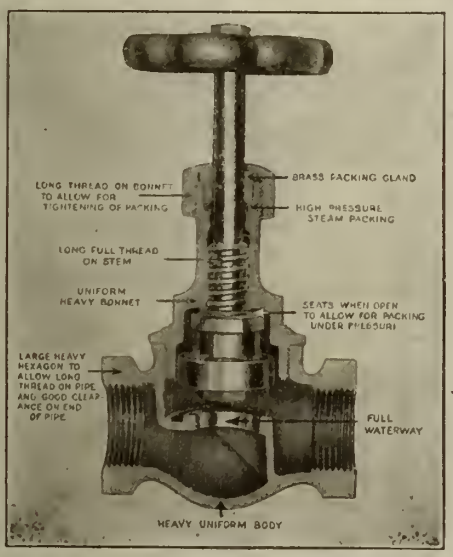
CANADIAN DISTRIBUTORS: Beveridge Paper Co., Ltd., 16 Ste. Therise St., Montreal. Shell Bar Boico Supply, Ltd., 376 Dufferin St., Toronto. Gorman, Clancey & Grindley, Ltd., Calgary, Alberta.

Power House, April 5, 1919, Vol. XIII., No. 3. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1.00; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

Waste of Time and Money


LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
BRASS PACKING GLAND
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREAD ON PIPE AND GOOD CLEARANCE ON END OF PIPE
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HEAVY UNIFORM BODY

WHEN overhauling your equipment, don't patch up the worn parts, it wastes time, labor and money—to say nothing of reduced plant efficiency, and lower turnout.

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About your valves—if those you have installed do not do their job, don't tinker with them—it will cost you more money than they are worth.

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EMCO Valves are guaranteed efficient, strong and durable. The design is approved and registered in the Provinces of the Dominion by Inspectors of Steam Boilers for a working pressure of 175 pounds. They are made of the best Bronze Metal. Each valve is subjected to a thorough hydraulic test before leaving our factory.

Look for the word "EMCO" on each valve.

Write for our catalogues. They contain valuable information you no doubt require.

Registered in the following Provinces as follows:—

GLOBE VALVE A840

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Empire Manufacturing Company, Limited

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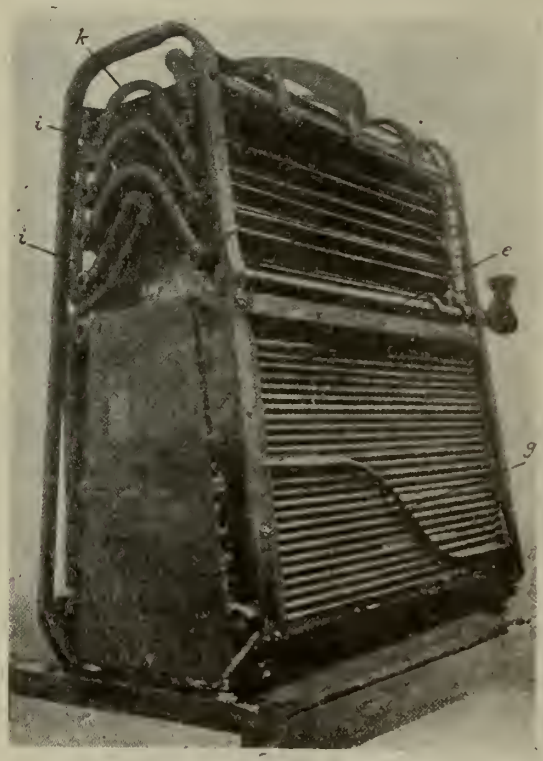
TALBOT

Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)



Head of Boiler Casing Removed

Talbot Oil-Fired Boilers require about one-seventh the space of the ordinary boiler. No brickwork is necessary and the cost of operation is cheaper than any known power producer.

The "Talbot" is a boiler of the contra-flow type, water entering near the stack and leaving in the form of steam near the furnace.

The circulation is through water tubes and is forced at a high velocity by means of a pump, doing away with a water drum. By preventing gravity circulation the steam is drawn directly from the lower tubes, eliminating the steam drum. The boiler is internally fired, and hence self-contained. Feed water and fuel burners are automatically controlled to adjust the boiler to widely varying demands for steam.

Tubes easily replaced under high steam pressure.

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SPROCKET RIM

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Brings Out-of-the-way Valves Within Easy Reach from the Floor

The Babbitt always gives you immediate control of the valve by simply pulling a chain —that's all. No rods, nor handles, no treacherous step ladders, no lost time.

The Babbitt can be attached to any valve—quickly, at little expense.

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Reducing Valves

Pump Regulator
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If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

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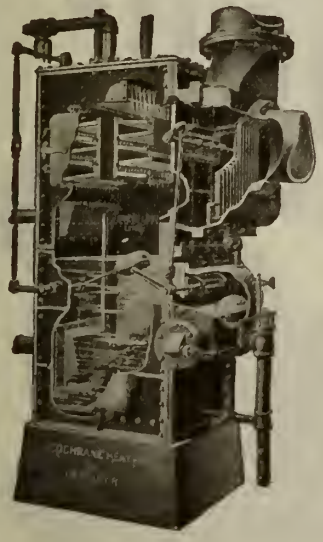
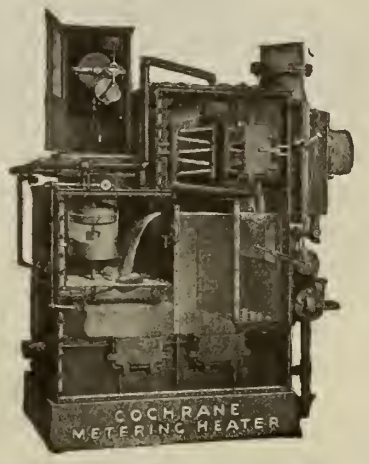
COCHRANE
COAL SAVERS

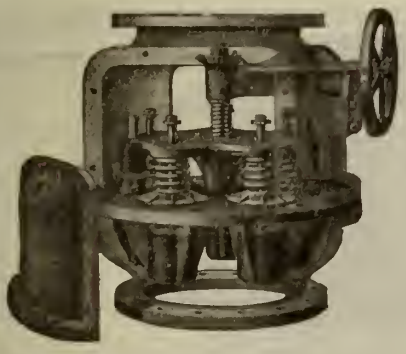


The Cochrane Open Feed Water Heater saves coal by utilizing exhaust steam to heat the feed water; 1% saving for each 11° F. rise.

The Sorge-Cochrane Hot Process Water Softener saves coal by heating the boiler feed water and by protecting the boilers against scale and corrosion.



The Cochrane Metering Heater saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.



The Cochrane Multiport Back Pressure Valve saves coal by preventing leakage of exhaust steam and by making it easy to adjust the back pressure whenever desired. The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.

The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.

Canada is Saving Many Thousand Tons
of Coal Per Year by Using Cochrane Heaters

Here are the figures:

The **horsepower** of Cochrane Heaters in use is about 10,000,000 boiler horsepower.

The corresponding amount of **coal burned** is 35,000,000 lb. per hour.

Considering an average of 10 hours' operation per day, 300 days per year (many heaters run 24 hours per day, 365 days per year), this amounts to 105,000,000,000 lb. of coal per year, or 50,000,000 tons, worth at $5.00 per ton, $250,000,000.

The saving due to the use of **Cochrane Heaters** is 1% to each 11° F. rise in temperature. On the average, the water is raised from 100° F. to 210° F. using steam at atmospheric pressure, 10% or a saving of 10%. Cochrane Heaters are thus **saving about $25,000,000** per year, which is vastly more than the heaters cost.

In addition, Cochrane Oil Separators are saving millions of tons of coal by **purifying exhaust steam** so that it can take the place of live steam in heating and drying coils, low-pressure turbines and industrial processes.

Sorge-Cochrane Hot Process Water Softeners are saving millions by **keeping scale and corrosive substances out of boilers** and thus saving expense and labor in cleaning boilers, and for new tubes and other boiler repairs.

Cochrane Metering Heaters are also telling hundreds of **steam-plant owners**, managers and operators how much they are **gaining in economy** by using different coals, different methods of firing, different methods of controlling the draft, stopping up air leaks in boiler settings, cleaning soot and scale from heating surface, etc. The total gains realized in this manner often amount to 25% or more.

Our engineering department has given hard study to fuel economy for over 25 years. It will be glad to aid you with suggestions if you will describe your present boiler feed water heating, softening, or metering arrangements, the amount of exhaust steam you have available and what you are using it for.

Ask for a book on "The Profitable Utilization of Exhaust Steam."

CANADIAN-ALLIS CHALMERS
HEAD OFFICE: TORONTO **LIMITED**

Branch Offices: MONTREAL, QUEBEC, HALIFAX, OTTAWA, HAMILTON, LONDON, COBALT SOUTH PORCUPINE, WINNIPEG, CALGARY, EDMONTON, NELSON, VANCOUVER and VICTORIA

The ANDERSON
Steam Trap

From the day you put it in, this Anderson Model "D" Steam Trap will stay tight. Operated by a counter-balanced Lake Superior Copper float, it will work perfectly under high or low pressure in any boiler-room. Its every part is machined to solid gauge. Its large area valve, permanently under deep water seal, will not wire draw.

We venture to say you never saw a trap made with the painstaking care that makes this Anderson Trap permanently tight under conditions most trying. It has a self-contained strainer, an outside gauge glass, a self-contained by-pass. And its construction affords complete accessibility to all parts.

This Anderson Trap will save you expense and trouble and time. Install it in your boiler room. Booklet on request.

THE V. D. ANDERSON COMPANY
1935 West 96th Street, CLEVELAND, OHIO

Stays Tight

No Clinker formation
No Coal lost in the ash pit
No Waste with--

You might call these the perfect-combustion-making grates because their 60 per cent. air space and 90 per cent. underdraught extract from fuel the last atom of energy. Burning any grade of coal, even screenings, these Grates prevent the formation of clinkers, for their use insures perfect combustion, no matter how good or how poor the fuel used. In every power plant in which these Cyclone Improved Shaking and Dumping Grates are used, steam costs less for the reason that less fuel is used. Your engineer can install Cyclone Grates without delay or trouble. You can have them on 30 days' trial.

Write us to-day.

The Canadian Steam Boiler Equipment Company, Limited
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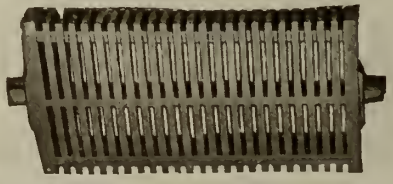
AGENTS: St. John, N.B., F. W. Blizzard, 329 Charlotte St.; Montreal, Mason Regulator Co., Ltd., St. James St.; Hamilton, Robt. Fitzsimmons, 8 Grove St.; Winnipeg, Vulcan Iron Works.

Cyclone  Grates

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CLEAN YOUR USED OIL!

A Bowser Filter in the power house will clean the dirty oil, make it practically as good as new, the oil can be used over and over again.

BOWSER ESTABLISHED 1885 FILTERING SYSTEMS

effect an immense saving in lubricating oil, give better lubrication with less oil, less labor, reduce wear and tear on bearings. There is a Bowser Oil Filtering System suitable for your power house.

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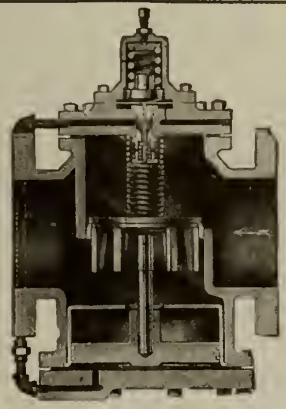

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Regulating Valves
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FOR EVERY SERVICE

SALES ENGINEERS

THE ARTHUR S. LEITCH CO.

TORONTO

One Man in a RILEY STOKER PLANT Can Often Care For 5,000 to 10,000 Horse-power of Boilers.

Live Grate Surface

One feature alone of the RILEY STOKER — *its moving grates* — is worth the hand work of a dozen skilled operators.

Even the most skilled would find it impossible to keep the fuel-bed free from holes and clinkers without dropping the efficiency by opening the fire-door.

The RILEY STOKER moving grates keep the fire-door shut—the fuel-bed open and porous—and discharge the ash as fast as it is formed.

The *moving grates* of the RILEY STOKER not only intensify combustion but enable the stoker to burn the poorest coals obtainable economically and at high capacity.

Sanford Riley Stoker Co.

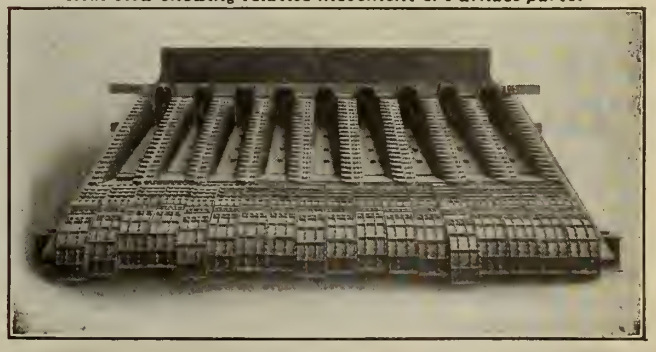
WORCESTER, MASS.

British Licenses: Erith's Engineering Co. Ltd., London. French Licenses: Erith-Leroy & Cie., Paris, France.

Our catalog HR-4 explains in detail the live grate surface of the RILEY STOKER.

For information on Murphy Automatic Furnaces for small boilers see last month's advertisement—or send for Murphy Furnace Catalog HM-4.

Rear view showing relative movement of Furnace parts.



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NINE HUNDRED SHEET

Is unsurpassed for superheated steam joints.

It is equally well adapted to air, acids, ammonia,

Or any severe condition where sheet packing is required.

It is made of the highest quality of long fibre asbestos,

And is built up into sheet form under tremendous pressure,

Thus securing great toughness, flexibility and tensile strength.

It is not affected by extremely high pressures and temperatures,

And does not require following up after gaskets have been applied.

Joints can be opened as often as desired without injury to gaskets.

This sheet is furnished in all thicknesses from 1/64 inch to 1/4 inch.

Gaskets of all shapes and sizes can be cut by us from Nine Hundred Sheet.

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Handle it Mechanically

With The JEFFREY Improved Carrier

Mr. Power Plant Engineer, your reputation is in the hands of the public, and no one has more at stake, for you must keep the wheels of industry moving and assure the many comforts of the home by supplying electric power, steam, light, heat and water.

Your Engineers and Generators, Boilers and Stoker Equipment may be the best that money can buy, but unless you have an adequate and efficient system for bringing the coal from the cars to the stokers, you cannot insure the continuous service demanded.

The Jeffrey Improved Carrier

represents the supreme development of the Pivoted Bucket Carrier for the handling of coal and ashes in the power plant. It has proved in many installations over the country, its Reliability of Action and Qualities for Long and Satisfactory service.

In presenting our New Catalog No. 210-A on the Jeffrey Carrier we believe we are rendering a service to the engineer and to the public. Write for a copy of this book.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms:

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LINDE PRODUCTION STANDS SUPREME

Because at all times really fine materials are used; and because each and every machine receives a degree of individual attention that is impossible in mass production.

The LINDE CANADIAN REFRIGERATION CO., Limited

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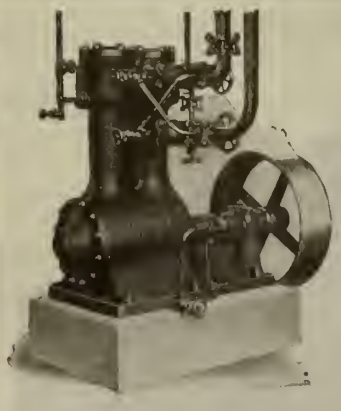
TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

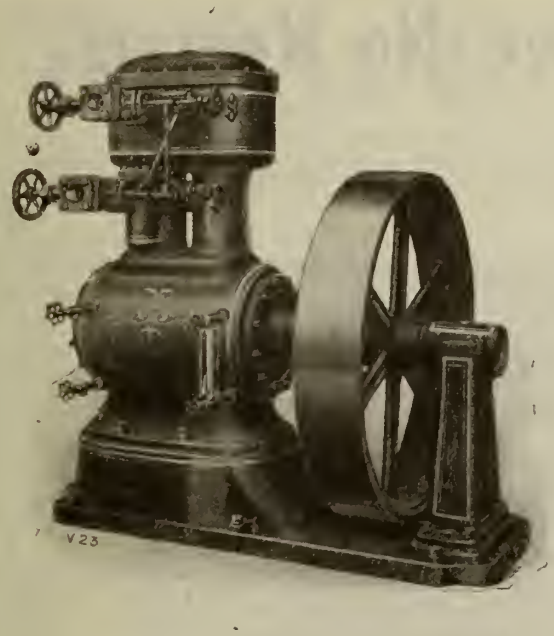
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



Get Your Plant Ready For Big Business

1919 is going to prove the fact that people of all classes have been taught to conserve food.

Ice-making plants will be taxed to capacity to supply the demands for household purposes.

Refrigerating Plants and Cold Storage Houses will also prove excellent investments.

All orders for Ice-making and Refrigerating Equipment will receive prompt attention. Ammonia Fittings and Supplies shipped on short notice.

Write for Catalogs.

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of "Ice and Frost."

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

After Five Years' Service at Zero

"It is with pleasure that we speak most favorably regarding the way Nonpareil Corkboard has stood up in our ice cream room," wrote Mr. N. B. Kuhlman, President, Mono Service Cream Company, Knoxville, Tenn., on October 28, 1918. "The corkboard was put into the hardening room something like five years ago. We have never had any cause for complaint, and our hardening room stands at a temperature of zero to ten below. If we ever enlarge or build additional hardening rooms, we will certainly insulate same with your Nonpareil Corkboard."

That seems to be the general opinion among ice cream men regarding

Nonpareil Corkboard Insulation

For Hardening and Cold Storage Rooms

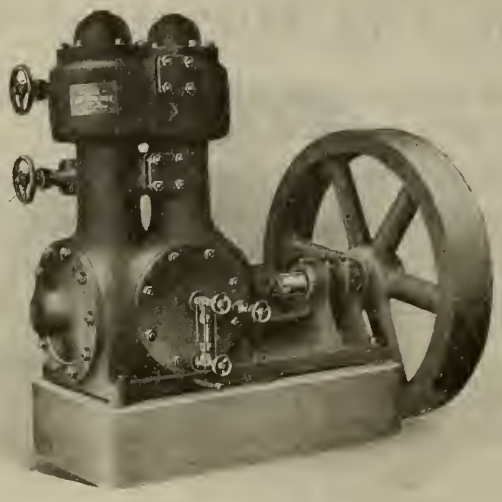
Of course, there is a good reason for it. Nonpareil Cork combines all the essentials of a satisfactory cold storage insulation. It is a fine non-conductor of heat; it does not take up moisture; it keeps free from mold or rot; it is easy to install in all kinds of buildings; and lasts almost indefinitely when properly erected. That's why the Mono Service Cream Company and many others all over the country specify Nonpareil Corkboard when they build new plants or make repairs and additions.

You, too, will swear by Nonpareil Cork if you once try it. Now is a good time to investigate. Literature and samples will be sent on request.

Armstrong Cork & Insulation Company, Ltd., 504 McGill Building MONTREAL, QUE., CANADA

Also manufacturers of Nonpareil Cork Covering for cold pipes

Quality Products Leave No Regrets



York Ice-making and Refrigerating Machinery is not made to fit the price. We have a standard of quality and service which has been maintained ever since the York Organization was started.

It is betraying no secret to say that many owners of ice-making and refrigerating plants have expressed to us, by word and letter, their keen regret at having turned down a York contract because the price seemed too high.

Price is a poor gage to use in buying such important equipment as Ice-Making and Refrigerating Machinery. Confidence is a better one. You know from your own experience that business born of confidence begets new business.

No customer can truthfully say that the York Organization ever tried to take advantage of him. It is on this basis that we have been selling our products, and it is for this reason that we have been successful.

An inquiry from you will be appreciated. You are not obligated to buy York equipment until you are satisfied as to its quality and our good intentions.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 626 Coristine Bldg. | CALGARY 605 Second St

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. HAGERSTOWN, M.D., U.S.A.

Belliss & Morcom, Ltd.

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LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

Hays CO_2 and Draft Recorder

Tells the Story of Boiler Efficiency

The exact reason why 30 to 50 per cent. more fuel is consumed in your plant than should be, is shown by the Hays CO_2 and Draft Recorder. With these appliances installed, your firemen can fire intelligently; they will work with accurate facts before them—instead of groping in the dark. For Hays CO_2 and Draft Recorder permanently record the story of efficient combustion

and Point Out Errors in *Firing, Draft, Boiler Settings, Etc.*

YOU

need this Hays CO_2 and Draft Recorder to fire your Boilers intelligently

Hundreds of plants are using these Hays Appliances and saving 30 to 50 per cent. of their fuel expense as a result.

The Hays Recorder is automatic, self adjusting, infallible. It does not depend on hand adjustment and mechanical action for accurate operation. Indications are controlled by rising and falling columns of mercury, water and caustic potash.

We invite you to investigate, believing the facts will convince you that these Hays Appliances would quickly earn their cost in your plant.

Write for booklet "FUEL"

The Jos. W. Hays Corporation

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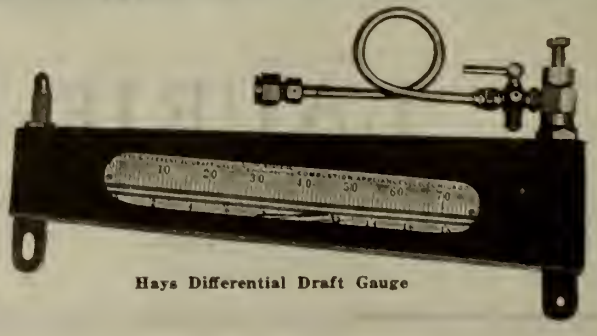

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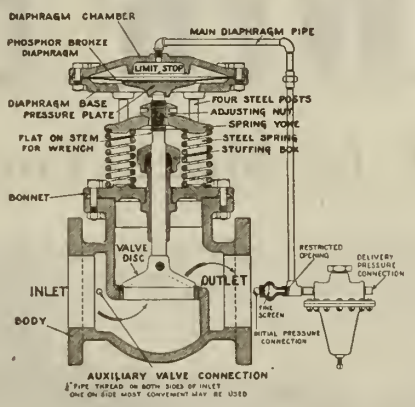

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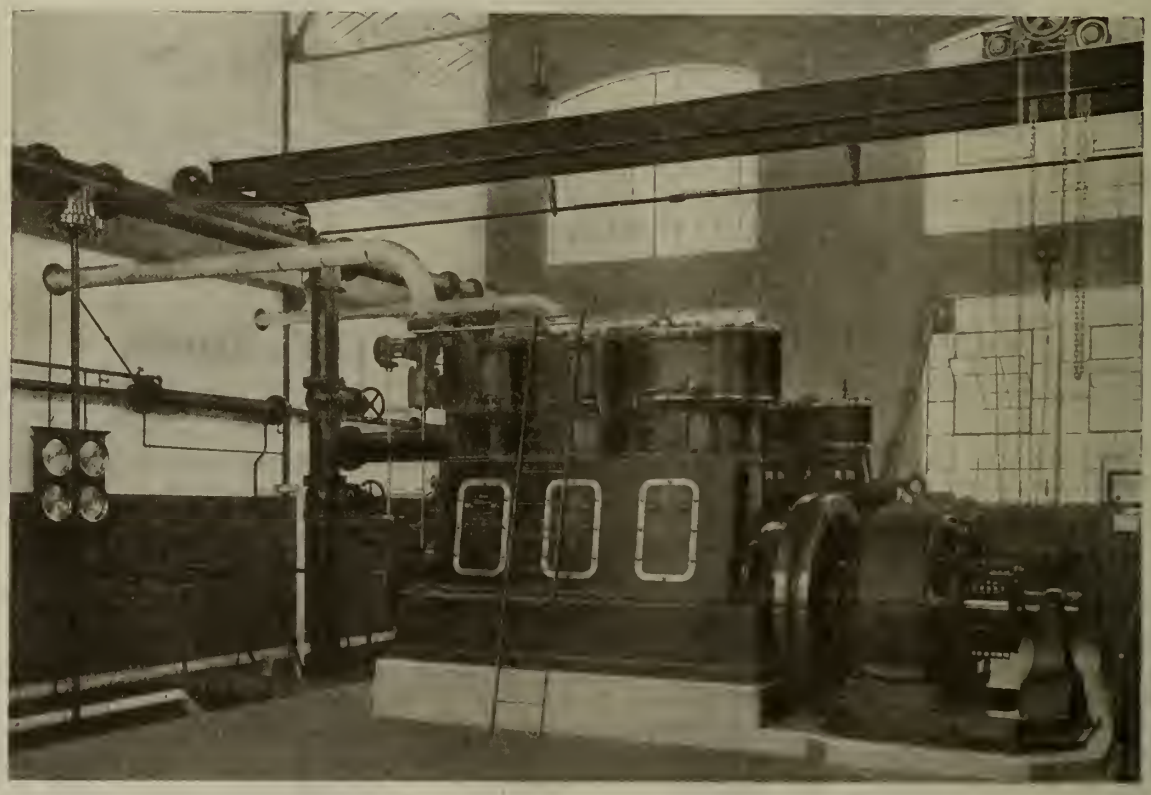

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POWER HOUSE

Established 1907

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The Coquitlam Buntzen Hydro-Electric Plant

One of the Most Interesting Hydro-Electric Developments in British Columbia Supplies Power to Vancouver and Adjoining Municipalities

By F. C. PERKINS

THE water powers of British Columbia are all of great importance, but the Coquitlam Buntzen Hydro-Electric development is of special interest, as shown in the accompanying illustrations and drawings, which give the details of construction, which are worthy of careful study. Coquitlam Lake and Lake Buntzen may be noted in the photographs, as well as the Coquitlam dam, pipe lines and the electrical equipment.

The power house No. 1, as well as power house No. 2, at Lake Buntzen are thoroughly up-to-date, and the transformer electrical equipment and high tension switch rooms of the No. 2 station of the Coquitlam Buntzen Hydro-Electric British Columbia development are modern in every respect.

One of the British Columbia Hydro-Electric plants, which supplies power to the City of Vancouver and the adjoining municipalities, was first placed in operation in 1905. This plant was originally designed for 12,000 horse power, and was at that time considered of sufficient magnitude to meet the needs of the district for many, many years. Owing to the enormous expansion of Vancouver and the surrounding territory, the Lake Buntzen plant has grown to 85,000 horse power, while the City of Victoria is now supplied from Jordan River, forty miles east of the city, and together with the Goldstream plant has power available up to 38,000 horse power installed to meet the industrial needs of the community.

It is estimated that within reasonable distance of the cities of Vancouver and Victoria, without going beyond the present-day limits of long distance electrical transmission, 750,000 horse power can be economically developed, a possibility that will place these cities among the most favored for the expansion of many existing and future industries. Among other notable powers of the provinces is that of the Powell River, where 24,000 h.p. is utilized in the manufacture of pulp and newspaper. At Ocean Falls, 11,000 h.p. is utilized for the same purpose.

POWER HOUSE, SHOWING ATTRACTIVE EXTERIOR

The writer is indebted to J. T. Johnston, of the Dominion Water Power Branch, for the accompanying photographs, and to R. G. Conway for the engineering data of the water powers of the Province of British Columbia. The Coquitlam Buntzen Hydro-Electric power scheme for the supply of electrical energy to the City of Vancouver, and the municipalities of the lower mainland of British Columbia is owned and operated by the Vancouver Power Company. This company was incorporated under the provisions of the "Water Clauses Consolidation Act" of the Statutes of British Columbia, and is a subsidiary company of the British Columbia Electric Railway Company, Ltd., which controls the electric railway, light and power systems in the cities of Vancouver, New Westminster, Victoria, and the surrounding districts.

The original Coquitlam Buntzen scheme comprised the raising of the surface of Coquitlam Lake by means of a small rock-filled crib dam with crest 443 feet above sea level, and delivering the water so stored through a tunnel 2¼ miles long to Lake Buntzen, a small lake due west of Coquitlam Lake, and thence through steel pipes to a power house on the shore of Burrard Inlet, an arm of the sea. By the construction of a concrete dam at the north end of Lake Buntzen, an ideal forebay reservoir was obtained. When the original tunnel was designed, it was thought that ample provision had been made for any increased demand for water, which might occur on account of extensions to plant No. 1, Lake Buntzen, but the rapid development and growth of the district around Vancouver soon made it evident that the demand for power would, in a very short time, exceed the maximum capacity of the tunnel. After careful investigation it was decided that the existing development could be considerably enlarged so

COQUITLAM LAKE

as to utilize almost the entire run-off of the Coquitlam watershed. The enlargement of the Coquitlam Buntzen tunnel and the construction of a dam to increase the storage capacity of Coquitlam Lake was therefore decided upon; extensions were also carried out at the power house. By the time the enlargement of the tunnel had been completed, the rate of growth of the company's load was such that the construction of an entirely new plant at Lake Buntzen was decided upon.

It is of interest to note that Coquitlam Lake is the main storage reservoir of the scheme in the Province of British Columbia. The lake is about seven miles in length, with an average width of about one third of a mile. Its average summer level, prior to the building of the small crib dam at its outlet, was about 432 feet above sea level, and its ordinary area about 3,190 acres. The area of the watershed is approximately 105 square miles, and the mountains rise precipitously on either side to a height varying from 3,000 to 6,000 feet. The precipitation over the watershed for the last eleven years has averaged 153 inches. The winter snows over the watershed are heavy and remain on the higher peaks until late in the summer.

The original dam at Coquitlam Lake was built across the Coquitlam River a little below the outlet of the lake. It is a rock-filled crib structure of the overflow type, 170 feet in length, with the crest 443 feet above sea level and about 11 feet above the original level of the lake. It is 113 feet in length along the crest, and 9 feet of free board is provided. The new Coquitlam dam is of special interest. The precipitation and run-off records of Coquitlam Lake showed that in order to utilize the entire run-off from the watershed, a dam to raise the level of the lake another 60 feet was required. The site of the new dam at Coquitlam Lake is a little below the old crib dam, now buried in the upper toe of the new one. A dam of the hydraulic fill type with heavy rock toes was decided upon owing to the impracticability of obtaining a satisfactory foundation for a necessary dam, as bedrock was only revealed on the eastern portion of the site. The new dam is built upon a natural barrier formed at the outlet of the lake by a receding glacier, and is formed of fine blue and gray glacial boulder clays together with inter-stratified layers of cemented gravel and boulders.

The new dam was built with its crest at El. 518 and with spillway at El. 503. The maximum height of the dam above the lowest point of foundation on the centre line is 100 ft., the extreme width at the base is 655 feet, and the length along the crest, including the spillway, is 1,200 feet. The slope of the upstream face is 1 in 5, and of the downstream face, 1 in 2 to 1 in 4. The width of the spillway is 250 feet, with 15 feet of free board, which provides spillway capacity considerably in excess of any recorded flood. The construction of the new dam provides storage amounting to 180,500 acre feet available for power purposes. The total quantity of material in the dam amounts to 544,710 cubic yards. Of this quantity, 116,360 cubic yards consists of rock placed in the toes by hand and by cableways; the remainder of the material in the dam is sluiced material.

During the construction of the dam the outflow from the lake was carried around the dam site in a tunnel driven under the spillway. This tunnel has an area of 412 square feet and is 490 feet in length; it was designed to carry 12,000 cubic feet per second. For controlling the flow of water through this tunnel, permanent gates are placed in a concrete tower at its upper end. As the City of New Westminster has drawn its water supply from Coquitlam Lake for two decades, and as the raising of the lake level rendered the original intake works useless, an entirely new intake for the New Westminster water works had to be provided. The new intake structure is a substantial concrete tower founded on bedrock on the east side of the lake, about 1,000 feet north of the dam. The tower is circular in plan, with an inside diameter of 18 feet. In the walls of the tower four intake openings are provided, which are protected by screens and controlled by means of gates placed within the tower. A secondary intake is placed within the tower, so designed that water may be drawn off at any desired elevation. From the intake tower the water enters a tunnel about 2,000 feet in length, which passes under the spillway and also under the sluice tunnel. The lower end of the tunnel is connected by means of a pipe line, with a distributing chamber, from which the water supply mains for New Westminster emerge. For the protection of the New Westminster water supply, extensive clearing operations were carried out along the shores of the lake.

Regarding the Coquitlam-Buntzen tunnel, it is said that the total length of the tunnel, which conveys water from Coquitlam Lake to Lake Buntzen, is 12,650 feet. This work was begun in 1902 and completed in 1903. A square section about 9 feet by 9 feet, with rounded corners, was adopted, and it was designed to carry 500 cubic feet per second. The enlargement of this tunnel formed part of the program in connection with the extension of the Lake Buntzen plant. The section of the tunnel was increased to 192 square feet, which is sufficient for the ultimate development of the Coquitlam Buntzen scheme. The intake of the Coquitlam Buntzen tunnel was rebuilt when the new dam was constructed; it consists of a heavy masonry retaining wall founded on bedrock and built against the steep hill above the tunnel entrance. This entrance is protected by a trash rack 41 feet wide and 35 feet high, supported by heavy steel cables and counterbalanced so that it can readily be raised and cleaned. Two independent sets of head gates are provided for controlling the flow of water through the tunnel. One of these gates is of the Coffin type, 9 feet in diameter; the second set consists of two Stoney sluice gates, placed side by side. The operating gear for both ends of gates is placed in chambers cut in the face of the mountain well above high water level; the gates are arranged for operation either by gasoline engine or by hand.

In reference to the Lake Buntzen storage reservoir it may be stated that Lake Buntzen lies immediately to the west of Coquitlam Lake, from which it is separated by a range of mountains which reach an elevation of 4,000 feet. The precipitation at Lake Buntzen during the last eleven years is shown in the accompanying table. The average rainfall during this period was 112.53 inches.

The area of Lake Buntzen is about 500 acres and the drainage area about 7 square miles. By the construction of a concrete dam 54 feet in height and 361 feet long on the crest, an excellent forebay was provided. The elevation of the crest of Lake Buntzen dam is 400 feet above sea level. Ten outlets, 54 inches in diameter, with the necessary trash racks and hand-operated head gates, were provided for the connection of pipe

lines which convey water to power house No. 1, and two openings 24 inches in diameter were provided for the exciter pipe lines. It may be of interest to consider the hydro-electric equipment of the original power house known as Lake Buntzen power house No. 1, which is situated on the east shore of Burrard Inlet, about 16 miles from the City of Vancouver. The power house is built of hewn granite, the main floor being 5 feet above high water. The original installation had been added to from time to time, and the present equipment includes 4-1500 k.w. Westinghouse generators driven by Pelton water wheels, and a 5,000 k.w. Canadian General Electric driven by Pelton water wheels, and a 5,000 k.w. Kerr generator driven by Doble water wheels, and a 5,000 k.w. Canadian General Electric generator driven by Doble water wheels.

All of the above units are of the horizontal type, the water wheels and generator being in all cases mounted on the same shaft. In addition to the above equipment, four exciter units are provided. All of the generators are of the three phase, 60 cycle type, generating current at 2,200 volts. For regulation purposes, Tirrill regulators are provided. The generating equipment is installed on the main floor of the power house, 5 feet above high water level. The operating bench board and switch board are placed on the gallery along the back wall of the generating room. Behind the switch board the generator switches are situated, and on the floor above these are placed the low tension transformer switches.

The transformers and high tension switching equipment are housed in a separate building behind the power house The transformer equipment consists of three banks of three k.v.a. single phase, oil insulated, water cooled transformers, which step up the voltage from 2,200 to 36,000. This voltage will be increased to 60,000 at an early date. Electrolytic lightning arresters are placed in concrete shelters on the roof of the building. The high tension switches are of the K. 15 type and placed in a separate room behind the transformer compartments. All of the equipment in the transformer house was supplied by the Canadian General Electric Co.

In this No. 1 station, each of the 1,500 k.w. units is supplied with water from Lake Buntzen by means of a pipe line 48 inches in diameter and 2,000 feet in length. Two pipe lines 60 inches in diameter are provided for the fifth unit. One pipe line, 84 inches in diameter at the upper end and tapering to 72 inches in diameter at the power house, is provided for the sixth unit, and a similar pipe line provides water for No. 7 unit. In the original installation the first 800 feet of the pipe lines below Lake Buntzen dam were of woodstave construction. The woodstave portions of these pipe lines have now been replaced with pipes of riveted steel.

Regarding the plant No. 2 at Lake Buntzen, it may be mentioned that 4 years ago the installation of additional machines at Lake Buntzen was decided upon, and as it was impracticable to build further extensions to power house No. 1, a new power house site was found about one-third of a mile to the south of the original power house. The work undertaken in connection with plant No. 2 comprises the construction of a reinforced concrete power house containing water wheels of a total capacity of 40,000 h.p. generators and transformers, together with the necessary high and low tension switching equipment. Water for driving the units is obtained from Lake Buntzen through a concrete lined pressure tunnel 14 feet 8 inches internal diameter and about 1,800 feet long, driven through solid rock and controlled by three Doble needle intake valves placed with their seats on a concrete foundation on the bottom of Lake Buntzen. An outer cylinder is provided, which may be lowered down to a horizontal seat, thus excluding water from the needle valves, so that they may be inspected without the use of a diver. These needle valves are operated by means of oil pressure.

Engineer Conway points out that near the lower end of the pressure tunnel and close to the top of the hill, a steel surge tank 30 feet in diameter was provided, and from this point the water is conducted to power house No. 2 through three steel pipe lines. Close to the surge tank a Pelton water Doble Venturi butterfly valve is installed in each pipe line. The pipe lines are 8 feet 6 inches in diameter and ½ inch thick at their upper ends, tapering to a diameter of 7 feet at the power house, where the thickness is 1⅛ inches. About 200 feet from the power house, the pipe lines pass into tunnels driven through rock. The pipe line grades are very steep, the slopes ranging from 28 to 53 degrees, thus rendering difficult the hauling of the large pipe sections.

It will be seen from the illustrations that power house No. 2 is built on solid rock and is of reinforced concrete construction. The design of the building was carefully studied from an architectural point of view and its massive proportions harmonize with the precipitous mountains, which form the background. On the main floor of the building, which is 5 feet above high water level, three units of a total capacity of 40,500 h.p. are installed. Each units consists of one Dick Kerr 8900 k.v.a. three phase, 60 cycle generator of revolting field type, generating current at 2,200 volts, direct driven at a speed of 200 revolutions per minute by four Pelton Doble water wheels, the combined capacity of which is 13,500 h.p. The generator and four water wheels are all pressed on to a hollow nickel steel shaft 51 feet 3 inches long, forged in one piece. A separate pipe line is provided between the surge tank and the power house for supplying water to each unit. Close to the back wall of the power house this pipe line divides into four branches, each branch supplying water to one wheel of the unit; on each branch a Doble hydraulically-operated gate valve is provided, which controls the admission of water to the two nozzles which direct the water onto the buckets of each wheel.

In this station the speed regulation of each unit is controlled by a Lombard governor, which opens and closes the main nozzles according to the load on the unit, through links attached to a rocker shaft. Each unit is also provided with two Pelton Doble auxiliary relief water economizing nozzles. Should the load on the unit fall off suddenly, these two relief nozzles are opened by the action of the governor as the main nozzles are closed, thereby avoiding the sudden change of velocity in the pipe

COQUITLAM DAM

line. The relief nozzles are closed slowly by means of springs, and water hammer in the pipe lines is thus reduced to any desired extent and wastage of water is minimized. For excitation purposes, three 300 k.w. exciter units are provided, one of which is placed at the rear of each main unit. Each exciter is composed of a Dick Kerr induction motor generator set direct driven by one Pelton Doble water wheel mounted on one end of the shaft.

The busbars are placed in cells in the busbar room at the level of the main floor and the voltage is controlled by Tirrill regulators. The low tension generator and transformer switches, which are of the Canadian General Electric type, are placed in the low tension switchroom situated above the busbar compartments. The transformer room is situated immediately above the low tension switchroom, and the equipment consists of four banks of three 3,000 k.v.a. single phase, oil insulated, water cooled transformers by means of which the voltage is raised from 2,200 to 34,600, to be increased at an early date to 60,000 volts. The high tension switchroom, which also contains the lightning arrester equipment, is situated above the generator room. All of the low tension and high tension switches are electrically controlled from the operating bench board, which is situated on the operating gallery in the generator room.

TRANSFORMER ROOM, LAKE BUNTZEN POWER HOUSE NO. 2

LAKE BUNTZEN NO. 2 PLANT, PIPE LINES 1, 2 AND 3

SCALE

Boiler scale is very common, and more or less of it is quite sure to be formed unless the water is unusually soft and pure. It varies greatly in composition, but its chief constituents are usually sulphate of lime, carbonate of lime, and carbonate of magnesia. Chloride of magnesia and sulphate of magnesia also occur more or less frequently, and these are particularly objectionable because they are corrosive and tend to attack the metal of the boiler. The physical constitution of the scale varies greatly, and two samples of similar chemical composition will sometimes differ a great deal in hardness and porosity. Sulphate of lime usually makes a hard, stony scale when it is present alone, or when it is the chief constituent. Carbonate of lime, under ordinary conditions, forms a soft scale in horizontal tubular boilers, though it often takes a hard form in heaters and in water-tube boilers. It is rare to find a scale composed of any one substance alone, however. Various substances are usually present in it, mixed in varying proportions, and combined also with sand, clay, iron-rust, and other sedimentary deposits. Boiler scale tends to deposit wherever the circulation in the boiler is sluggish, and where the heat is greatest and the evaporation most rapid. Scale that is formed in the upper parts of the boiler also becomes dislodged from time to time, falling down upon the lower parts, where, if not removed at proper intervals, it is likely to become cemented together in a compact mass, which not only diminishes the efficiency of the boiler, but also causes it, in many cases, to become badly damaged by overheating.

WHY CONCRETE CHIMNEY STACKS FAIL

By M. E.

From the day concrete made its advent in building construction its merits were fully recognized. It must be admitted that for a large number of structures there is actually no better material than concrete. It became evident very soon, however, that it is entirely unsuitable material for any purposes where it is subject to the attack of heat, products of combustion, or undiluted acids. One of the best known structures in which such conditions prevail is the chimney.

For the moment we do not want to discuss those where the structure collapsed during construction or soon after. We refer for the present only to those which decayed very soon after being put in operation. The thin walls of the stack permitted a very rapid radiation of the heat. Condensation took place on the inner side of the stack, and the condensate worked its way into the fissures, rapidly destroying the texture of the material and attacking the reinforcing steel. The stacks started to lean, to burst open, or collapsed entirely. Recently this inherent defect has been in part overcome by using a lining of burned clay extending the full height of the stack of the chimney. In the United States of America there is little difference in the cost of a well constructed concrete stack, with a lining extending the full height, against the cost of a radial brick chimney.

Power Plant Management; Coal and Ash Handling

Various Types of Conveyors Described—Power Required For Various Types of Conveyors and Conditions Under Which They Are Operated—Pivoted Bucket Conveyors—Various Installations Described

By ROBERT JUNE

Part II.

THE power plant owner, who is considering the installation of mechanical coal and ash handling systems, is confronted by a number of fundamental problems which must all be solved correctly if he is to make a satisfactory decision. If the solutions require time and study, he will do well to refuse to be hurried in his investigations. Of all the white elephants which at times invade industrial plants, the improperly chosen conveying system is one of the largest, whitest and most voracious in appetite when it comes to eating up profits.

Prominent among the questions to be answered are the following:—

(a) What type, or types, of equipment are best adapted for the conditions in the industrial plant under consideration?

(b) Shall the coal and ash handling systems be divorced?

(c) Granted that questions (a) and (b) are correctly answered, will the equipment chosen meet the requirements of the O.M.I.-less-than-H. formula; that is, will operating costs O, which include power, labor to operate, oil, etc., plus the maintenance costs, M, which include repairs of any nature, labor required to make repairs, depreciation, etc., plus interest, I, on total money invested, which must include not only equipment and parts purchased from manufacturer, but cost of labor to install, cost of foundations, bunkers, and other changes, be less than the cost of doing the same work by hand, H.

In order to arrive at some understanding of the factors entering into the first of these three problems, we began last month a brief survey of the different types of coal and ash handling equipment. Continuing our description, we come to:

Apron Conveyors:—The apron conveyor was developed with the idea of obtaining a self-supporting continuous belt for handling heavy material. It consists of a double strand of roller chains on which are mounted steel plates, the width of which corresponds to the pitch of the chain. These plates are beaded or curved over each other to form a closed joint. The sides are also made overlapping, so as to produce a closed trough.

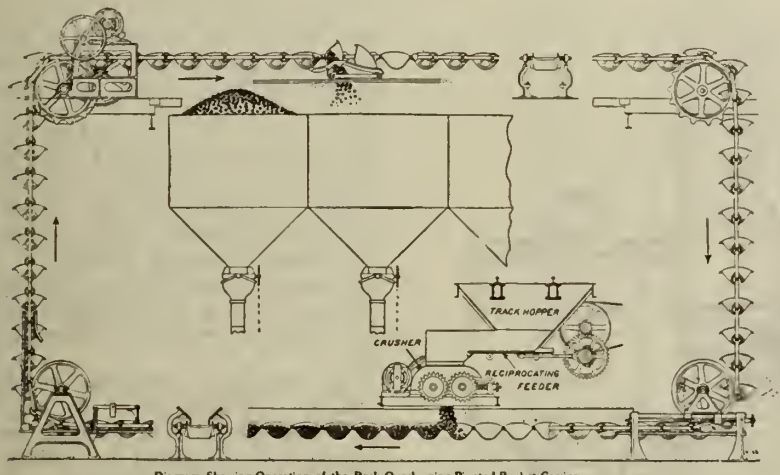

Diagram Showing Operation of the Peck Overlapping Pivoted Bucket Carrier

FIG. 1—PECK CARRIER AS MANUFACTURED BY THE LINK-BELT CO.

Apron conveyors are commonly used for conveying coal from track hoppers to the main conveyor and elevator. Only end discharge, of course, is possible, and thirty degrees inclination is the practical limit in elevation. Owing to its construction, this type of conveyor is comparatively expensive to install. However, since the load is carried and not dragged, less power is required than with the scraper type, and the maintenance is lower.

In estimating power requirements, the formula previously given for flight conveyors may be used with a reduction of 10 per cent. in the final figures.

Pan Conveyors.—In the pan conveyor, the flights are omitted and the trough itself is made in sections and mounted on the chains. By this change the material is carried, with consequent reduction in wear.

This type of conveyor is used where pans, deeper than those of an apron conveyor, are required, as on inclines too flat for elevators and too steep for efficient operation of flight, or apron conveyors. The usual speed is 30 to 50 feet per minute. When supported by self-oiling roller wheels, the power consumption is but little above theoretical load requirements. For purposes of estimate, the power may also be assumed as 10 per cent. less than that of the formula previously given.

In passing, it should be noted that on account of the abrasive character of the materials, the employment of pan and apron conveyors for ashes is apt to

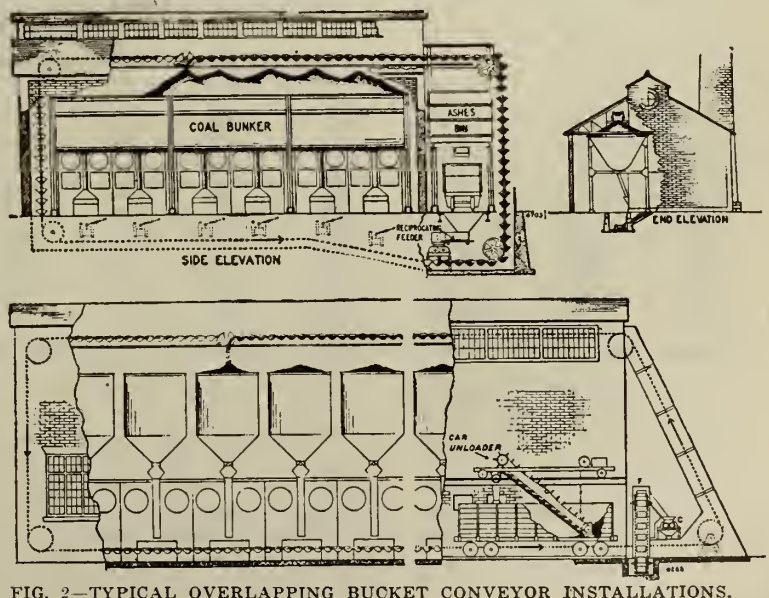

FIG. 2—TYPICAL OVERLAPPING BUCKET CONVEYOR INSTALLATIONS.

result in excessively high maintenance costs.

V--Bucket Conveyors.—In this type the buckets are rigidly fastened to the conveyor chain, with the result that on the vertical runs, the material is lifted, whereas on horizontal runs, it is dragged through the trough ahead of the bucket.

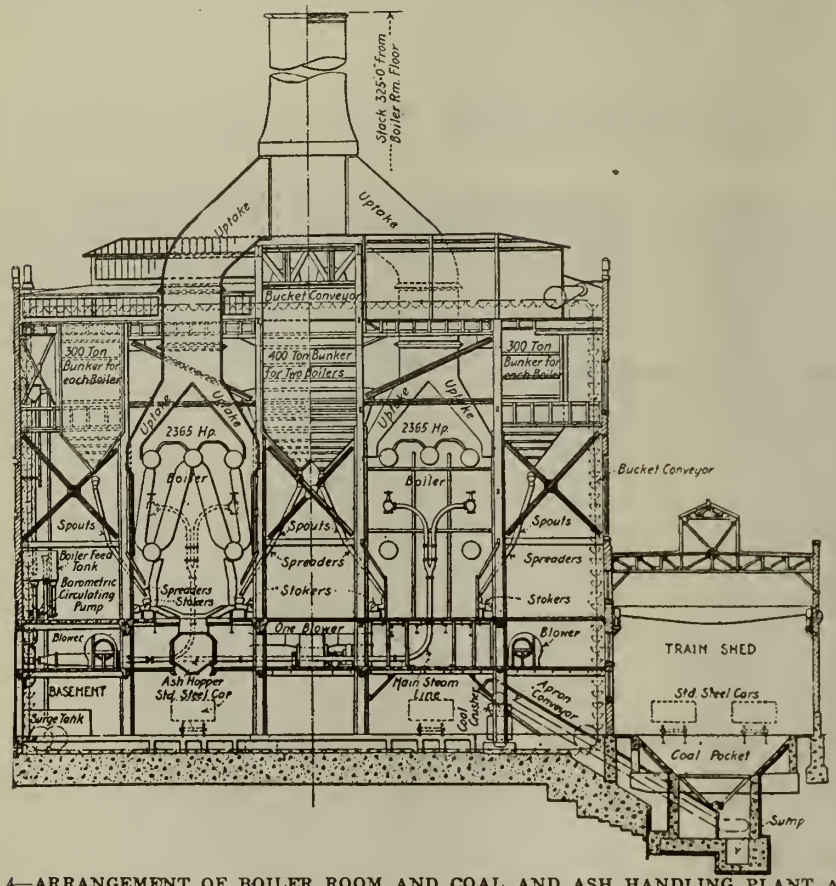

FIG. 4—ARRANGEMENT OF BOILER ROOM AND COAL AND ASH HANDLING PLANT AT THE CONNERS CREEK PLANT, DETROIT EDISON CO.

V-buckets are one of the less expensive forms of chain conveyors, and should be given consideration in the smaller power plants. While not as popular to-day as in the past, there are a goodly number of fairly representative medium-sized plants that employ them to good advantage.

Power requirements may be approximated from the following equation, supplied by courtesy of Professor Gerhart:

$$HP = \frac{AWL,S}{1000} + \frac{BLT}{1000} + \frac{TH}{1000} + \frac{1}{2} X'$$

in which

A,B—constants as in Table II.

W—weight of conveyor per ft. of run, lbs.

S—speed of conveyor, ft. per min.

T—capacity of conveyor, tons per hr. (note: figure 50 lbs. coal per cu. ft. and 40 lbs. of ashes).

L'—horizontal length of conveyor, ft.

L,—total horizontal length traversed by the loaded bucket, ft.

H—total vertical traverse, ft.

x'—number of 90 degrees turns in the conveyor.

TABLE II
Value of Constants in Chain Conveyor Power Formulas

Angle of conveyor with horizontal deg.	A			B				B		
				Scraper, Apron and Open Top				V-BUCKETS AND PIVOTED BUCKETS		
	Sliding blk.	3½" roller, 3¼" pin.	6" Roller, 1⅞" pin.	6" roller, 1½" pin.	Anthracite coal.	Bituminous coal.	Ashes.	3½" Roller, ¾" Pin.	6" Roller, 1⅜" Pin.	6" Roller, 1½" Pin.
0	0.030	0.0043	0.0046	0.0050	0.33	0.60	0.54	0.070	.070	0.083
6	0.030	0.0043	0.0046	0.0050	0.43	0.69	0 63	0.18	0.18	0.19
12	0.030	0.0043	0.0045	0.0049	0.54	0.79	0.73	0.28	0.28	0.29
18	0.029	0.0041	0.0044	0.0048	0.63	0.88	0.82	0.38	0.38	0.39
24	0.028	0.0039	0.0042	0.0046	0.72	0.95	0.90	0.48	0.48	0.49
30	0.026	0.0037	0.0040	0.0043	0.79	1.02	0.97	0.57	0.57	0.58
36	0.025	0.0035	0.0037	0.0040	0.80	1.08	1.03	0.66	0.66	0.66
42	0.023	0.0032	0.0034	0.0037	0.92	1.12	1.07	0.73	0.73	0.74
48	0.020	0.0029	0.0031	0.0033	0.97	1.15	1.11	0.80	0.80	0.81

Pivoted Bucket Conveyors.—This is the most popular form of chain conveyor for both medium and large sized power plants. The pivoted bucket carrier is composed of a continuous series of malleable iron buckets 18-inch pitch. There are several different forms of this carrier on the market. The differences in these carriers are principally in the method used to empty the buckets at the discharge point, the method used to close the gaps between adjacent buckets to prevent spillage, and the method of driving the conveyor. In one form of carrier, the buckets are made with an overlapping lip, in a second a roller is introduced between adjacent buckets, etc. The roller chain is carried and guided by a track composed of standard tee-rail. This rail is mounted on special cast-iron rail chairs, both horizontal and vertical runs. The buckets can be dumped at any desired point by means of an adjustable dump mechanism, which may be set wherever desired.

As the buckets are pivoted and always remain in the horizontal position, except when being dumped, this conveyor can be used for handling material both horizontally and vertically. The pivoted bucket carrier is generally installed in power plants, so arranged as to handle both coal and ashes in the same carrier. It is installed in the form of a loop, running through the basement, up one end of the boiler house, over the top of the overhead coal storage bunkers and down the other end to the basement. Coal is discharged from the receiving track through a track hopper, feeder and crusher, into the pivoted carrier in the basement, and carried up to the overhead storage bunkers. Ashes are dropped from the ash pits into the horizontal run in the basement and carried up to an overhead bunker for storage.

Pivoted bucket conveyors possess the following advantages:—

1. The material is carried and the buckets are supported by rollers. Destructive friction and injury to the material itself is, therefore, eliminated, and the power required for operation reduced to the minimum.

2. The ability of the one machine to elevate and convey avoids transfers, which are always troublesome, take up valuable space, and necessitate deep pits. The driving connections are also correspondingly simplified.

3. The material is readily discharged at any desired point.

4. The operation is comparatively silent, and as they are run at slow speed, there is little vibration.

Figure 1 illustrates the Peck Carrier pivoted bucket conveyor, as manufactured by the Link Belt Company. Coal is fed to the crusher by the "reciprocating feeder," which is usually placed directly under the track hopper. The

feeder consists of a heavy steel plate, mounted on rollers and having a reciprocating movement, effected by a crank mechanism from the carrier. The amount of coal delivered depends upon the distance the plate moves, and this can be varied by changing the throw of the eccentrics. The number of strokes corresponds to the number of buckets. Any size coal can be readily handled. When the distance from the track hopper to carrier is so great that the reciprocating feeder is not practicable, a continuous or "belt" feeder is used to supply the crusher with fuel. The equalizing gear" is designed to impart a pulsating motion to the driving sprocket wheel, which will counteract the natural pulsation to which long pitch chains are subject, producing violent increase of the normal strain at frequent intervals. This is accompanied by driving the spur wheel with an eccentric pinion, causing the pitch line to describe a series of undulations, corresponding to the number of sprockets on the chain wheel.

Figure 3 (supplied by courtesy of Prof. Gebhart) shows the method of handling coal and ashes in the power house of the South Side Elevated Railway. Coal is discharged from the railway cars into a track hopper and from there delivered by a "feeding apron" into a crusher, which reduces it to such a size as can be conveniently handled by the stokers. It is then discharged into a short apron or pan conveyor, which carries it to the main system of buckets and it is elevated to the proper level and discharged into the overhead bunkers. The ashes are dumped from the ash pit through a series of chutes into the lower run of buckets, by which they are elevated and discharged into the ash hopper.

In Figure 4 we illustrate the use of a combination of conveying systems at the Connors Creek Plant of the Detroit Edison Company. The coal enters the train shed in drop-bottom cars, usually of the 50-ton size. The cars dump into the hopper under the tracks in the train or coal shed, there being one hopper for each unit of one turbine and two boilers. A motor-driven variable speed flight conveyor with a capacity of 120 tons per hour receives coal from the hopper, carries it up a rather sharp incline and discharges it into a four-roll motor-driven crusher of similar capacity. This crusher breaks from 18-inch cubes, or smaller to 100 per cent. through a 1¾-in. ring.

The crusher discharges into a motor-driven variable speed hopper bucket conveyor, with 30 to 36 inch buckets. This conveyor forms an endless chain which entirely encloses the section of the boiler house. It carries the coal up on the side nearest the coal shed and discharges it into any one of the three coal bunkers which serve the two boilers of one unit.

The hopper, pan conveyors, crusher and bucket conveyors for each unit of one turbine and two boilers, are so located that they can deliver chutes to one adjacent range of bunkers, serving thus as a spare for that range.

An estimate of the power required for any proposed installation of pivoted bucket conveyors can be obtained by reference to the formula given for V-bucket conveyors, subtracting 10 per cent. from the final figures.

The use of pivoted bucket conveyors is generally regarded as the best method of conveying coal in the power plant. Unfortunately, it is probably the most expensive installation, usually requiring, in addition to the investment in the equipment itself, special boiler house construction. As local conditions may make its adoption to plants already in existence impracticable, we will take up next month the consideration of belt conveyors, hoists and mono-rail systems.

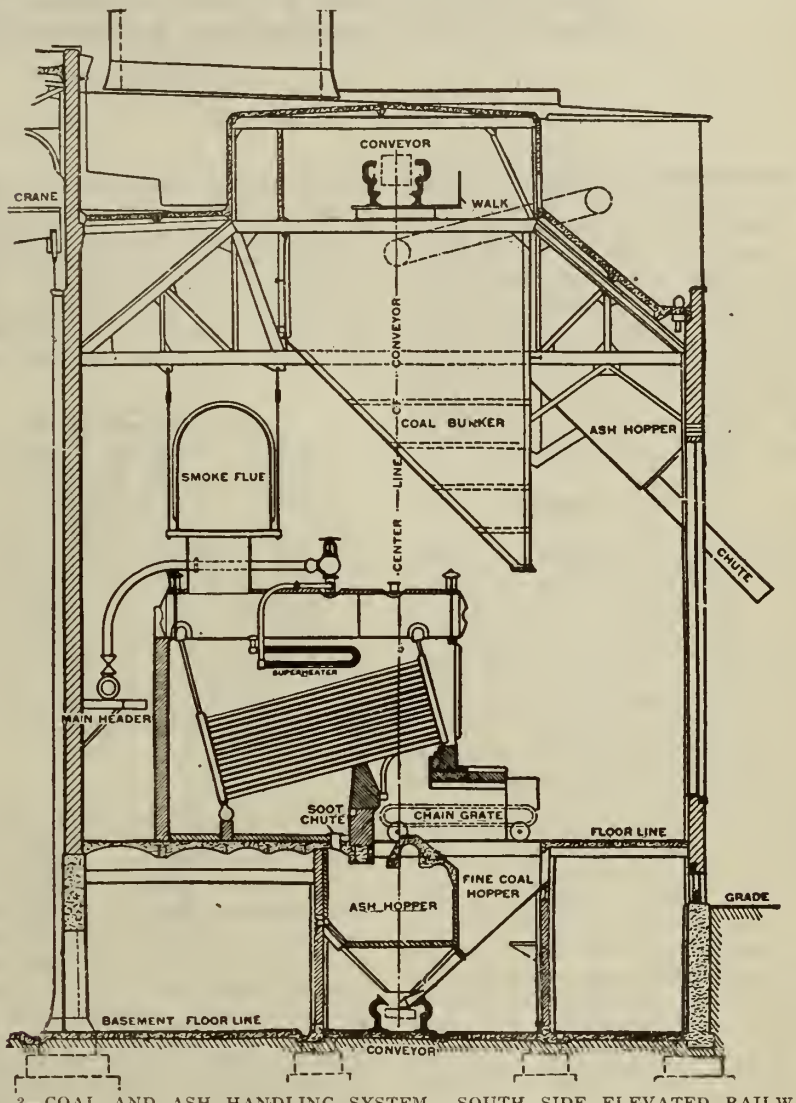

FIG. 3—COAL AND ASH HANDLING SYSTEM, SOUTH SIDE ELEVATED RAILWAY POWER HOUSE, CHICAGO

SELF-LUMINOUS PAINTS IN WAR AND PEACE

Self-luminous paints were largely used during the war for the dials of watches and instruments, for trench signs, for buoys, and many other purposes. Very little was known of the best composition of such paints and the best way of using them until Professor Clinton of University College, London, and Mr. J. H. Dow, of the Illuminating Engineering Society of Great Britain, carried out tests with a special form of electric glow-lamp photometer. They used paints made of radium bromide and zinc sulphide, which at first show a quick rise in the light given off, followed by a slow decay. They found that if more than a certain minute proportion of radium was used, the light fell away so rapidly that no advantage was gained. They also found that the same thing happened if the paint was laid on too thickly. Owing to the high cost of radium, these results enabled big savings to be affected in the expenditure on self-luminous paints during the war. They will be no less valuable in peace, when the use of these paints is developed for the illumination of instrument dials, electric switches, signs and sign posts, buoys, and other things, where it is desirable to provide permanent visibility.

Starting Rheostats for Shunt Motors

The Shunt Motor Requires a Resistance in Series With the Armature to Prevent Excessive Current—The Various Connections Used Are Described and the Size of Resistances Calculated

By TERRELL CROFT

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RESISTANCE is required in series with the armature in starting a shunt motor, to prevent an excessive current from flowing through the armature before it has had time to commence rotation and thereby induce a counter e.m.f. Resistors of practically the same construction and connected in practically the same manner are used with series and compound as with shunt motors. With a resistance in circuit the following formula will be true:—

$$(1)\quad Ia = \frac{E - Eb}{Ra + Rr} \text{ (amperes)}$$

Wherein—Ia = current, in amp., through armature. E = e.m.f. impressed on motor and rheostat, in volts, Fig. 1. Eb = counter e.m.f., in volts, induced in the motor armature. Ra = resistance of armature circuit in ohms. Rr = resistance of starting rheostat in ohms.

At the instant when the motor is started, there is no counter e.m.f., that is Eb is then zero. Therefore, the current through the armature at this instant is:

(2) Ia = E ÷ (Ra + Rr).

Hence, at the instant of starting, enough starting resistance, Rr, must be cut in series with the armature to limit the starting current to a reasonable value—one which will not dangerously heat the machine and cause excessive sparking at the commutator. The maximum (Fig. 2) starting current permissible is usually assumed as that intensity which if exceeded would injure the motor windings, cause excessive sparking and pronounced line voltage drop. In practice the maximum starting current is limited to about 15 times normal full-load current. The minimum starting current permissible is that necessary to develop the required starting torque.

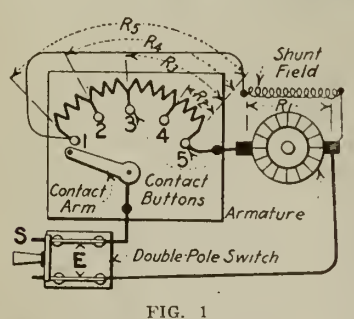


FIG. 1

Frequently the total resistance of the rheostat is made such that with all this resistance (R_6, Figs. 1 and 2) in circuit with the armature 50 per cent. of the normal starting current will flow through the armature. This is, when the contact arm of Fig. 1 is on contact button "1," one-half the normal starting current will flow as shown in Fig. 2. This current is, since it is only one-half normal, insufficient to start the motor, assuming that it must develop full-load torque to start.

When the arm is moved to button "2" the rheostat resistance then in series is such that the normal starting current

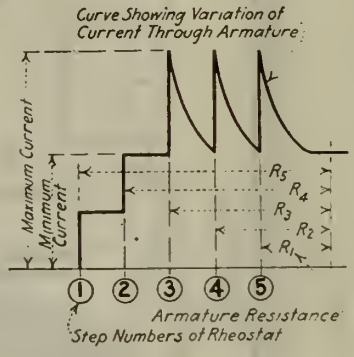


FIG. 2

flows through the armature as shown in Fig. 2. This may not be a great enough current to start the load. But when the arm is moved to button "3" the maximum permissible current will be forced through the armature from the line and the load should start. As the motor increases its speed its counter e.m.f. increase and the current decreases, as shown in the diagram of Fig. 2. The contact arm is then shifted successively over the other contact buttons until its rests on button "5." Now all of the rheostat resistance is cut out, the only resistance in the armature circuit being that (R_1) of the armature itself, because the motor armature is now inducing a sufficiently height counter e.m.f. to itself limit the current through the armature.

A starting rheostat for a shunt or compound motor, or as it is usually called "a starting box," is an apparatus wherein are assembled the devices essential for the starting of the motor and frequently also those for the protection, after the motor is in operation, of it and of the circuits which feed it. The term "starting rheostat" as it is commonly used implies more than merely an adjustable rheostat. Fig. 3 shows diagrammatically a "starting rheostat" of the simlest type. There are numerous variations in practice to satisfy the many possible conditions. See the author's *American Electricians' Handbook* for detailed descriptions. A commercial shunt or compound motor starting rheostat usually comprises:—*First.*—An adjustable resistor or starting rheostat pure and simple, the function of which is to limit the armature current at starting as described above. *Second.*—A no-voltage release, described below. *Third.*—A no-field release, described below. *Fourth.*—An overload release, described below. This device is frequently omitted.

The operation of starting a shunt motor is as follows: The line switch is closed, impressing the line voltage across brush B and metallic swinging arm C (Fig. 3). Then the arm is moved up to contact with button 1. This connects both the armature and the field circuits to the line and current is forced through each. The current through the armature, which is small, being limited by the starting resistance as described above, flows via the route:—L_1, L, C, 1, 8, A, B_2, B, D, L_2. The path of the field current is:—L_1, L, C, 1, M, F, W, D, L_2.

Note then, that when the arm is on the first button, a small current flows through the armature and that the field winding is connected directly across the line (magnet winding M is in practice of very low resistance as compared with the resistance of the shunt-field winding). So the field is strong—a maximum—and the armature current weak. Now the arm is moved successively over buttons 2, 3, 4, etc., with a pause at each button. The current through, and the torque of, the armature will be thereby gradually increased as described above.

It will be noted that the armature resistance is inserted in the field as the arm advances, but the field is weakened only slightly because the rheostat resistance is very low compared to that of the field. This weakening of the field tends to assist in speeding up the armature. From 15 to 30 seconds should ordinarily be consumed in starting a motor.

Finally, the arm is moved to contact with button 8 where it is held by the attraction of magnet M on iron keeper K, which is attached to the arm. The field current energizes M, the functions of which are treated in detail below. With the arm on 8, the armature is connected directly across the line and the field winding is across the line in series with M and the starting resistance. The combined resistance of the *starting resistance* and M in series is small as compared with the resistance of the motor field winding. Hence, the shunt-field strength is affected little thereby.

To stop the motor, pull the line switch. Magnet M will then be demagnetized and spring S will force the arm back to its original position shown in the illustration.

A no-voltage release device is provided on motor starting rheostats to protect the

motor and the circuits feeding it against an excessive rush of current in case the line e.m.f. is discontinued and is then again impressed on the motor without the starting-rheostat handle having meanwhile been returned to the starting position.

Explanation.—Assume that the starting rheostat of Fig. 3 is not equipped with

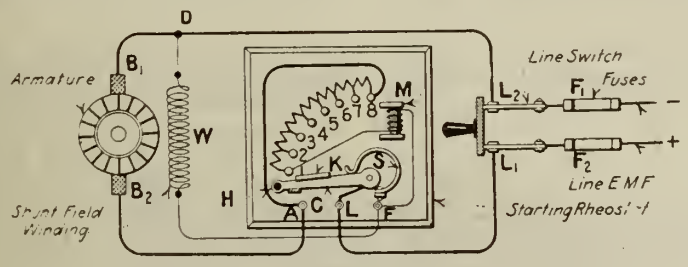


FIG. 3

the no-voltage release magnet M or the spring S. Then, if the lever arm C were moved into contact with button 8, the arm would remain in that position, even if the line e.m.f. were discontinued from any cause. Assume that the arm is in contact with 8, that the line e.m.f. is discontinued and the motor armature slows down or ceases to rotate in consequence. Now if the e.m.f. is again impressed on the line, C still on 8, there would be very large current forced through the armature, because it would be turning slowly or at rest and, therefore inducing little or no counter e.m.f. This excessive current would cause sparking at the commutator and might damage it or "burn out" the motor windings or the wiring.

But with the no-voltage release magnet M arranged as in Fig. 3, when the line e.m.f. is discontinued and the armature ceases rotating, M is demagnetized and C is forced back into the "off" position by spring S. Then the circuit through the motor is open and the resumption of line e.m.f. can do no harm.

A no-field release device is provided on motor starting rheostats to prevent the armature remaining connected to the line in case the motor field becomes weak or ceases to exist. Frequently, as in the diagram of Fig. 3, the same magnet, M, answers for a no-voltage and a no-field release.

Explanation.—With a weak field the armature speed will become excessive. An armature rotating at a speed much in excess of that at which it was designed to operate may have its windings torn off by centrifugal stresses. With no field at all, the armature will cease rotating, and, there being no counter e.m.f., a dangerous current will be forced through it. However, with the holding magnet M (Fig. 3) connected in the shunt field circuit, if this circuit opens or the current through it becomes too weak, iron keeper K will be released and arm C will be forced back to the "off" position, thus opening the circuit.

An overload release on a starting rheostat is sometimes provided to prevent excessive current flowing through the motor or wiring, if the motor is overloaded or if a short-circuit or similar trouble occurs on the motor circuit. Circuit breakers and fuses perform functions similar to that of the overload device and are frequently substituted for it, because they may protect both sides of the circuit (F and F_2, Fig. 3). Usually the overload device described below protects only one side of the circuit.

Explanations.—Fig. 4 illustrates the principle of an overload release device of one type. The holding magnet M is the same one as in Fig. 3. The overload release magnet is shown at S. The low-resistance winding of the magnet is in series in one of the line wires of the rheostat so that the motor current actuates it. This magnet S is so proportioned that if a current greater than that which the motor and circuits can safely carry flows through it it will attract the iron keeper I which is attached to the metal arm Q. This will raise Q into connection with contact points P, and P_2. Thus a shunt or short circuit is established around the winding of M which is thereby demagnetized. Then the keeper K (Fig. 3) which M was holding will be released and arm K will be forced back to its "off" positions, opening the motor circuit.

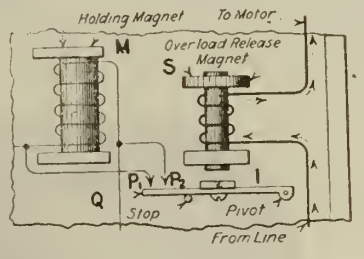


FIG. 4

A PROBLEM IN LUBRICATION

By M. E.

Mr. W. B. Hardy, M.A. (secretary of the Royal Society), discussed the problem of lubrication in relation to colloids. Water, ether, alcohol, benzine, and strong ammonia were apparently entirely incapable of maintaining a lubricating film on glass. "Seizing" occurred just as readily when they were present as it did with cleaned surfaces. Glycerine differed from those fluids in the fact that, though it would not maintain a lubricating film, it did prevent "seizing" when present in excess. For instance, the maximal tangential force which a pair of cleaned surfaces would support without slipping was measured in grammes 55. Flooding the surface with water, benzine, alcohol, etc., left that value unchanged. When a film of glycerine was deposited on the surface the force stood at 55, measured in grammes, but it fell as the quantity of glycerine present was increased to 9, when the surfaces were fully flooded. The expression "film" denoted a layer of fluid on the solid surface, so thin as to comprise probably only a single layer of molecules. With a true lubricant the facility for slipping was maximal when a layer of such excessive tenuity separated the solid faces and nothing was gained by increasing the thickness of the layer. Thus with castor oil the weight required just to start one face of glass slipping over another was 10 grammes, when only the invisible film of fluid mentioned above was present, and it was still 10 grammes when the surfaces were flooded with oil. Some fluids indeed seemed to lubricate better in thin than in thick layers; to act, that is to say, in the contrary way to glycerine. Acids as a class behaved in that way, the solid faces again being of glass. The pull in grammes was as follows:

	Film	Surface flooded
Acetic acid	40	47
Sulphuric acid	37	47
Oleic acid	10	13

If that result could be fully substantiated it would be an important and striking physical fact likely to throw much light upon the process of lubrication.

One broad conclusion emerged—namely that lubrication depended wholly upon the chemical constitution of a fluid, and the fact that the true lubricant was able to render slipping easy when a film of only about one molecule deep was present on the solid faces suggested that the true lubricant was always a fluid which was absorbed by the solid face. If that be so, then the problem of lubrication was merely a special problem of colloidal physics.

GOOD ENGINEERS AND FIREMEN

It is hard to exaggerate the importance of having good men in charge of the boiler room. The unskilled man usually proves expensive. He is wasteful of fuel and of other supplies,—not intentionally, but because he is careless or unskilled. There is also a large chance that the inferior man will damage the boilers and machinery under his care, by incompetence or neglect; and many costly boiler explosions have resulted from failure to do something or other in the right way, or at the right time. Sometimes the authority to hire the men, or to determine what shall be paid to them, rests with the wrong person.—with a person, namely, who does not appreciate that while a clerk can usually waste nothing but his own time, a boiler-room attendant can not only waste tons of coal in addition, but can also endanger the whole plant. A mistake of this kind should be promptly rectified, by giving more authority to some one who has a better understanding of the boiler-room problem.

The owl has no power of motion in its eye, the globe of which is immovably fixed in the socket by a strong, elastic, hard, cartilaginous case, in the form of a truncated cone; but in order to compensate for this absence of motion in the eye it is able to turn its head round in almost a complete circle without moving its body.

The Principles of Two-Stage Air Compression

Adiabatic and Isothermal Expansion Defined—Advantages of Two-Stage Compression—Function of the Intercooler and Its Design—The Removal of Moisture

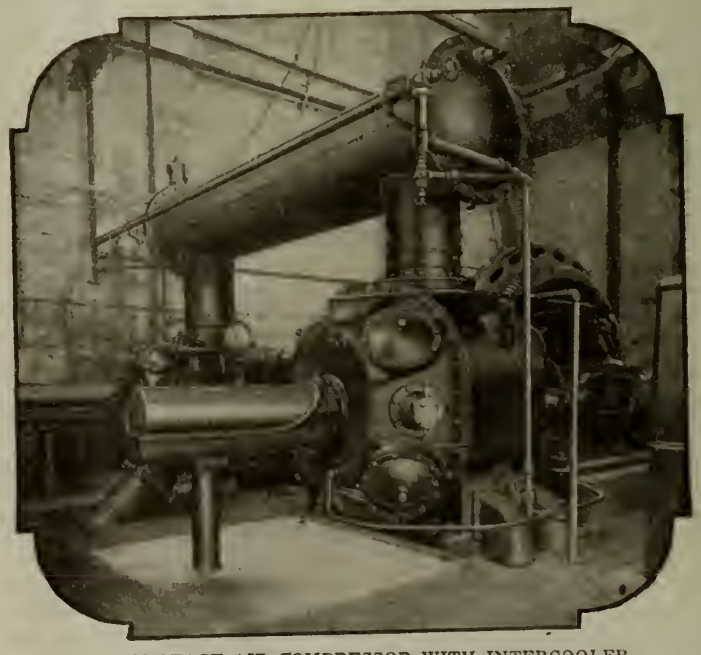
By A. W. SWAN

IN the literature of compressed air there are two terms continually appearing of rather terrifying appearance, "isothermal" and "adiabatic." However, one long word expresses the meaning of a whole sentence of shorter words, and this is the case with these two expressions. Speaking of air compression, "isothermal compression" means "compression with no increase of temperature"; "adiabatic compression" means "compression without loss of the heat generated by the compression." The terms "work" and "heat" are interchangeable, and if air is compressed without any chance for the heat to escape the temperature of the air will increase. In actual compressor practice a certain amount of the heat does escape, but the compression is so rapid that in the ordinary air compressor the compression is nearer the adiabatic (increasing temperature) than the isothermal (same temperature).

There are a number of reasons why the heat of compression should be removed if possible. Air expands when heated, hence if a compressor delivers 1,000 cu. ft. of air at 485 degrees (the temperature of adiabatic compression to 100 lbs. gauge), on cooling to atmospheric temperature the actual delivery will be considerably less than 1,000 cu. ft., so that to have an actual delivery of 1,000 cu. ft. the compressor will have to take in more than this amount, and the power to drive the compressor is correspondingly increased. Hence the lower the delivery temperature the greater the saving in power to drive the compressor. This is by no means the only gain from low delivery temperature; with a temperature such as 485 degrees there is considerable danger of spontaneous ignition of even the best lubricating oil; also the sudden extremes of temperature succeeding each other so rapidly have a harmful effect on the cylinder and piston, and hasten wear.

Compressor efficiency, therefore, depends on the degree to which the heat of compression is removed. Jacket cooling is necessary to keep the metal of working parts at a reasonable temperature, and to prevent the coking of the lubricant, but is not very efficient in removing heat from the air as it is being compressed for two reasons. In the first place air is a very poor conductor of heat, and in the short time of compression in the cylinder only the film of air next the cylinder wall has time to be cooled. Further, the amount of cooling surface becomes smaller towards the end of the stroke when it is most needed. The most efficient method of removing the heat of compression is by splitting the compression into two stages and cooling the air between the stages in an "intercooler." By this means the air does not reach an excessive temperature in either stage; it is delivered at a temperature considerably below the lowest possible with single stage compression with the most careful jacketing, and the resulting economy is correspondingly great. Additional advantages come from the fact that the temperatures in the two cylinders are not high enough to cause danger with the lubricant (and allow the use of ordinary lubricant where a special grade would be necessary to cope with the excessive temperatures of single stage compression). Then again the lower temperatures are beneficial to the wear of the machine, the compounding gives better balance, and the stresses are not so high as with single stage compression.

With such a list of advantages for two-stage compression, it is not surprising that for pressures above 80 lbs. gauge, as a rule only the smaller air compressors are built single stage.



TWO-STAGE AIR COMPRESSOR WITH INTERCOOLER

The success of the two-stage compressor in securing economy greater than that given by single-stage compression depends to a large extent on the design of the intercooler. The intercooler consists of a receiver containing a nest of tubes, through which flows cooling water. From the discharge valve of the low pressure cylinder the air passes through the intercooler, where it is cooled by contact with the cold water pipes. It has been found that the saving in power due to two-stage compression is about one per cent. for every ten degrees of cooling. From this it follows that the design of the intercooler plays a very important part, as the more effective the cooling the greater the saving in power. For instance, if the atmospheric temperature is 60 degrees, and the first stage of compression is to 25 lbs. gauge, then the temperature of the air after the first stage of compression will be about 230 degrees. If the cooling in the intercooler is to 70 degrees (about the best possible in practice), the saving in power will be 14 per cent. over single stage compression, while if the cooling is only to 90 degrees, the saving will be only 12 per cent.

The requirements of the efficient intercooler have been summarized as follows:—

1. The air in passing through the intercooler should be very thoroughly subdivided. Air is a very bad conductor of heat, and every part of the air should have as much contact as possible with the cooling surface.

2. The velocity of the cooling water would be such as to remove heat from the air with the minimum waste of water. The water supply is sometimes a serious problem.

3. The air passages should be such as to give the correct air velocity.

4. Expansion and contraction due to

changes in temperature should be provided for in the intercooler shell and tubes; if this is not done, leakage of air or water will result.

5. There should be a moisture trap to remove all the moisture deposited by the cooling of the air. The removal of moisture is one of the principal benefits of intercooling; the dryer the air, the less the chance of freezing in the hoist, pneumatic tool, or rock drill.

6. The intercooler should be of ample size; acting as a receiver between the stages the intercooler steadies delivery

The moisture trap is seen at "M" in the figure.

At first sight it would seem that the ideal material for intercooler tubes would be brass or copper in preference to iron, as these are better conductors of heat. However, when it is considered that air is a very poor conductor it is easy to see that it is far more important to have the air in the intercooler brought into frequent and intimate association with the cooling tubes than to have the tubes of material having good conductivity. This is borne out in Kent's

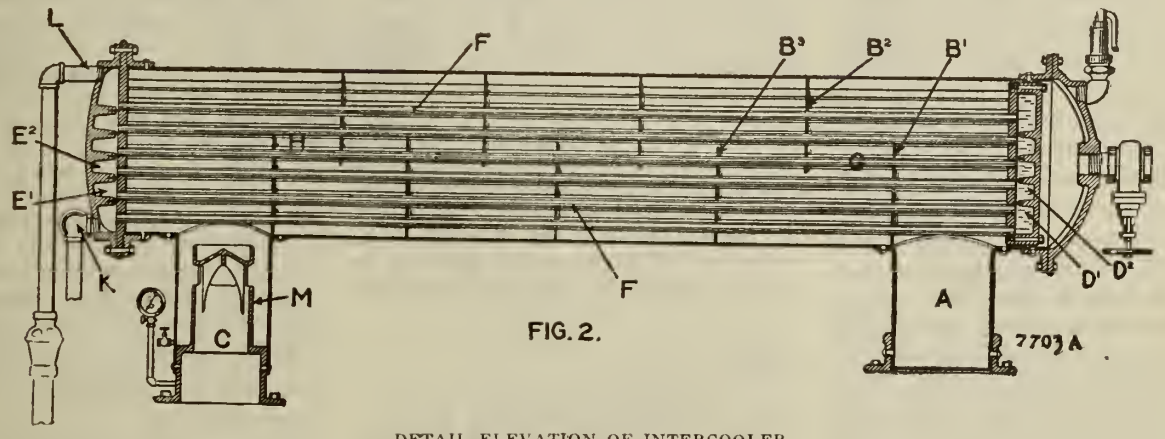


FIG. 2.

DETAIL ELEVATION OF INTERCOOLER

These requirements are shown in a discussion of a standard intercooler (intercooler for PRE-2 Compressor of Ingersoll-Rand). For ordinary pressures this consists of a shell containing a nest of tubes, inside which the cooling water flows. Air enters from the low pressure discharge at A, passes up and around the baffle plate B1, down and under baffle plate B2, over B3, etc. The air is thus taken up into a number of small streams, and by means of the baffle plates is forced into contact with the water tubes a large number of times.

The velocity of the cooling water is important. In a comparative test between this intercooler and an earlier model of the same company, the more modern intercooler averaged one-third less water consumption for the same cooling, and was able to cool the air to a point not reached by the older model.

There is considerable dispute as to the correct velocity of the air as it passes through the intercooler, but a mean speed must be found between that at which an appreciable drop is caused in pressure, and that found too low for thorough cooling. As the air cools it decreases in volume, and to keep the air speed constant, good design places the baffle plates nearer together at the high-pressure (cool) end of the intercooler, as can be seen in the illustration.

To secure free expansion, one tube-plate (the right-hand in the illustration) is free, while the other is attached to the shell. The free end is able to slide back and forth with changes in temperature without any strain or leakage; water connections are, of course, made at the fixed end of the intercooler.

Handbook, where it states that: "Taken generally, the results of these experiments show that there are practically but slight differences between iron, copper, and lead, in evaporative activity. Mr. W. B. Johnson formed a like conclusion from the results of his observations of two boilers of 160 h.p. each, made exactly alike, except that one had iron flue-tubes and the other copper flue-tubes. No difference could be detected between the performance of these two boilers.

THE THERMOMETER

The word "Thermometer" is a combination of two words, thurmo being taken from the Greek word "Thurmos," meaning "heat," and meter is a measure. A thermometer is therefore a heat measure, or, more properly speaking, an instrument for measuring intensity of heat, or temperature, by means of expansion of a liquid or gas. Mercury is generally employed, and an ordinary thermometer consists of a spherical or cylindrical glass bulb at the end of a very fine tube, the bulb being completely filled, and the tube partly filled, with mercury, whilst the space above the mercury contains only a small quantity of mercury vapor, which offers no resistance to the expansion of the mercury. A rise in temperature, which simply means that the atmosphere or air has absorbed more heat, is indicated by a rise of the mercury in the tube, owing to expansion, and conversely a fall of temperature is indicated by a fall of mercury in the tube.

A graduated scale is attached with two fixed points: the lower, or freezing point, and the upper, or boiling point of water. The distance between the two fixed points is then divided into a certain number of equal parts or degrees, which are continued above and below the two fixed points. On the Celsius or Centigrade thermometer (used by scientific men everywhere, and in general use in Continental Europe), the distance between the two points is divided into 100 degrees, the freezing point being 0° and the boiling point 100°; on the Fahrenheit thermometer (used in England and America) the distance is divided into 180 degrees. With the Fahrenheit thermometer the boiling point would therefore be 180° above the freezing point, but since zero or 0° is not at the freezing point, but is 32° below at the point where salt water freezes, the boiling point is 212° above zero. The two systems make it very confusing to one not accustomed to both. In this country everyone is familiar with the Fahrenheit thermometer, but occasionally a scientific article appears where the centigrade degree is used, being marked °C, and before it can be understood by the ordinary Canadian layman it has to be translated into Fah. To do this it is simply required to multiply the number of centigrade degrees by 9 and divide the result by 5 and add 32. This will be understood because 100 degrees C = 180 degrees Fah. A degree Fah. is therefore one hundred, one hundred and eightieth, or five-ninths of a degree C., and vice versa, a degree C is nine-fifths of a degree F. If the temperature is 100°C we multiply it by nine-fifths, which makes it 180° Fah. above the freezing point or centigrade zero, and by adding the 32° we make it 212° Fah. above the Fahrenheit zero.

Centigrade is taken from centum, meaning 100 and grade relating to the graded or graduated scale. Fahrenheit is the name of the man who originated that system.

It is said that 21,000,000 yards of burlap could be saved if fertilizer dealers would abandon the use of the 100-pound bag and made use of the 200-pound bag instead. On account of the general use of burlap in shipping articles of food now being sent abroad, there is a great scarcity of burlap.

The Securing of Economy in the Burning of Fuel

The Process of Combustion—The Influence of Draft on the Burning of Coal and the Use of Draft Gauges—The Importance of Eliminating Air-Leaks

By J. F. PATTON

DURING the process of combustion of coal in a furnace the combustible elements, carbon, hydrogen, and sulphur combine with oxygen, forming carbon dioxide, steam, and sulphur dioxide respectively. Air by volume is 21 per cent. oxygen and 79 per cent nitrogen, the latter being an inert element of no value in this work. During combustion heat is driven off, and if one pound of carbon is burned to carbon dioxide 14,600 B.T.U. will be released. For every pound of hydrogen turned to. steam or water vapor 62,100 B.T.U. are released while 1 lb. sulphur releases 4,000 B.T.U., when changed to sulphur dioxide. This liberated heat is used in several ways, part raising the temperature of the fuel bed, part going to surrounding surfaces, and still another part raising the temperature of the products of combustion. The heat carried away by the gases represents a distinct loss as it does no work and, in addition to being inert and of no heating value, the nitrogen acts as a carrier and absorber of heat, as its own temperature is raised before it escapes. During the process of combustion one pound of carbon forms 3.67 pounds of carbon dioxide, which is composed of 12 parts carbon an parts oxygen by weight. Therefore 32/12 pounds of oxygen will be necessary to burn 1 pound of carbon or $32/12 \times 1 = 2.67$ pounds of oxygen are needed. Ordinary air contains but 23 per cent. oxygen and in order to obtain 2.67 pounds of oxygen, $2.67 + .23 = 11.6$ pounds of air is required. As 11.6 pounds of air are used and only 2.67 pounds are oxygen we therefore, have a waste of $11.6 - 2.67 = 8.93$ pounds nitrogen.

When hydrogen burns the product is H O or water, which is 2 parts hydrogen and 16 parts oxygen. To burn 1 pound of hydrogen it is necessary to use $16/2 \div 8$ pounds of oxygen. To obtain 8 pounds of oxygen $8 \div .23 = 34.8$ pounds of air is required. Eight pounds of this are used and almost 27 pounds passes up the chimney without aiding combustion. When burning sulphur we form SO_2 which is 32 parts sulphur and 32 parts oxygen. This makes it necessary to use 32/32 or 1B. of oxygen to burn 1 pound of sulphur. In order to obtain 1 1B. of oxygen $1 \div .23 = 4.35$ pounds of air must be burned. It is evident that if the percentages of carbon, hydrogen and sulphur are known the air necessary to completely burn 1 pound of coal will consist of 11.6 times the weight of carbon $\div$ 34.8 times the weight of hydrogen 4.35 times the weight of sulphur For average coal this will be about 12 pounds of air to one of coal. It is also evident that the air supply should be watched very carefully if efficient operation is obtained, owing to the enormous amount of nitrogen which passes through the furnace.

Any air above the chemical requirement for complete combustion is known as excess air and as every cubic foot of oxygen used is replaced by a cubic foot of CO_2 or carbon dioxide the percentage by volume of this gas in the flue may be used to indicate the state of combustion.

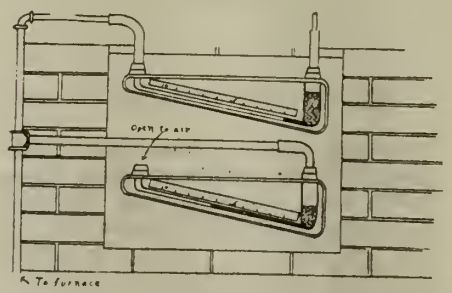


FIG. 1— DRAFT GAUGE

If just enough air is supplied to insure the complete combustion of the carbon, the oxygen will be replaced by the CO_2 and the percentage of CO_2 by volume in the mixture will be the same as the percentage of original oxygen. If twice as much air is used as is necessary the same amount of CO_2 will be formed, but this will replace only ½ of the oxygen, and therefore its percentage will be only ½ as great as in the former case. If the air supply is insufficient the carbon cannot combine and form CO_2 but form CO, or carbon monoxide, as this uses but half as much oxygen, and in this case there is a great difference in the amount of heat liberated, as one pound of carbon burned to CO_2 gives off 14,600 B.T.U.,but only 4,500 B.T.U. wen CO is formed. As this represents an enormous heat loss the per cent. of CO must be kept as low as possible.

In perfect combustion every particle of carbon must come in contact with the proper amount of oxygen, therefore to insure this contact a slight excess of air is necessary.

Draft as used in connection with this work does not mean the motion of the air in the stack or through the fuel bed, but the difference in pressure inside and outside the stack. When there is an opening into the furnace this difference in pressure will force air into it. the amount depending on the condition of the fire and the resistance offered to the air flow. Every boiler should be equipped with two draft gauges, one connected directly into the space above the fire. the other into this space as well as the gas passage below the damper, as shown in figure 1, as this will give the drop in pressure through tubes and baffling. The draft over the fire should be used in controlling the fire and when everything is in good condition there should be a definite loss in draft through the setting. Any increase in this loss will indicate holes in the fuel bed or that the tubes are clogged. A decrease will indicate a dirty fuel bed or the presence of clinkers or excessive ash.

The only practical means of determining conditions inside is by a study of the flue gases. Every plant should be equipped with apparatus for making a CO_2 analysis. One type is shown in figure 2. It consists of a glass retainer "A" for the liquid, which may be a solution of equal parts of potassium hydroxide and water or of concentrated lye; a graduated glass "B" which holds exactly 100 cu. centimeters; a bottle containing water and a rubber bulb "P" with the necessary pipes and tubing.

When this is used, first bring the liquid in A to the mark "M" just below the cock D. This is done by lowering the bottle C. The cock D should then be closed. The cock E operates three ways and should now be opened to glass B and to the air through F. By raising the bottle, the water in the glass is brought to the mark H at the top of the glass, then the cock is closed to the glass but opened to the sampling pipe and the air. The dead air should now be blown out by working the bulb, then close the cock to the air at F and open it to glass B. A sample of the flue gas is now pumped until the liquid in the glass stands at 100 C.C., then grasp tubing between the bottle and the glass so that there can be no change in the liquid in the glass. The cock is now momentarily opened and the liquid in the glass and bottle again leveled, and the gas driven into A by raising the bottle. Drive back and forth several times, then stop when level in B is exactly at 100 C.C. The cock is now closed and the level of the liquid in B and C brought to the same point.

The percentage of CO_2 may now be read directly on the graduated glass.

Proper precautions should be taken to

eliminate all air leaks as even a slight leak will invalidate the result. The apparatus should be hung on the setting at a point as near as possible to the point where the sample is taken, as the object is to determine what the fire is doing, and it is important that short connections be used, as this reduces the time which elapses between the time of taking the sample and the determination of the result. No elaborate sampling apparatus is needed. One frequently used consists of a double tube arrangement extending across the gas passage, holes being drilled into the tubes. This is not reliable as the holes may become clogged with soot, which makes it impossible to determine the exact point from which a sample is drawn. It is best to take a sample through the end of a straight tube consisting of a piece of ¼ inch gas pipe. When this is used the point of sampling may be known with accuracy. Great care should be taken to place the end of the tube in the exact centre of the main gas stream as shown at 2 in figure 3 and not in any of the dead gas pockets as shown at 1 or 3. Samples taken from the latter places will not show representative CO_2 values. The tube should always be inserted at the point when the gas stream leaves the heating surfaces for the last time. Care should also be taken not to heat the end of the tube to redness as this will invalidate the reading, as some of the carbon in the iron will combine with the oxygen in the flue gas. It is also well to use a small cloth filter between the sampling tube and the bulb, and the entire apparatus should be protected from drafts while the experiment is being performed. This test is easily executed and can be completed in two minutes' time by an average fireman with only a little training.

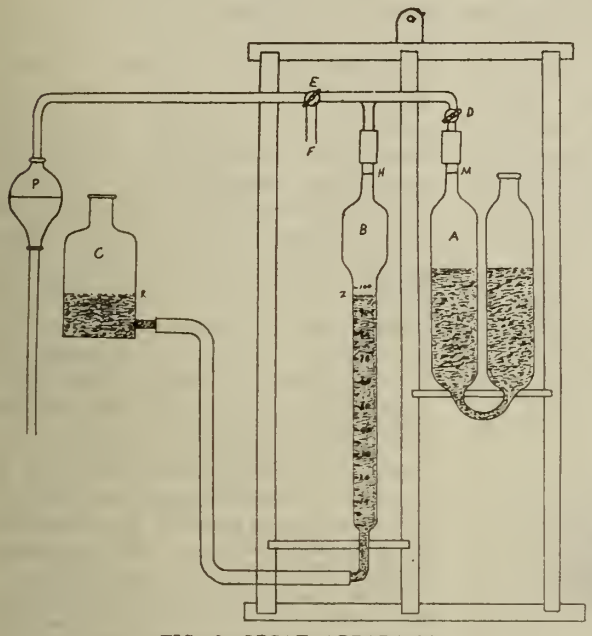


FIG. 2—ORSAT APPARATUS

There is always a very definite relationship between draft, capacity, fuel bed thickness, and air passing the fuel bed for every grade of coal, and the efficient engineer will determine these for his own particular plant. Before making a test it is well to see that there are no air leaks through the setting. The test should be made at a time when a constant load may be expected for a considerable time. The fire must be clean and the fuel bed of even thickness and all the tubes clean. Assume a draft and fuel bed thickness sufficient to carry the load without loss of pressure, then take simultaneous readings of the draft gauge and CO_2. Repeat these as rapidly as possible, keeping records of all readings. The fuel bed should now be varied and the draft adjusted so the load may be carired without loss of pressure. When these conditions have become constant another set of readings should be taken, and so on. If, on starting the test, the fuel bed is too thin, the draft and CO_2 readings will increase as the thickness of bed increases, but in every plant a point will finally be reached when an increase in the bed does not result in any increase in the draft or CO_2 percentage, and this represents the proper values for the given load. The test should be repeated with different loads within the daily range of the plant. These will show that with a given load certain well defined limits of draft give maximum CO_2 readings and the draft therefore becomes the key to the entire situation. When the load requires a certain draft then the proper thickness of fuel bed is known, provided the fire is kept clean, free from holes, and the tubes are clean. These latter conditions can be determined from differential draft gauge readings as shown in figure 1, which should be taken with the other readings of the test. A chart can easily be made for the direction of the fireman, the following of which will result in efficient plant operation.

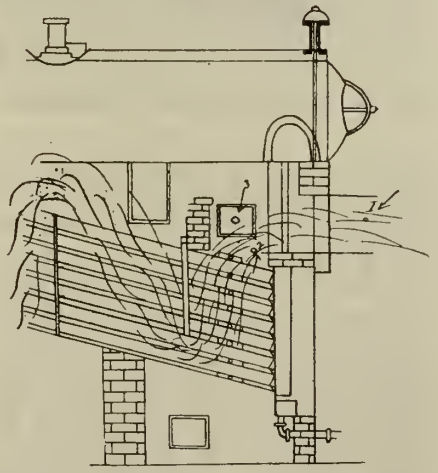


FIG. 3—DRAWING GAS SAMPLES

ELECTRIFYING ITALY'S RAILWAYS

Great savings in the use of coal, according to the Italian Bureau of Public Information, have been effected in Italy in the past few years through the electrification of railroads and harnessing the water power of the country to generate electricity. The percentage of railroads electrified in Italy from 1900-1915 is greater than in any other European country, and the economies resulting have been gratifying.

Electric traction of railroads began in Italy in 1900 with installations on the Varesina Line, which runs through Milan, Gallarate, Varese and Ponteceresio, and on the Valtellinese Line, which runs from Lecco to Chiavenna.

Railways which run on mountainous routes and carry heavy trains have been installed with different systems. The principal mountain routes electrified are the Moncenisio line, the Ceva-Port Savona line, the old line of Giovi, and the new supplementary Giovi line. These cover some of the most difficult territories traversed by any of the railroads in Europe.

The Moncenisio line is the longest of the mountain railways. It is 8.5 miles long, travels at an altitude of more than 1,000 yards above sea level and is continuously on the ascent. It has a nominal carrying capacity of 640,000,000 tons per mile, and actually carries 240,000,000 tons. The Ceva-Port Savona line is a series of steep inclines and declines. The Giovi line has the most rapid descent of any railroad in Europe and the supplementary Giovi line carries the heaviest traffic in Italy.

The perfect systems installed on these mountain routes have made possible the increase in the carrying capacity and the speed of the railways. There is at present under consideration the electrification of 1,250 miles more of railways.

DESTRUCTION TESTS OF ELECTRIC PLANT

Tests to destruction are occasionally used in engineering works to discover how much ill-treatment a machine will stand and which part is really the weakest. During the war every electric power station in Great Britain has been subject to very much the same kind of treatment. Thanks to the tremendous demand for electric power in munition works (ninety-five per cent. of these works were driven electrically) all the plant in the generating stations, boilers, dynamos, switchgear, transformers, and mains, was overloaded to a pitch which might well have meant destruction. The manner in which the plant stood up to this long and exacting ordeal is a magnificent proof of the sound design and construction of British electrical machinery and appliances. The difficulties were increased by the fact that, owing to the night and day demand it was generally impossible to overhaul the plant. In one typical case most of the boilers in the station had not been cleaned for a year. Now that this tremendous strain is relaxed British engineers realize that their electrical machinery has done better than ever they, in their most sanguine moments, would have expected it to do.

Water Pumping Water

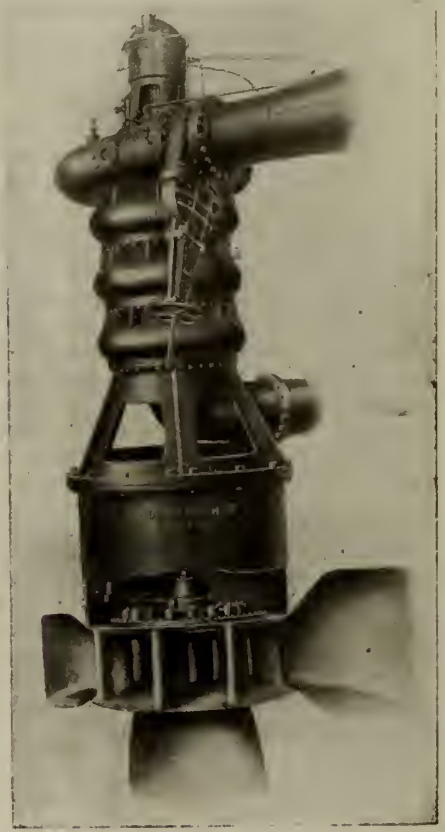
THE accompanying illustration shows the power and pumping equipment for the Grandview Irrigation District at the Sunnyside Unit of the Yakima Project at Washington. This plant is located at the head of the Mabton Feeder Canal, approximately two miles from the town of Grandview, on the Sunnyside main canal, and contains one direct connected turbine-driven pumping unit and two motor-driven units. All three units receive water from the Sunnyside main canal.

In this scheme, in which the water-power pumps the water for irrigation, the water which is used for operating the hydraulic turbine is discharged into the Mabton Feeder Canal, while the water which passes through the pumps is discharged through woodstave pipe lines to high line canals. The net power head under which the hydraulic turbine operates is 21 feet, while the working head against which the pump operates is 78 feet. The water is discharged through 6,000 feet of 40-inch inside diameter woodstave pipe, the maximum velocity in this pipe being 3 feet per second. The horizontal centre line of the turbine unit is placed 7 feet above tail water and 4 feet below the floor of the pump house. The turbine is installed in a closed concrete scroll and discharges through a concrete elbow-shaped draft tube.

It will be seen that the turbine consists of a vertical shaft 30-inch wicket gate unit, which under 21 feet head develops 214 brake horse power, at 225 revolutions per minute. The maximum discharge of the turbine is 110 cubic feet per second, but at point of best efficiency it discharges approximately 95 cubic feet per second. The design of the turbine is such as to give unusually high efficiency over the complete range of gate from half to full opening.

It is stated that during certain seasons of the year the water used by these plants contains a considerable amount of fine sharp silt, which is very destructive to the submerged wearing parts of the turbine and pumps, and this condition was given special consideration in the design of the machinery, and suitable provision made for protecting the parts against wear, and also for renewing with minimum expense and inconvenience such parts as could not be sufficiently protected. This design incorporated the use of a cast-iron ring or guide ring, which was embedded in the concrete scroll. This speed ring has stationary guide vanes which direct the water in towards the turbine runner. This speed ring was made very heavy and strong, and on account of the slow velocity of the water its action would be in no way detrimental to same. Inside this speed ring are placed the top and bottom plates, between which the wicket gates of the turbine are located. These top and bottom plates are provided with removable steel wearing plates which can be easily renewed.

It is of interest to note that the wicket gates are of cast steel, and the gate stems or spindles are cast integral with the wickets, and the gate spindles move in bronze bushed bearings in the top and bottom plates. The gate stems on the upper end extend through stuffing boxes in the top plate, and all the gate mechanism is located on the top plate where it is in plain view of the operator for the purpose of inspection and lubrication. This design leaves practically no movable part of the turbine in the water except the cast steel wickets, and the turbine runner. There is no step bearing in connection with the turbine unit as it is of the suspended type and the weight of the rotating element, including the turbine runner, the turbine shaft, and the downward thrust of the turbine, as well as the rotating parts of the pump unit are supported by means of an oil bath thrust bearing



WATER TURBINE USED TO PUMP WATER

placed on top of the pump unit, the turbine and pump being so designed as to support this bearing and the load which it carries.

It is pointed out that the top plate of the turbine is cored and the water drained from between the runner and the top plate down through the guide vanes of the speed ring, these guide vanes being cored out for that purpose, which is a design patented by the builders of the turbine. The speed ring and the extension ring above it (known as the pit liner) are so designed as to support the pump unit. The gate operating mechanism of the turbine consists of hand wheel and worm gearing so arranged that the turbine gates can only be moved very slowly, thus giving fine adjustment and avoiding water hammer due to the long discharge line.

As the photograph shows clearly, the pump is of the vertical shaft, four-stage type, with 20-inch diameter intake and discharge openings, having a capacity of 7,500 gallons per minute against 78 feet total head, and requires approximately 212 h.p. maximum. The general design and construction of the four-stage pump consists of four individual cases substantially bolted together, and extends about 16 feet above the floor. The intake connection is made at the bottom, and the discharge at the top of the pump. The three initial or lower stages contain suitable guide vanes, which guide the water in a continuous stream through the pump. These guide vanes form a part of the pump casting. The upper stage or discharge case of the pump is of spiral or volute form, increasing to 20 in. diameter where it connects to the discharge line, an outside screw rising stem 20 in. gate valve being located between the discharge flange of the pump and the pipe line.

There are steel wearing rings around the suction inlets of the pump impellers, also wearing rings in the pump proper provided for the purpose of insuring easy and inexpensive renewal of such parts as are affected by the silt in the water.

It is stated that "reliability of operation without attention except for short periods daily" is the manner in which the Government engineers specified the type of unit to meet the requirements of this plant, and the equipment furnished is as nearly "fool proof" as it is possible to design and build. The hydraulic turbine and accessories, together with designs of the concrete scroll and concrete draft tube, are of the S. Morgan Smith types, developed at York, Pa., while the Byron Jackson Iron Works type was developed at San Francisco, Cal.

It is held that a similar combined unit is to be used for installation at the Price Stub Pumping Plant of the Grand Valley Project of U.S. Reclamation Service in Colorado, where the net head on the turbine is 17 feet and the water is supplied to the turbine through a 60-inch diameter penstock, 150 feet long. The turbine will be a 25½ in. type "O," developing 125 h.p. at 240 revolutions per minute, and maximum water for power purposes being 77 cubic feet per second, and the normal 70 cubic feet per second.

It is said that the pump will operate against a total head of 31 feet including friction, and deliver 13,000 gallons of water per minute through 350 feet of 36 in. diameter discharge pipe. The pump will have 24 in. diameter inlet and discharge openings. This plant will be located on the Government High Line Canal, approximately two miles from the town of Palisades, Colorado, on the Denver and Rio Grande Railroad. These units are the latest and most efficient devices, and great extensions are expected in this service in the near future.

The Control of Large Amounts of Power---III.

The Author, in a Paper Read Before the Institute of Electrical Engineers, England, Gave Some Interesting Remarks Regarding Control of Large Amounts of Power and the Use of Reactances

By E. B. WEDMIERE

Current-limiting By the Use of Busbar Reactance

THE question is, how far in the system generally can the short-circuit current be controlled by the use of busbar reactance in the generating station.

The value of the short-circuit depends upon five availables:—

(a) The working voltage.
(b) The total generator capacity.
(c) The generator reactance whether internal or external.
(d) The busbar reactance.
(e) The number of busbar sections.

The results obtainable may be reduced to a single diagram, using the short-circuit current obtainable without busbar reactance as a unit. This is readily ascertainable as follows:—

$$\text{Short-circuit k.v.a.} = \frac{\text{Total generator k.v.a.} \times 100}{\text{Percentage generator reactance}}$$

Taking this as the unit, Figs. 6 and 14 show the reduction obtained with different values of busbar reactance "B" expressed in terms of the generator reactance "A" and for different number of busbar sections.

Fig. 6 represents the star design and Fig. 14 the closed ring design. In the latter, current is fed from both sides so that reactances are required of about twice the ohm value for the same degree of protection. In Fig. 14, therefore, the vertical scale has been doubled, and with this alteration it will be seen that the two sets of curves are very similar.

In Fig. 6 from the bottom of the diagram it is evident that the introduction of a small amount of busbar reactance has a big effect in reducing the short-circuit values. As the reactance value is increased its effectiveness by no means increases proportionally. The same is true of increasing the number of sections. The curves are figured from the following formula, giving the factor f, that is, the ratio between maximum short-circuit currents with and without reactance:—

$$f = \frac{(N-1)+\left(\frac{B}{A}\right)}{N\left(\frac{B}{A}+N+1\right)}$$

where A = generator reactance,
B = busbar reactance,
N = number of sections.

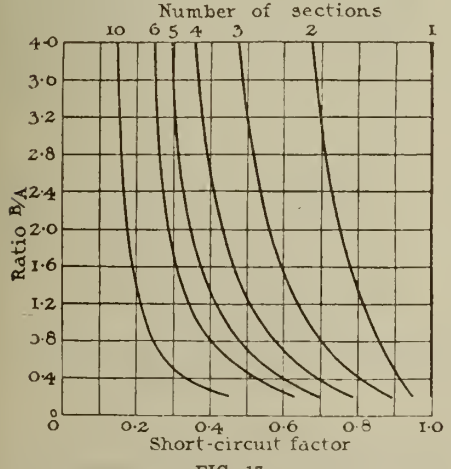


FIG. 17

The results are shown in a different form in Fig. 15, in which the horizontal ordinates are the inverse of those in Fig. 6. It will be noticed that the factor f has equal increments for each additional busbar section.

These curves are based on the assumption that the bull complement of generators is connected to each busbar section, whereas the worst case in practice is shown in Fig. 16. Separate curves would be required for each case there shown. The above curves give results a little on the high side if the total generator capacity is taken as a basis, and on the low side if the maximum of machines running on maximum output is taken as a basis.

These curves cover the ground of what is practicable, as it will be shown later that the amount of busbar reactance permissible is limited by the permissible voltage difference between busbar sections, and that in the endeavor to keep down short-circuit stresses the increase of generator reactance will keep down the ratio well within the range of the above curves and within economical limits. These are the factors which will be found to determine the cost, but a few words may be said here on the question of the best value of the ratio B A from the cost aspect.

We have to consider the total protective value obtained with generator plus busbar reactance, and this is indicated in Fig. 17, in which the vertical scale gives the number of times the short-circuit current exceeds the normal output of the machines. It should be noted that these curves are figured on the total plant capacity and not on the maximum output of the plant. They show the ratio for two and for five sections and with different values of busbar reactance.

Based on these, Figs. 18 and 19 have been prepared showing different combinations of generator and busbar reactance giving equal protection.

So long as the generator reactance can be provided internally the cheapest combination will be that with minimum busbar reactance, but even if all necessary protection of plant could be obtained with generator reactance alone it would still pay to employ busbar reactance owing to the protection afforded to continuity of supply.

In case some of the reactance is put external to the generators there will be a value of B A giving minimum cost. This ratio can be varied over wide limits without materially affecting the cost, and the best figure depends upon how much reactance is external and upon the number of busbar sections and transfer capacity required. As a rough guide it may be said that for five busbar sections the minimum is reached when B/A is in the neighborhood of unity, and with two sections when B is 1/3 A, but either ratio may be varied by 2 or even 3 to 1 without seriously affecting costs, so here again we have to look to technical grounds for our limiting features.

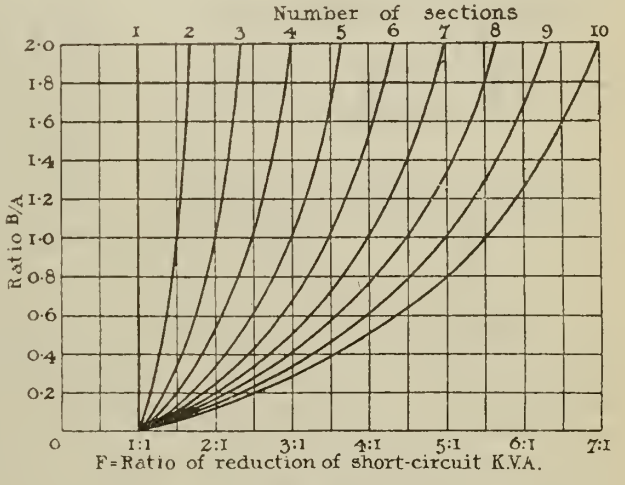


FIG. 18

Transfer of Load Through Reactances

The conditions requiring the largest load transfer with different numbers of machines per section are illustrated by Fig. 16. The relation between the generator capacity tied to a section and the maximum load on that section is scheduled below on the basis of machines of uniform size and of two spares. In practice one has to deal with unequal sections and machine capacities, but one aims at equal sections and generator capacity per section, two small machines counting as one large one. The spares of largest size are the principal determining factor, so that the conclusions drawn give a good idea of what is re-

quired and indicate the basis on which individual cases should be worked out.

Referring to Fig. 16, the diagram for two machines per section is typical. In this, the worst case occurs when the station is fully loaded, i.e., all but the two spare machines are running, and the two machines shut down are on the same section. The section is tied solidly to the adjacent section, forming one section with two machines directly connected, this being the permissible maximum. One reactance is also cut out, so that the doubled section is properly protected by a single reactance.

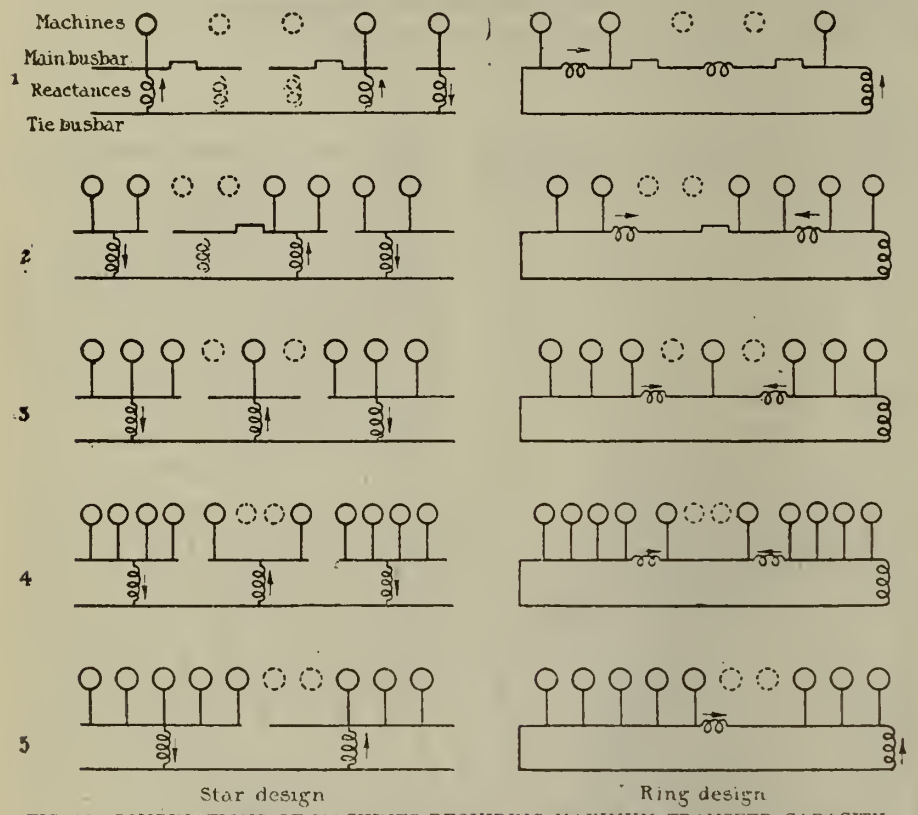


FIG. 16—COMBINATIONS OF MACHINES REQUIRING MAXIMUM TRANSFER CAPACITY

The conditions shown in the figure will arise not only out of necessity, but also out of convenience in the normal operation of the plant, and should be met by the provision of ample carrying capacity in the reactance, rather than by special switching operations involving the use of the auxiliary busbar.

Schedule A gives the transfer capacity for the star design for each of the cases illustrated. On referring to Fig. 16, and to the diagram for the ring design, it will be seen that the transfer capacity in the first figure must be the same for both ring and star design. In the remaining cases in the ring design the transferred load is divided between two reactances which so long as the ring is closed could, therefore, have half the current capacity. On the other hand if the ring is broken, as it is bound to be from time to time, then in the worst case one reactance must carry the total transfer as in the star design. This worst case is most likely to happen if there are only two busbar sections, and will happen in the other cases if we have two machines on one section down and need to shut down an adjacent busbar at full load, a rather unlikely contingency. If this case arises and is not provided for, then we shall be compelled temporarily to cut out reactance or operate with excessive potential difference.

With the ring design a compromise can be effected by allowing, say, three-quarters of the capacity shown for the star design.

A study of Fig. 20 will bring out the meaning of the data scheduled.

It will be noted that for a given total output and number of machines per section, the transfer capacity required does not vary much with the number of sections. The falling-off would be compensated if with the larger number of machines more than two spares were provided. It should also be borne in mind that the figures are based on one size of machine throughout, whereas on some sections, and especially the first installed, there will be an equivalent capacity made up of smaller machines. These require less transfer, so that in actual conditions the capacity required is practically determined by the final total output aimed at, and must be made sufficient for this.

For a given amount of protection and number of sections, the number and ohmic value of the reactances are fixed, so the cost varies only with the transfer capacity. These curves, therefore, give a good idea of the relative cost of different numbers of machines per section. It will be seen that one machine per section gives the lowest cost, but in some cases with an impracticable number of sections.

Further calculation shows that the cost of the reactances for a given measure of protection decreases with an increase in the number of sections, but on the other hand the cost of the necessary switchgear for the larger number of reactances is increased, and investigation of two typical cases indicates that the balance is negligible.

It is clear, therefore, that in considering the best number of sections to employ the question of cost of the reactance equipment is not a guiding feature.

Fig. 21 gives the results in a convenient alternative form.

Transfer of load through busbar reactances at high power factor. — When energy is transferred from one busbar section to another at a power factor higher than that of the load, the shortage of magnetizing current has to be made good by the machines connected to the section receiving energy. These machines will then be operating at a reduced power factor and consequently with a reduced energy output. Fig. 22 shows the relation between rated output and power factor typical of modern machines, and it will be seen that if the machine is rated at 100 per cent. k.v.a. at 80 per cent. power factor, then the k.v.a. output is reduced ultimately to about 80 per cent. at zero power factor.

Fig. 23 shows the voltage difference required for the transfer of load at 80 per cent. power factor through reactance between busbars, the reactance in this case being the effective reactance of any combination of units there may be in

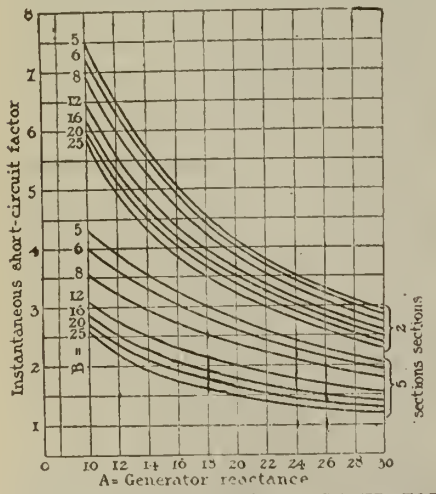


FIG. 17—COMBINED EFFECT OF GENERATOR AND BUSBAR REACTANCES, STAR DESIGN WITH TWO AND FIVE SECTIONS.

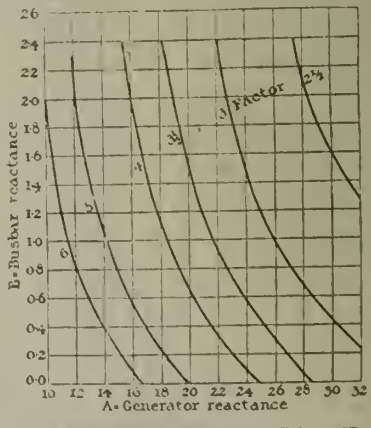


FIG. 18—COMBINATIONS OF "B" AND "A" GIVING EQUAL PROTECTION, STAR DESIGN WITH TWO SECTIONS.

series and parallel between the sections in question.

Fig. 24 shows the advantage of furnishing magnetizing current from the machines running in the section to which energy is being transferred. The load is

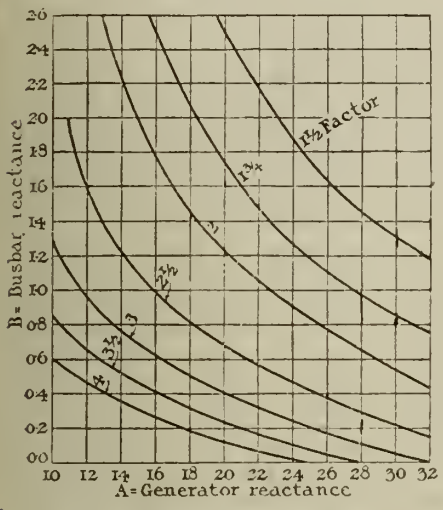


FIG. 19—COMBINATIONS OF BAND "A" GIVING EQUAL PROTECTION, STAR DESIGN WITH FIVE SECTIONS.

again taken at 80 p.c. power factor. The lower curve requires transfer of load at 80 per cent. power factor. With the top curve the whole current output of the machines running on the section is taken as magnetizing current. It will be seen in this case that with half the machines running, if the section output is to be three-quarters of the section capacity (i.e., allowing 25 per cent. spare plant), one is limited to 11 per cent. equivalent reactance between machines, but this rapidly increases up to a theoretical limiting figure of 30 per cent. as the power factor of the running machines is decreased.

These curves are drawn for a potential difference of 1¾ per cent., this figure being the drop due to the reactance. There will be a small additional drop due principally to the energy component of the load causing I R drop. This will be in general less than ¼ per cent., so that the figures of 1¾ and 2¼ per cent. chosen correspond to a maximum difference of about 2 and 2½ volts, or a variation from normal of 1 and 1¼ per cent. in volts.

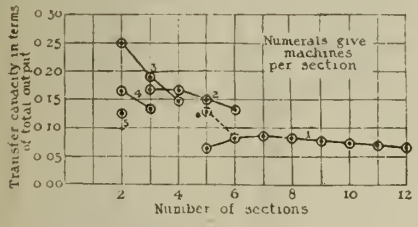


FIG. 20—TRANSFER CAPACITY OF REACTANCES (STAR DESIGN).

We can now determine the maximum value of busbar reactances for different conditions of running. These are set forth in Schedule B. This Schedule is prepared to cover different numbers of machines per section and of sections, and covers a very wide range, because it will be found that with a given number of machines per section, the number of sections does not exercise much effect; for in the first place one has to allow from the commencement the transfer capacity that will be necessary in the complete installation, and in the second place it will be found that if each likely combination of machines and sections is worked out in detail the maximum values of B do not vary much with the number of sections.

The third line shows the maximum load transfer required at full load in the most unfavorable case as shown in Fig. 16, and the next line shows the maximum value of B for 2½ per cent. voltage difference, the load being transferred at 80 per cent. power factor.

If we meet this extreme case by adjustment of the machine power factor we get at once a big increase in the possible amount of reactance, and with a voltage variation of 1 per cent. from normal we can get the results shown in line 5.

Generally at full load on any one section we can arrange to have not more than one machine shut down on that section, and can thus transfer at 80 per cent. power factor through much larger reactances. The figures are given in line 7.

For investigation of the limiting effect on short-circuits the author has assumed

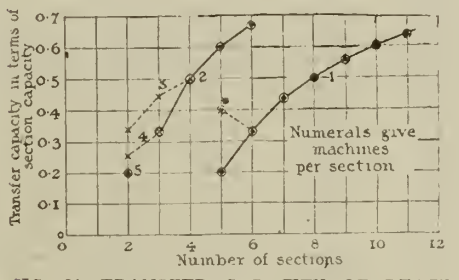


FIG. 21—TRANSFER CAPACITY OF REACTANCES (STAR DESIGN).

this to be the normal condition of operation, and that adjustment of power factor will be resorted to only in the extreme case and then will be limited to 50 per cent. power factor. We then get the permissible maximum B by combining lines 5 and 7. The result is shown in line 8 and does not necessitate approaching the 50 per cent. power factor limit except where there are 3 or 4 unit machines per section.

Based on these figures for B, the short-circuit factors are figured and shown in Schedule C. This factor is the figure by which the rated capacity or output, as the case may be, must be multiplied to get the maximum instantaneous output on short-circuit.

Heating and Stresses Due to Heavy Currents

We have now considered how the concentration of power on a fault occurring can be limited. We have yet to consider the heating and stresses due to the large currents still to be dealt with, both under normal and under faulty conditions.

Electromagnetic Stresses on Conductors.—In modern practice conductors in different phases may be spaced at 1-inch centres or less as in cables, or at 2-ft. centres or more as in large switchboards.

With adjacent conductors at 12-inch centres carrying currents in opposite directions, the maximum repulsive force between them will be 9 lb. per foot run for 10,000 amperes, R.M.S. value. The

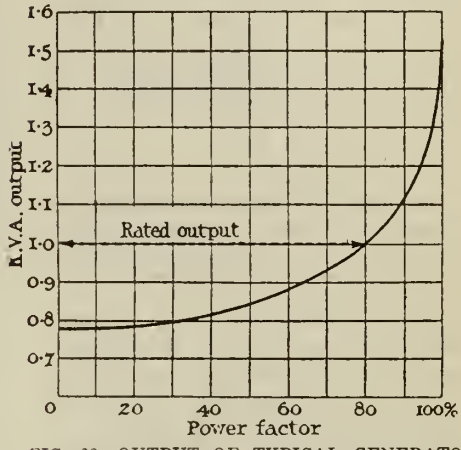


FIG. 22—OUTPUT OF TYPICAL GENERATOR AT DIFFERENT POWER FACTORS.

force varies inversely as the distance and proportionally to the square of the current, and often attains serious proportions in modern practice.

In a three-phase cable carrying 100,000 amperes on a fault the force may reach a maximum of 12,000 lb. per foot run, and would approach this in the joint boxes.

Conductors spaced 1 foot apart will be subjected to 900 lb. per foot run on the same current. If the conductors are securely fixed at the ends, the stress on the end supports may be many times this. It becomes essential to support the bars in such a way as to prevent these forces from causing destruction.

A current of 100,000 amperes may be met with on the direct-current side of large rotary converters and on the low-tension side of large power transformers, as well as on the high-tension circuits in very large power stations.

In current transformers designed with multiple-turn primary windings and with coils lying side by side, large forces are

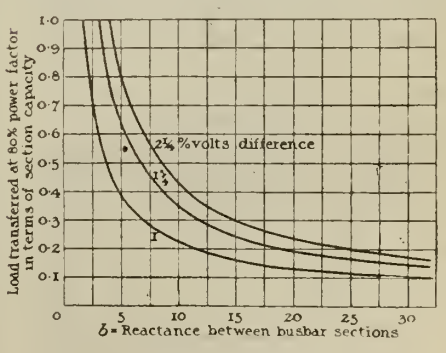

Load transferred at 80% power factor in terms of section capacity
2½% volts difference
1¼
1
δ = Reactance between busbar sections

FIG. 23—VOLTAGE DIFFERENCE DUE TO TRANSFER OF LOAD.

produced on short-circuit, tending to drive the coils apart and distort the ends if unsupported.

With typical modern designs the safe limit is reached when the currents are of the same order of magnitude as indicated below also for heating limits. The

transformer should not be subjected to more than 200 times normal load current.

Where a conductor forms a loop there is a force tending to expand the loop, the magnitude of which is given by the following formulae:—

In Fig. 25 (a), $F = \frac{9C^2}{D}\left(\log_e \frac{4D}{d} + 0{\cdot}1\right) \times 10^{-8}$

In Fig. 25 (b), $F = \frac{9C^2}{D}\left(\log_e \frac{2D}{d}\right) 10^{-8}$

where F = lb. per inch,
D = inches,
C = amperes.

These cases are illustrated by Fig. 25, and, based on the figures they give, a fair estimate may be made of most cases which arise in practice.

A 300-ampere isolating switch of the type shown in Fig. 26, or an oil switch of the type shown in Fig. 27 with insulators at 10-in. centres, may have a force of 100 lb. distributed over the blade on a current of 20,000 amperes, or 600 lb. for 50,000 amperes. If the switch be designed as in Fig. 28, the conductors will be almost in line with the blade, and the force due to the loop formation will be relatively negligible.

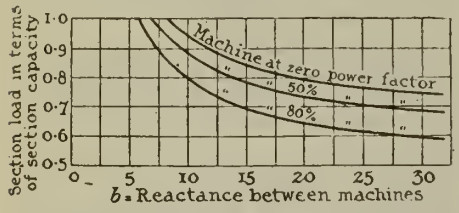


FIG. 24—INFLUENCE OF POWER FACTOR OF MACHINE ON OUTPUT OF SECTION. LOAD AT 80 PER CENT. POWER FACTOR.

It is good practice to lock or latch the blades of all back-connected isolating switches on 6,000-volt plants where the output may reach 10,000 k.v.a. or upwards, and to latch all switches where the output may exceed 20,000 k.v.a. These figures are typical of what is required.

The forces acting on the conductor carrying current in the arc in a direct-current circuit-breaker with 6-in. break may be roughly estimated. When the carbons separate, the force of 10,000 amperes may be of the order of 3 lb. per inch, and when a loop of 3-in. radius is reached the force will be again something like 3 lb. per inch run.

Design of large conductors.—Up to about 2,000 amperes' capacity the design of conductors for alternating-current

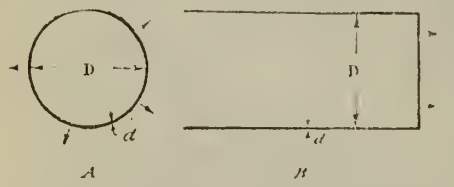


FIG. 25—DIAGRAMS SHOWING FORCE IN CONDUCTORS CARRYING CURRENT.

circuits presents no peculiarity except in machines and transformers where eddy currents may be set up in them, but above this figure "skin effect" has to be seriously considered. The skin effect in circular conductors admits of simple mathematical treatment. The figures for conductors of square cross-section can be calculated approximately from the solution for cylindrical conductors. The case of a very wide strip conductor also admits of easy solution, and by interpolation between these results one can

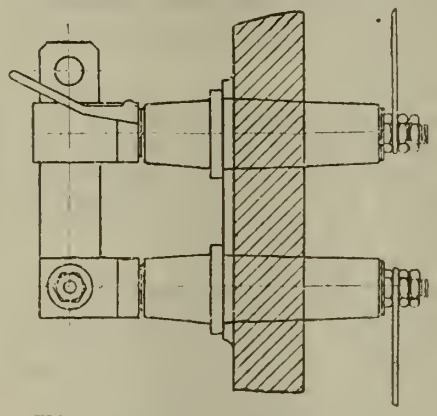


FIG. 26—TYPICAL ISOLATING SWITCH, SUBJECT TO LARGE FORCES.

arrive at a fair idea of what happens in rectangular conductors as usually employed for busbars and heavy conductors, in the form of laminated bars with ventilating ducts between the laminations.

As to the thickness of lamination ¼-inch is a common and convenient dimension with ¼-inch ducts. With vertical conductors the ducts should be increased where practicable to ¾ inch. There is no benefit in building up alternating-current conductors of bars ⅜ inch thick.

So long as the total thickness of the copper in the several laminations added together does not exceed 1¼ inches, skin effect does not become serious, but above this figure it rapidly becomes a most important factor.

Additional capacity can only be got by increasing the width of the bars in some way, or alternatively by so arranging them that the inner and outer conductors are changed over so that each current stream flows through roughly equal lengths of inner and outer conductor. The bar should then be constructed of an even number of laminations, suitably separated by light insulation and space provided for by the cross-over connection, which is not a very simple affair.

Where currents of the order of 5,000 amperes or upwards have to be or may have to be dealt with, it is, therefore, essential to provide ample room for the maximum width of strip which may be ultimately necessary and to keep down the maximum current to be dealt with, as, for example, by interleaving heavy incoming and outgoing circuits as in Fig. 8.

Stresses Due to Heating of Conductors—If a copper conductor is prevented from expanding and is then heated, it will exert a stress of about 240 lb. per square inch for each degree Centigrade rise of temperature. If the supports spring sufficiently to admit of expansion taking place, the stress will be limited to the amount necessary to spring the supports.

A copper busbar 10 ft. long and 2 sq. in. cross-section, able to carry, say, 2,000 amperes, will thus exert a theoretical maximum pressure of about 15 tons for a total temperature change, due to electric heating and atmospheric conditions, of 60 degrees C. This same bar for the same temperature change will increase in length by about ⅛ inch. This can be absorbed by deflecting the bar about an inch at the centre if it is free to move, or by the slipping of the bar on its supports. Expansion is generally taken care of by slipping. It is, however, good practice on long busbars to limit this by the use of expansion joints.

Heating Effects of Large Currents

With the increase in the size of plant we reach limiting conditions due to heating effects, as we have on emergency conditions very high current densities to contend with. The heating effect being proportional to the source of the current quickly reaches abnormal figures. A plant may be quite safe against heating troubles and have perhaps a factor of safety of 4, but on doubling that plant the margin disappears.

If heat is generated in a conductor very rapidly there is no time for radiation, convection, and conduction to play their part, and the heat is practically wholly absorbed in the conductor, resulting in a corresponding temperature rise Currents flowing in copper conductors 1,000 amperes per square inch will raise the temperature 50 degrees C. per hour if the heat is all absorbed. On this basis a current of 100,000 amperes, say 1,000,000 k.v.a. on 6,000 volts, will raise the temperature of a 0.1 sq. in. cable at the initial rate of about 12,500 degrees C. per second.

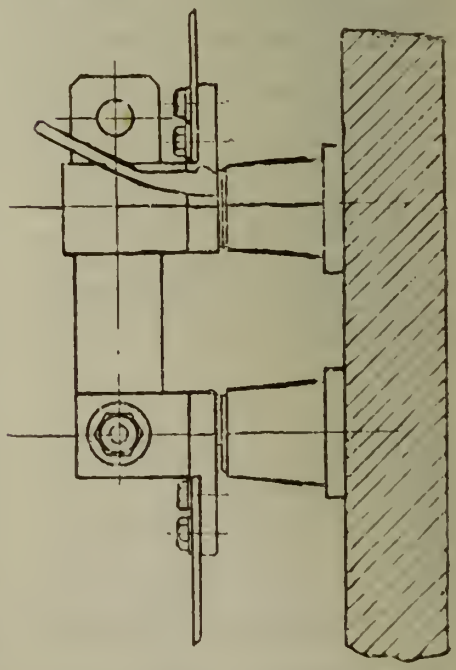


FIG. 28—TYPICAL ISOLATING SWITCH SUBJECT TO SMALL FORCES.

Under conditions which are permissible, the insulation on conductors does in fact absorb a considerable amount of heat and the theoretical maximum temperatures are not reached. For coils

wound with wire or thin strip the rise may not be more than half the theoretical figure. On average underground cables the discrepancy would be something more like 10 per cent. Using this latter margin we get the following round figures for temperature rises:—

Density	Rate of Temperate Rise
10,000 per sq. in.	1¼ degrees C. per second
100,000 per sq. in.	125 degrees C. per second
200,000 per sq. in.	500 degrees C. per second

The effect of these figures in practice will be seen by an examination of the round figures in the following table, giving the maximum permissible k.v.a. in a circuit for a current density limited to 100,000 or 125 degrees C. rise per second.

Cable.	Maximum Current.	k.v.a. at 6,000 Volts.	k.v.a. at 20,000 Volts.	k.v.a. at 30,000 Volts.
Sq. in.	Amp.			
0.025	2,500	25,000	85,000	125,000
0.050	5,000	50,000	175,000	250,000
0.100	10,000	100,000	350,000	500,000
0.250	25,000	250,000	850,000	1,300,000
0.500	50,000	500,000	1,750,000	2,600,000

The current values are R.M.S. values and the k.v.a. is figured three-phase.

The above figures give the initial temperature rise. The effect of the initial rise is, however, to raise the resistance of the copper conductors, the specific heat remaining steady so that the rate of rise is accelerated as it proceeds.

The serious overheating of a conductor in a cable may damage the cable from end to end.

Experience with stations designed in recent years and having a maximum short-circuit current of 10 times their normal rated output, has shown that it is necessary that the smallest current transformer on the main switchboard should have a carrying capacity not less than one-twentieth the station output. Current transformers of good design and much smaller than this have been known to be exploded by the heat generated on a short-circuit.

On one plant already existing in this country it has been found desirable to limit the cross-section of the smallest conductor to 0.15 square inch. The figures given above show clearly that in the large plants now in contemplation this feature will require careful consideration.

SCHEDULE A.
Transfer Current Capacity of Reactances: Star Design.

Number of Sections	Total Generator Capacity, one Machine as Unit	Maximum Total Output, two Spares	Output per Section, one Machine as Unit	Sections Coupled in Worst Case	Output of Coupled Sections, one Machine as Unit	Load transferred to Coupled Sections, one Machine as Unit	Load transferred to Coupled Sections, Generator Capacity of one Section as Unit	Load transferred to Coupled Sections, total Generator Capacity as Unit	Load transferred to Coupled Sections, total Output as Unit
One Machine per Section.									
5	5	3	0.60	2	1.20	0.40*	0.4*	0.08*	0.133*
6	6	4	0.67	2	1.33	0.33	0.33	0.055	0.083
7	7	5	0.71	2	1.43	0.43	0.43	0.061	0.086
8	8	6	0.75	2	1.50	0.50	0.50	0.062	0.083
9	9	7	0.78	2	1.56	0.56	0.56	0.062	0.080
10	10	8	0.80	2	1.60	0.60	0.60	0.060	0.075
11	11	9	0.82	2	1.64	0.64	0.64	0.058	0.071
12	12	10	0.83	2	1.67	0.67	0.67	0.056	0.067
Two Machines per Section.									
3	6	4	1.33	2	2.67	0.67	0.33	0.111	0.168
4	8	6	1.50	2	3.00	1.00	0.50	0.125	0.167
5	10	8	1.60	2	3.20	1.20	0.60	0.120	0.150
6	12	10	1.67	2	3.33	1.33	0.67	0.111	0.133
Three Machines per Section.									
2	6	4	2.00	1	2.00	1.00	0.33	0.167	0.250
3	9	7	2.33	1	2.33	1.33	0.44	0.148	0.190
4	12	10	2.50	1	2.50	1.50	0.50	0.125	0.150
Four Machines per Section.									
2	8	6	3.00	1	3.00	1.00	0.25	0.125	0.167
3	12	10	3.33	1	3.33	1.33	0.33	0.111	0.133
Five Machines per Section.									
2	10	8	4	1	4.0	1.00	0.20	0.10	0.125

*In this case one reactance carries load transferred to two coupled sections. In all other cases two or more share it.

SCHEDULE B.—STAR DESIGN.
Maximum Value of B for Different Conditions.

(1) Machines per section	1	2	3	4	5
(2) Number of sections	7	5	4	3	2
(3) Transfer capacity, worst case	0.43	0.60	0.50	0.33	0.20
(4) Maximum B for 2½ per cent. difference	5	4.6	5.7	7.6	9.2
(5) Maximum B for 1¾ per cent. difference in volts with machines at 50 per cent. power factor	Above 25	Above 25	9	16.5	Above 25
(6) Transfer capacity, one machine off	0.43	0.3	0.17	0.08	0.00
(7) Maximum B for 1¾ per cent. difference in volts with machines at 80 per cent. power factor	4	7.2	11.5	Over 25	Over 25
(8) Maximum B for conditions (5) and (7)	4	7.2	9	16.5	Very large

SCHEDULE C.—STAR DESIGN.
Short-circuit Factor.

Machines per section	One			Two			Three		Four	
Number of sections	5	6	4	5	6	2	3	4	2	3
Number of machines	5	6	8	10	12	6	9	12	8	12
Bus reactance B	4	4	7½	7½	7½	9	9	9	16	16
General reactance A	**Factor in Terms of Total Capacity.**									
10 per cent.	3.8	3.6	4.1	3.5	3.1	5.6	4.5	3.4	5.6	4.2
15 per cent.	2.8	2.7	3.0	2.7	2.4	3.8	3.3	2.7	5.1	3.0
20 per cent.	2.2	2.2	2.4	2.2	2.0	2.6	2.6	2.1	3.0	2.4
30 per cent.	1.6	1.6	1.8	1.7	1.5	2.1	2.0	1.6	2.1	1.8
	Factor in Terms of Maximum Output.									
10 per cent.	6.3	5.4	5.4	4.4	3.7	8.4	5.8	4.3	7.5	5.0
15 per cent.	4.7	4.1	4.0	3.3	2.9	5.8	4.2	3.2	6.8	3.6
20 per cent.	3.7	3.3	3.2	2.8	2.4	4.4	3.4	2.6	4.0	2.9
30 per cent.	2.7	2.5	2.4	2.1	1.9	3.0	2.4	1.9	2.8	2.1
	Factor in Terms of Section Capacity.									
10 per cent.	19	22	16	18	19	11	14	14	11	13
15 per cent.	14	16	12	14	14	8	10	11	10	9
20 per cent.	11	13	10	11	12	5	8	8	6	7
30 per cent.	8	10	7	9	9	4	6	6	4	5

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Grading Coal For the Small Consumer

THE proper utilization of coal in many cases depends upon the getting of satisfactory coal in the first place. The suggestion received from a correspondent and which we print on another page deserves considerable attention as tending to eliminate the practice, on the part of the dealers, of selling to the small consumer coal of inferior quality. The power plant owner who has no facilities for testing and who does not buy sufficient coal to warrant purchase by specification would benefit greatly by the proper grading of coal and the householder, needless to say, would derive equal advantage to the elimination of much slate, clinkers and bad temper.

War conditions in many cases were seized upon by operators as a golden opportunity to unload upon the public and the power plant owner, coal of a greatly inferior quality and the disappearance of the culm heaps at the pit mouth give evidence to the amount of inferior coal sold. This condition, no doubt, is to some extent excusable under war conditions, but with the coming of peace and the return to normal industrial conditions more rigorous control of the quality of coal supplied would not only be welcome but would seem quite feasible.

Selling Alberta's Coal Output

THE coal operators of Alberta are having troubles all their own seeking to place their product in successful competition with the American coal in the Winnipeg and Western Canada market. They were quick to make use of the shortage last fall to urge upon Western Canada the advisability of turning to Alberta for their coal supply. They had a big chance to fence off the field, but they find that the element of price also enters into the deal, and in a very pronounced way.

Basing the figures on the returns for the year 1918 it is found that some two million dollars' worth of Pennsylvania coal entered the Western market. The Alberta operators make the point that were this amount spent with them it would enable them to keep their mines going for a greater period than nine months in a year. The longer the mines work, and the greater the amount turned out, it will be seen that tonnage costs come down in proportion.

Be that as it may, the problem for the West right now is how to meet the U.S. producer on a price basis in Winnipeg. Take the two points of production, and trace the costs. Starting at a mine near Pittsburgh the coal costs, including mine labor, overhead charges and loading, are $2.60 per ton.

By the time it reaches Fort Erie, where it is loaded on the boat to be carried up the lakes, it costs $4.32 a ton.

Lake freights, customs duties and various other charges bring the cost at Fort William to $5.51 a ton.

Dock handling charged at Fort William increases the cost at that point to $6.11 a ton.

Freight to Winnipeg brings it to $9.21 a ton.

And the coal dealer who handles it, delivers it, and makes a profit out of it sells it for $12.25 a ton.

That's the story in costs of a ton of Pittsburgh soft coal put into the basement of the owner of a Winnipeg block.

The Alberta coal loaded costs between $5 and $5.25 per ton, and right here the Pennsylvania coal gets an advantage of $2.63 per ton. This is not because the Alberta miners get higher wages, but physical conditions surrounding mining in this country make the costs higher. Taking a ton of coal at the mine, for which the mine owner gets $5, and adding the freight to Winnipeg, the Winnipeg dealer finds it costs him $9.80 or 50 cents more than the Pittsburgh product. And the Winnipeg dealer sells it for $12.75 as against $12.25 for the imported product and makes nine cents a ton less than on handling the imported product, while the consumer pays 50 cents more.

Alberta has a definite job ahead of it now if it wants to fence off Western Canada as its biggest and best customer for coal. That definite job consists of wearing off that fifty cents per ton difference that now rests in favor of the U.S. producer of coal. A little more efficiency in mining and handling might go a long way toward accomplishing this end, while the freight charges might be made the subject of a very close inquiry. Flattening out this fifty cents per ton in playing for a two million dollar order looks like a worth-while proposition.

Association and Personal

John A. Greig, of Ross and Greig, has been elected president of the Caledonian Society of Montreal.

The death occurred, on Monday, March 24, of R. A. Hogge, purchasing agent for the past few years for the Steel Company of Canada in Montreal. Mr. Hogge was born in Dumfries, Scotland, in 1886, coming to Canada in 1910. After a period of service with Messrs. Hugh Russell and Sons, iron and steel merchants, he entered the employ of the Steel Co. of Canada in 1912 as clerk in the works office, subsequently being promoted to purchasing agent.

The death of George W. Cole occurred at his late residence, 64 Parkway Ave., Toronto, from heart failure. Mr. Cole was born in Norwich, Ont., and was in his fifty-ninth year. He came to Toronto about seven years ago and organized the business known as George W. Cole, Limited, 2002 Dundas St. West, of which he was president and general manager at the time of his death. Private services were held at his late residence, after which the body was taken to Norwich. Mr. Cole leaves a widow, one daughter, Margaret M., and two sons, Brock L and Grant E.

Contemplated Expansion. — Peacock Bros., of Montreal, who for many years have been Canadian agents for G. and J. Weir, Limited, of Glasgow, are now manufacturing the Weir feed pumps in their own factory recently established in Montreal. Considerable new equipment has been obtained from the States and England, and the new plant is amply equipped to handle efficiently this new branch of their operations. It is announced by officials of Peacock Bros. that the Clyde Engineering Works are contemplating increased expansion of their business in Canada.

Briquetting of Coal.—At a recent meeting of the Montreal branch of the Engineering Institute of Canada, a paper was read by Paul A. Seurot, M.E.I.C. on "Coal Briquetting," in which he emphasized the importance of developing this industry for the purpose of materially assisting in the solution of the ever-present fuel problem, and at the same time aid in making Canada more independent in this regard. He stated that of the total coal brought out of the mines, from 10 to 35 per cent. was practically wasted, and if proper facilities were provided the bulk of this could be economically utilized. Some little attention was given to this matter out West where some 1,100 tons of coal was briquetted per day, but when compared to other countries, Canada was far behind in the development of this industry.

CHANGES ANNOUNCED

The Canadian Ingersoll-Rand Company, Limited. has recently absorbed the Jenckes Machine Company, Limited of Sherbrooke, Que., thus putting them in possession of two plants, the "Jenckes plant," and the "Rand plant." The products of the "Jenckes plant" will continue to be those familiar to customers of the Jenckes Machine Company, manufactured to the latest designs. Briefly, these are: structural and plate work; tanks, penstocks, etc., mining machinery and equipment, ore crushers, cars, cages, etc., and pulp and paper equipment such as barkers, grinders, water wheels, etc. The headquarters of the Canadian Ingersoll-Rand Company are at 260 St. James St., Montreal.

Jobs For Them.—One thousand jobs are awaiting Detroit's returned crippled soldiers at Ford Motor Company's plant in Highland Park. This announcement was made by Edsel B. Ford, president of the company. The men will be paid the minimum wage of six dollars a day of eight hours now in effect in the plant. "The thousand soldiers are wanted for our new self-starter department," said Mr. Ford. "The only requirements necessary are that they are crippled soldiers, Detroit men, and have use of their hands. Men who have lost both legs and an arm will find work with us that they can do. We can use these men whether they have to stand up or lie down at their work."

A METHOD FOR THE PROTECTION OF THE PURCHASER OF COAL IN SMALL LOTS

The Editor.—

IN the matter of purchasing coal, large corporations protect themselves by buying under rigid specification as to calorific value, ash content, etc., but for the small consumer, whether buying merely for household needs, or for a small industrial plant, there is no protection whatever.

It has occurred to me that it might be possible to institute some system of Government control, whereby the supplies obtained by dealers could be sampled and properly tested by an expert in the employ of the Government, who would grade the coal according to its value as a fuel, arranged, for example, into classes A, B, C, D, etc., and the coal could then be sold on a grade basis.

It is not proposed here that the Government should exercise any control over actual prices charged, but merely that matters should be so arranged as to prohibit a dealer from selling, say, a grade "D" coal at a grade "A" price, thus instituting at least some measure of protection in the interests of the small consumer.

I am fully aware that the working out of this suggestion is not so simple as it looks, but cannot persuade myself that the difficulties are insurmountable.

Even if the ideas proposed above should prove to be impracticable for some reason or other, I think it should be quite feasible for one of the Provincial Government departments to arrange a system, whereby, should a consumer feel dissatisfied with his purchase of coal, he should be able to arrange for a sample to be taken from his coal bin by a Government expert for test, and, if it be found that his grievance is a real one, there should be machinery established, by means of which he could obtain some redress.

At the present time, if any one wishes to have a sample of water tested, it is a simple matter to have this done by sending it to the Parliament Buildings, where an analysis is made. There seems to be no good reason why similar facilities could not be afforded to the public in connection with coal. The sampling would no doubt be a little more awkward, as it would be necessary for an expert to undertake this, since the ordinary householder, or even the owner of a small industrial plant, assuming him to be honest enough to do his best, could not be expected to obtain from his bin a really representative sample.

There are, of course, various details in connection with either of the foregoing suggestions, which would have to be worked out in order to establish a thoroughly practicable scheme, but I think that for a start, some general discussion of the main ideas would be profitable.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

1. A horizontal return tubular boiler, 72 in. dia. by 18 feet long, made in three courses, has sustained damage by the plate over the fire becoming overheated. The plate has come down in a blister of elliptical form, the axes being 14 in. in a longitudinal direction, and 36 in. in a circumferential.

How would you put a single riveted patch on this boiler so as to preserve the full strength of the longitudinal seam? Would you put the patch inside or outside the plate?

2. In the case of a pump having a lift of over twenty-six feet, would the fitting of a foot valve be of any help in starting the pump. Generally speaking, where does the advantage of a foot valve in a suction line lie?

3. Can you state, clearly and definitely, why a longitudinal seam of a boiler requires stronger riveting than the circumferential? Show by figures the relation between the two.

4. The area of a safety valve on a boiler is proportionate to the grate area. What is this proportion, and in what way does the grate area affect the safety valve area?

5. What is the proportionate weight of air to weight of coal used to obtain combustion? Give any formula you know.

6. Can you give a clear description of what takes place when a boiler explodes through failure of a plate. What is the sequence of events?

Readers' Queries

Question.—We have six Scotch boilers working at full capacity. What is the best method to clean fires without letting down steam? Is it possible?

Answer.—This is a question that has been troubling engineers since fires were first lit under a boiler. The ability to clean fires without losing steam is governed by several factors: the condition of the fire, the skill of the man cleaning the fire, and the co-operation of the firemen on the other boilers.

Broadly speaking, there is no better way than the method pursued by firemen at sea, and also ashore, of burning down one half the fire. That is one side of the fire is allowed to burn itself down for perhaps 15 to 20 minutes, while the other side of the fire is fired lightly and evenly, keeping it a good bright fire. When ready for cleaning any unburnt coal on the top of the side to be cleaned is winged over by a slice bar to the side still burning, and the remaining ash, etc., is pulled out as fast as it can be done. When the bars are cleaned the red, fresh coal from the burning side is whisked over onto the clean side, and fresh coal is fired on lightly, and the cleaned side is allowed to burn up before the other side is touched.

In the meantime the other fires are kept in good condition, and worked as hard as they can be. Speed is the essence of the contract, and if the fire door is kept shut, except when actually working at the fire, as much cold air as possible is excluded.

The difficulty arises when a fire is badly clinkered, and the clinker has to be broken to get it through the fire door. Time is inevitably lost, and the man standing up to the hot fire gets played out, so that his activity is seriously curtailed. If now the boilers are being worked hard, and the steam begins to drop, it is going to be some time before it raises again.

Before cleaning a fire, the feed check valve should be shut off, the boiler being cleaned. Intelligent adjustment of the feed checks helps a lot. The boiler being cleaned, has a certain amount of grate surface out of business, and its capacity of evaporating drops. It therefore does not require so much feed, and if the water is a few inches in the glass, the feed can be closed altogether.

If the fire is very dirty, don't attempt to burn down. Pull the whole thing out. You may lose some unburnt coal, but you will lose more by wasting time in trying to burn your fire down, and allowing the steam to drop. The trouble in allowing steam to drop is this:

The steam having less heat energy in it, the engines require a greater weight of steam to perform the same work. The feed water supply has to be augmented to supply this steam. The feed pumps use a greater percentage of the steam produced by reason of the extra number of strokes, and the extra quantity of water passing through the heater lowers the feed water temperature.

Before cleaning, work your water well up in the gauge glasses, so as to have a reserve. Try and arrange to clean only one fire at a time. Clean quickly, and keep the other fires up to their work. You can clean fires without losing steam, but you have to make everyone hustle.

* * *

Question.—We have two banks of transformers, one delta-connected on the low tension side, and the other of a star connected, both primary sides being in delta. Would it be possible to connect these two banks onto the same buses, as the secondary voltages are the same?

Answer.—While at first glance it might appear feasible, any attempt at paralleling the two banks would be disastrous. The voltages due to the two secondaries connected up in these ways are not in phase, but are 30° out of phase with each other, and if paralleled this condition would lead to trouble.

LEAKAGE AT THE BLOWOFF

It often happens that the blowoff valve does not close tightly, either because it is worn or corroded, or because some obstacle has lodged on the seat. In such cases there is a continual flow of hot water out of the boiler, to an extent depending upon the magnitude of the leak; and the heat that escapes in this way is entirely wasted. Leakage of this sort is easily detected by the eye when the pipe discharges directly into the air. When it discharges into a sewer or a blowoff tank, however, some other method must be adopted. The simplest plan is to feel the blowoff pipe from time to time. Leakage can be detected in this way very easily, because the continual escape of hot water, even in small amounts, keeps the pipe abnormally heated, beyond the valve.

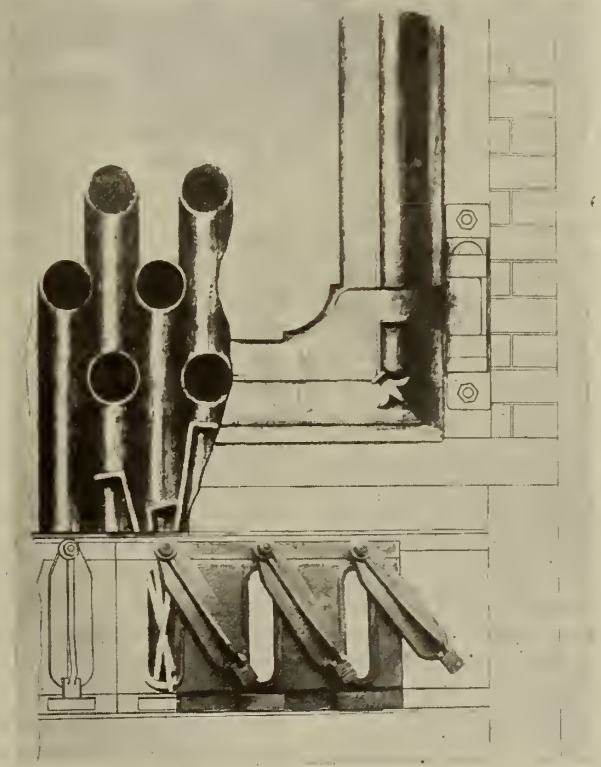
Progress in New Equipment

SOOT-CLEANING EQUIPMENT

IN the average boiler plant equipped with forced draft underfeed stokers burning bituminous coal, or with the Coxe stoker burning small sizes of anthracite or coke breeze, it is usual to operate the boilers at considerably above their rated or nominal capacity.

High ratings are obtained by high air pressure under the grates, the effect of which is to lift small particles of incandescent coke and ash from the grates, which are carried through the boiler in the furnace gases. A certain proportion of this coke or ash adheres to the bottom and sides of the tubes in the bottom row immediately above the fire.

A gradual building up of this cinder occurs slowly, closing the opening between the tubes, so that in the course of a few days or weeks, as the case may be, the area of gas passage is materially reduced, often so much as to reduce the capacity of the boiler.

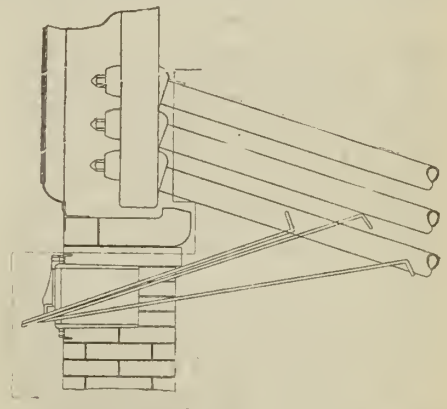


DOORS FOR SOOT CLEANING; FRONT OF WATER-TUBE BOILERS

This cinder can not be dislodged by the usual soot blowers or tube blowers, nor by the older hand lance method, and the only recourse is to cut the boiler out of service and scrape the cinder from the tubes after cooling down the furnace. This is an expensive operation and would be entirely unnecessary if means were provided whereby it would be possible to scrape this cinder off the tubes while the boiler is in service.

The usual tube dusting doors provided in horizontal water tube boiler settings do not give access to the under side of the bottom row of tubes. To meet this condition the Combustion Engineering Corporation, 11 Broadway, New York, offers the C. E. C. tube device, consisting of tube scraping door casting, bottom tnbe scraping doors, scraping tube cleaning or scraping wall boxes and access doors for tube scraping. The device is illustrated herewith. Its purpose is to provide openings in the front or rear wall of a boiler setting, through which a light hook may be used for scraping the cinder from the bottom and sides of the lowest row of boiler tubes.

These boxes are made in sections of 3, 4 and 5 doors which are spaced the same distance apart as the boiler tubes in the boiler in which they are installed. Two or more sections are bolted on angles or a bar along the top and bottom sides, providing one opening or door for each space between tubes. The openings are not in line with the tubes, but are half way between the tubes, so that the sides of the tubes may be reached as well as the bottom, and also the bottom of the second row of tubes.



METHOD OF SCRAPING TUBES

The castings are of sufficient strength to support the brick wall above them and they will, when placed under the rear header of a horizontal water tube boiler of the Heine type, support the weight of the boiler also.

The boxes are about 12 in. deep and heavily ribbed vertically between each door or opening. When installed, the brick work is so laid that the boxes are protected from radiant heat, and being in short sections of 21 to 35 in. in length will not warp and twist and loosen the brick work above and below.

Each opening is covered by a swinging door or cover, also of cast iron, the lower end of which passes behind a tapered spring catch, which can be adjusted by a light blow of a hammer to hold the door tightly against the box.

When cleaning the tubes the attendant takes a rod about ⅝ in. diameter and 10 to 12 feet long, of the same shape as an ordinary fire hook with one prong about 5 in. long. By striking a projecting lug on the door, the door is swung to one side and the hook pushed in the hole. The two tubes immediately in front of the opening are then scraped with one or two passes of the hook along the sides and bottoms, the hook withdrawn and the door closed by striking the door lug with the hook. In this manner the lower tubes may be cleaned once a day or once in two days, or more, as may be required.

This device is inexpensive and costs little to instal.

Every time a boiler is cut out and cooled down it is necessary to burn a certain amount of coal to merely heat the boiler brickwork up to the normal operating temperature. This amount is variously estimated at from 650 to 1,200 lbs.

If the cinder is allowed to accumulate on lower tubes, the capacity may be reduced to the rated horsepower of boiler in two weeks' time and the economy will fail, particularly if the plant is designed for maximum economy at a certain overload. The sum of the economies that may be maintained by the use of this device is a considerable one, and while it is difficult to give exact figures it is not hard to show wherein the benefits derived will warrant the cost of the installation.

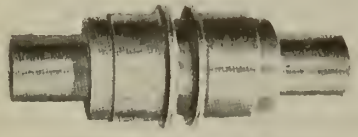
THE HANSON FRICTION CLUTCH

It is a well known fact that the majority of present day clutches are so large and heavy they have a tendency to cause trouble due to their weight alone and do not lend themselves to their ready incorporation into machine tools and other locations where appearance and reliability are matters of some consideration.

The clutch recently developed by the Hanson Clutch and Machinery Co. of Tiffin, Ohio, eliminates the cumbersome features of many older types and permits the installing of an extremely powerful clutch in very restricted locations. Its light weight, small size and neat appearance make it particularly adaptable to machine tool use.

Its capacity for transmitting large amounts of power is very great and where the outside diameter of a clutch is limited by design requirements the required horsepower can be transmitted. Takes the load gradually without a jerk owing to the double cone wedge expansion of the steel ring which grips the cylinder.

Several types are made. Fig. 1 shows a friction cut-off coupling by means of which a line shaft or any part of it may be cut-off or operated without interfering with the rest of the shop. As will be seen two coned friction disks engage



DOUBLE CLUTCH EXTERIOR.

with a double cone friction ring when the clutch is closed by means of the lever system actuated by the operator.

The clutch is adjusted by means of a threaded ring on the coned hub of the clutch. Its simplicity and positive uniform adjustment make it one of the simplest and most easily adjusted clutches and any unskilled workman can adjust it with success. All toggles are made of cast steel carefully proportioned and their complete enclosure by the guard renders the clutch extremely safe in operation.

The guard serves another useful purpose as it is used as an oil retainer, eliminating the necessity of constant lubrication, it being necessary to refill only every few months.

The clutch is thrown into and out of engagement positively and is locked in either position. It is impossible for it to engage itself even partially by centrifugal force.

In the friction cut-off coupling illustrated the ends of the shaft meet in the coned hub. This insures the absolute alignment of the shafts and a phosphor-bronze bushing is provided to carry the end of the extended shaft.

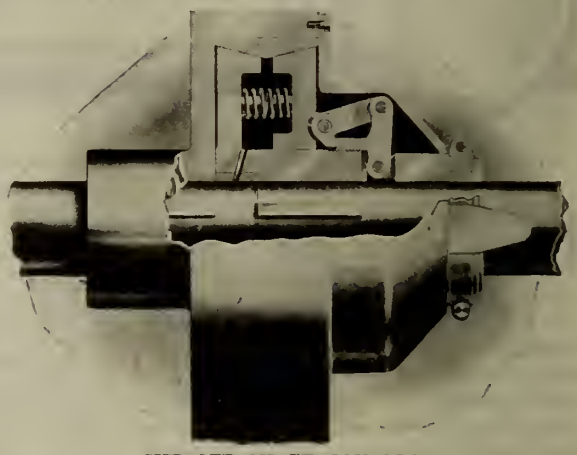
In the clutches used for machine tools and in other locations where small diameter is desirable a variation on the clutch above described is used. The operating sleeve engages with a wedge member, which in turn brings the two cones into engagement with the friction ring. As may be seen the resulting clutch is compact, cylindrical and perfectly balanced. All working parts are completely covered and are kept free from grit and dirt. The clutch can readily be adjusted to any desired tension without removing any parts by means of a single sleeve, which gives a uniform adjustment at all points around the shaft.

The double clutch shown in Fig. 3 requires but little more space than the single and is provided with two friction cylinders for mounting pulleys, gears, sprockets, etc., as desired, the dimensions of the sleeves varying to suit requirements.

Two varieties of friction surfaces are regularly applied. The standard surfaces are steel and iron bathed in oil and of long life. Where required friction surfaces are supplied of friction paper and steel. This type of clutch is designed for slow speed and heavy duty.

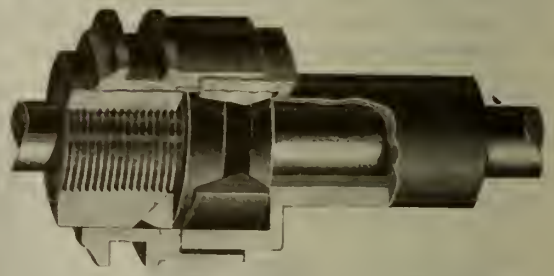
BURNING WASTE

Waste of the most unpromising character can often be burned with success and utilized in the generation of steam but special forms of furnaces are usually necessary in order to carry out the operation properly. Shavings, sawdust, bagasse, and spent tanbark are among the commoner forms of waste that are put to use in this way, and many cities are also generating steam by utilizing their refuse as fuel. The most important thing to do in burning waste, especially when it is damp or wet, is to handle the fires so that an abundant supply of air shall always be present, and a large surface exposed, over which the combustion can extend, and from which the water that the fuel contains can be evaporated. It is of prime importance, in handling wet material, to see that it becomes dried at least as fast as it is consumed; for if this condition is not fulfilled the dry part will burn up and the fire will then go out. In starting a fire that is to burn waste, it is usually necessary to run with some other kind of fuel until the furnace has become thoroughly



CUT OFF SHAFT COUPLING.

heated. The waste can then be added a little at a time, until the mass has become well ignited and a considerable part of it has become dry. Furnaces for burning waste are preferably detached from the boiler itself, the combustion taking place in front of the



SECTION SHOWING SINGLE CLUTCH ENGAGED.

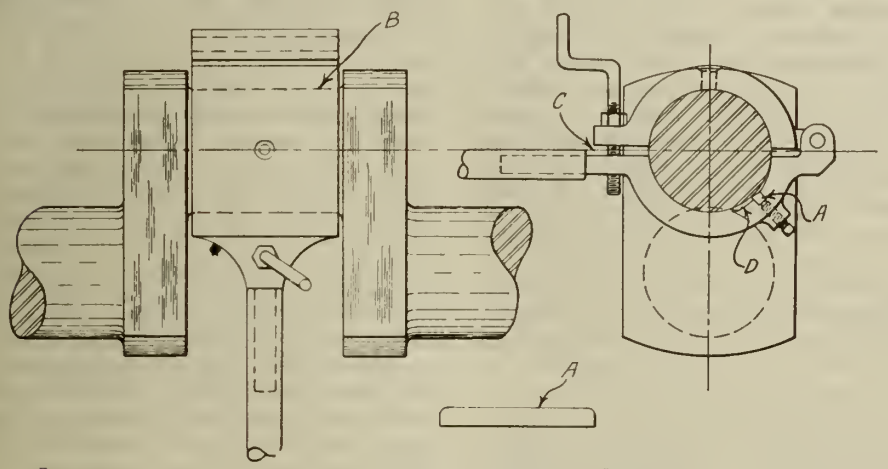
boiler, or below it, in a separate furnace from which the heated gases are led to the boiler by means of suitable fire-brick passageways. By conducting the operation in this way, it is possible to feed the fuel through openings in the top of the furnace—which is far better than introducing it through the doors in the front of the setting, as in firing with coal. The fuel should be thoroughly stirred up and worked over as it dries out and burns upon the grates, so that fresh portions of it may be continually brought to the surface. It is often best to handle the waste by a conveyor of some kind, the form of which will naturally depend upon the nature of the material itself. Blowers are used with good effect for handling shavings and dry sawdust. Considerable skill is required in order to burn wet waste effectively, and men cannot be expected to obtain first-class results until they have had the necessary training and experience.

The Operators' Point of View

ROUNDING UP WORN CRANK PINS

By A. L. MARSHALL

THE tool shown has given me so much satisfaction in rounding up worn cranks that I pass it along, hoping that it may be useful to others. The lower half of the tool-holder is made of machinery steel and case hardened; the upper half is of cast iron with a generous oil hole way cut through. The cutting tool at A is made as long as the crank is wide, while the body of the tool-holder is made slightly shorter. The hole is bored to the largest diameter of the crank pin B, with about 3-16 inch opening at C and the corners rounded to suit the fillets. In operation the tool-holder is clamped around the crank and as the tool-holder or the crank is revolved it is drawn together with the screw shown. A small set-screw near each end of the cutting tool serves for adjustment. The space D serves for the collection of the chips, and care must be taken that it does not fill up and score the pin. With a good supply of lubricant and a little care a crank can be rounded up in about 10 minutes. In this particular instance it might be stated that the tool was used on cranks for nail machine spindles, where the wear is chiefly on the high side of the crank and the little difference in throw did not matter.



RIG FOR TRUEING UP CRANK PINS

AN EMERGENCY GASKET CUTTER

By J. E. McCORMACK

AN emergency gasket punch was quickly made one day when we were cutting a gasket for a steam chest cover. The material used for the gasket was two or three ply sheet rubber, black, with cloth insertion. We wanted to cut holes in the gasket for size ⅝ bolts (if I remember right) and found no right size punch. The man who had formerly done this work had used his own tools, and, of course, took them with him when he left. While considering whether to use a knife or send for a new punch, one decided that "This will do when I get it sharpened a bit." His scheme was to take a piece of half-inch steam pipe, perhaps four inches long, screw a pipe cap on to one end and sharpen the edges of the other end. The method of using it was to place the sharpened end over the marked place on the gasket where a hole was required, then hit the tool on the other end with a hammer. A wooden block was used under the gasket to serve somewhat as an anvil, yet not dull the tool. The end of the grain of the wood uppermost gave the best results. The tool worked O.K. If the centre of the tool began to fill up with rubber pieces, they could be removed by unscrewing the pipe cap and poking the pieces out. I have used this scheme since for cutting holes in cardboard to make improvised coin cards, and with proper sized pipe it worked well for this also. Some variatin in the size of the hole it will cut can be made by the method of sharpening. Sharpening from the outside only will give a hole approximating the internal diameter of the pipe. Sharpening from the inside only, say by means of a drill, results in a hole approximating the outside diameter of the pipe, while a combination of these methods of sharpening gives an intermediate size. When sharpened from the inside the cuttings drop out, and of their own accord.

TWO VALUABLE TIPS

By J. E. N.

Most of us engineers have had experience with iron cements. Following is a formula which any reader can put together at any time. To join iron to iron for stove or furnace work, it is about perfect, and is just as good for iron joined together for outside work. It is practically impossible to separate iron cemented together with it, even if a sledge hammer is used. Take equal parts of sulphur and white lead and one-sixth proportion of borax; thoroughly mix them together; then take some of it and wet it with sulphuric acid; place a thin layer of it between the irons to be joined and press them together; let it set for five days, and no sign of the cement is left and the iron is practically welded together.

Probably thousands of your readers have made a mixture of flower of emery, etc., and used it to try for a razor edge. Of course, they secured poor results. Let them try the following mixture and they can put an edge on their knives, or their razor blades, that will be a joy and delight to them forever:

Take one ounce of levigated oxide of tin, one ounce of prepared putty powder, ¼ of an ounce oxalic acid, 20 grains powdered gum; make it into a stiff paste with water, and put a little of it over the sharpening strop. A few strokes of the blade over this will "do the trick."

It is ahead of most of the articles sold for the same purpose. A dab of moisture on the prepared strop will help to keep the paste on the strop in just the right condition for perfect work.

IMPROVISED DRAFTING COMPASSES

By J. E. M.

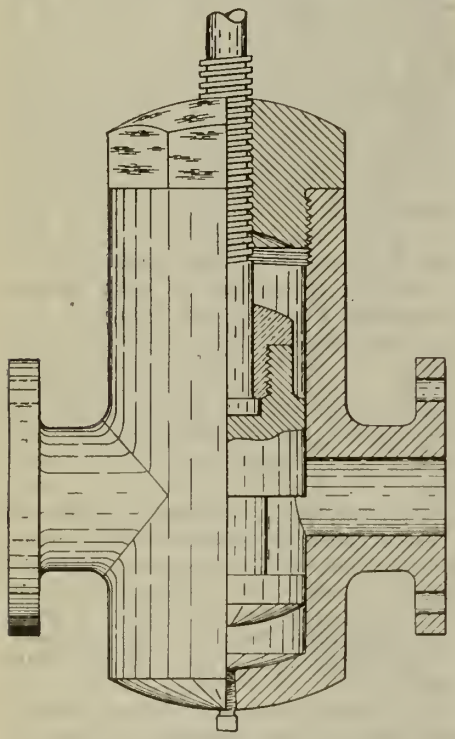
I wanted to draw upon paper some large circles in ink, but found that my drawing compasses were not large enough for the largest circles, but I had a pair of carpenter's compasses that were large enough; I also had what is called an accommodation writing pen. This consisted of a wooden handle, onto which was slipped a metal part made of thin sheet metal, and at one end so shaped as to receive the wooden holder, while the other end was so bent as to receive and hold the pen nib. I wrapped a piece of paper around the pointed end of one leg of the carpenter's compasses

until I had a bulk equal to that of the wooden pen holder where the metal part fitted onto it. I then removed the metal part from the pen holder and placed it on this leg of the compasses, still leaving the pen in place and turned the part so that the pen came into suitable position. I found that with this rig I could draw the desired circles. To ink the pen I dipped that leg of the compasses into the ink bottle. The object in wrapping the paper around the leg was to prevent the point of the leg of the compasses projecting too near to pen nib.

BOILER BLOW-OFF VALVE SUGGESTION

By K. WALSH

Blow-off valves have always been a source of more or less trouble to power plant operators, and the writer's experience has led him to offer the suggestion for a new design of valve that



DESIGN FOR BLOW OFF VALVE

would assist in overcoming some of the disadvantages generally encountered. In some respects, blow-off valves are subjected to more destructive abuse than any other unit of power plant equipment. Owing to the nature of its duties it frequently happens, when closing the valve, that a piece of scale will prevent the valve from properly closing, the result being the fireman will force the valve to its seat, often embedding the scale, the consequence, invariably, being a leaky valve.

The construction of the valve here illustrated removes some of these objectionable features; practically speaking there is no seat to the valve, as this consists of a piston sliding in a cylinder bored out to be a steam-tight fit for the plunger. The port through the valve at the time of closing. The close-plunger and the corners are left sharp to break any scale that may be in the valve at the time of closing. The close fitting piston prevents the steam or water from reaching the valve stem. Piston could be fitted with rings, if desired.

REPAIRING A DIPPER

By J. E. M.

A one quart dipper used in our department one day shed its handle. A new one was supposed to be sent for by the next messenger, but meantime a workman needed the dipper. Going to a box of the bifurcated rivets sold for mending harness, and also seen sometimes in narrow leather belts, he selected three to suit him, and with a hammer and sharp punch, soon had suitable holes through handle and dipper and had these rivets through and clinched. He made so good a job of it that the leakage was not noticeable unless watched for, and the dipper has since lasted as long as most of the new dippers last before losing the handle.

THE PRACTICAL JOKER IS A NUISANCE AND A SOURCE OF DANGER

MAY we be ever delivered from the practical joker in the power plant. His proper name is Fool, and his right place, a home for the mentally afflicted. Any man addicted to practical joking and allowing freedom to its call, should be driven from the power station as soon as the discovery is made. This does not refer to the "josser" or "jollier." A good-natured spoken joke or jolly is often a place promoter; for instance, if some man is somewhat slow in his movements when speed is wanted, it is generally possible to get him to hustle up by the proper application of a good-natured jolly; when, if a grouchy or curt order is given to speed up, it is quite possible the speed will increase, perhaps under a silent protest, with, perhaps, a mental determination to get back at the order giver sometime, somehow. I am not writing this article with no knowledge of the subject. I have had thirty years' experience in handling power plant employees. Many practical jokes are meant to be harmless, but they often work out the reverse way to that intended.

I remember seeing a man sitting in a chair tilted back against the wall in an engine room; a joker threw a burned-out 200 watt lamp which burst with a loud report under the chair, startling the sitter, causing him to upset the chair. His head hit the tile floor so hard that several weeks elapsed before he could resume his duties.

Another time at the General Electric Company's works in Canada a man was on a ladder; he was oiling shaft bearings, the top of the ladder being hooked over the shaft. A fellow worker thought it would be a joke to start the motor which operated the shaft, while the oiler was there. Just as the motor started the oiler placed his hand and arm through an iron pulley to reach an oil hole on the opposite side without moving the ladder. Result: a badly broken arm. In this case the man was not thrown from the ladder, the Lord only knows why, but he descended himself. I was at the bottom of the ladder, and to this day I am certain I heard the bone crack.

A workman connected wires to the two iron pulls on his tool drawer in such a way that anyone placing his hands on them would receive a severe electric charge. The manager came along and, standing with his back to the bench, placed his hands behind him and they came in contact with the drawer pulls. The shock he received knocked him insensible, and he was in danger of losing his life. Of course, the would-be joker was discharged and it was a close call to having to face a charge of manslaughter. It is an old joke and a mighty dangerous one to connect iron sinks in such a way that the user stands on a terminal and when he uses the fixture he receives a shock through the running water. While a fireman was taking a drink of water from the end of a hose line, the water being closed down so that only a thin stream was running; the joker came along and threw the water valve wide open; the fireman was thrown against the hot furnace doors and received several nasty burns. One joker loosened the set-screw holding a bushing on a governor pin on a steam engine direct connected to a D. C. generator; this made the engine pound and caused the lights to flicker very much; the engineer had to close down the engine, and it required some time to locate the trouble. This caused considerable annoyance to the manager by complaints from the light users, and the engineer got a call down for carelessness. Fortunately the joker had told several employees what he had done, so he "got his."

One day a new helper was taken on, a big husky fellow. One of the repair men thought it would be a joke to tell him to remove the bonnet from a two-inch valve while the pressure was on the pipe, it being cold water. The helper had a 36-inch trimo wrench and started to pull the wrong way; the joker did not attempt to put him right, he only laughed and told him to put more power to his pull; the husky helper did so to such good effect that he twisted the top of the bonnet from its screw. This ruined a perfectly good 2-inch valve. Incidentally the break was so unexpected and there being a high pressure on the pipe, both the joker and the jokee got a wetting.

And so it might go on. There have been jokes perpetrated in plants, meant

to be harmless, which have been directly opposite. No doubt lives have been lost and also much property lost through so-called jokes which have miscarried, and the guilty man never found out. Perhaps some perfectly innocent person had to take the blame. I remember a case where a joker, at night, removed one gallon of water from a five-gallon drinking water cooler in a factory, and replaced it with a gallon of grain alcohol; the result was that a number of the men got drunk on the job and were discharged; they also lost their name as reliable workers. Of course, they need not have drunk the mixture unless they wanted to; it seems to me that the so-called joker must have had some such idea of an ending in mind. The management offered a reward of $50 for the name of the joker; although he was known to several, no one exposed him. In this case justice miscarried, for he held his job, while his victims lost theirs.

Therefore, watch for him and when he is found in a power plant, "Scotch" him. He cannot be reformed, the disease is incurable, until the joker comes near his own death, or comes near killing someone else. Therefore, if you will not "fire" him, pretty near kill him at the first discovery.

JOHN PORT.

FEEDING BOILER COMPOUND

By R. MACLAREN.

In feeding boiler compound it is well to know when sufficient is being given. My method is as follows: — A testing mixture is prepared by stirring into a gallon of half alcohol and half water one ounce of phenolphthaleine.

The latter may be obtained from a druggist, and if you will read the police court columns of the newspapers you will probably find out where to obtain the alcohol.

A sample of water is drawn from the boiler.

If it is drawn from the try cocks care must be taken to see that enough is blown out of the column so that the sample will be from inside the boiler. A few drops of the testing mixture are dropped into the sample.

If sufficient compound is used the water will turn red.

As too much compound will make a boiler foam, it is worth while knowing the condition of the water.

One of my boilers once had an exceedingly bad attack of foaming.

The test showed only the proper amount of compound.

Investigation of the boiler disclosed the fact that the furnace gases were short circuiting through a hole just below the lower water column connection, and causing the water in the column to boil. As it might be difficult for some to get half a gallon of alcohol, a few ounces of the mixture in the ratio given will do as well.

Some Paragraphs About Steam and Boiler Operation

Coal shortages drew attention to a great many leaks that were turned into economies and raised the general average of the amount of water evaporated per pound of coal, which is the real function of every well-run boiler. Some facts on steam, evaporation, and condensation follow. Not only have the men in charge of boilers and engines learned more about these very facts, but those who are only indirectly concerned have evinced an interest in a most important subject.

* * *

One cubic inch of water evaporated at atmospheric pressure (15 lbs.) becomes one cubic foot of steam, approximately.

* * *

Boilers that are well designed and carefully operated will evaporate from 7 to 10 lbs. of water for every pound of coal burned—poor qualities of coal will reduce this amount considerably.

* * *

Every square foot of heating surface in a boiler is sufficient to evaporate two lbs. of water. This is the average basis of calculation and may vary with the operation. In figuring the size of boiler for a given engine whose consumption of water per horse power per hour is known, the boiler should have ½ sq. ft. of heating surface for each lb. of water consumed per H.P. per hour.

* * *

Wood has been burned largely during the past two years: its comparative value may be stated by saying that 9 lbs. of dry wood is equivalent to 4 lbs. of good steam coal.

* * *

The consumption of coal for a boiler may be roughly figured by knowing that on every square foot of grate surface there can be burned an average of 18 to 20 lbs. of soft coal or 10 to 12 lbs. of hard coal per hour with ordinary stack draft.

* * *

Engines are said to consume so many pounds of water per hour as stated above—really they consume the steam that is evaporated from the water, but as it is water (not steam) that is bought for a boiler, this form of statement is usual. Different types of engines consume from 12 to 52 lbs. of water per H.P. per hour, and from 1½ to 7 lbs. of coal.

* * *

The first cost of condensing engines and outfit is, of course, greater than for simple non-condensing engines, but the economies of operation make up for this cost in a short period. A good condenser will save approximately 1-5 of the fuel to be consumed, or it will increase the power of the engine 1-5 for the same amount of fuel used.

Condensing engines require, on the average, twenty-five times the amount of water for condensing purposes that is needed for boiler feed; this, of course, is not consumed as is the feed water. For the average engine from 1 to 1½ gallons of water per minute per H.P. is needed for condensing.

* * *

Surface condensers for compound engines require approximately two square feet of cooling surface per H.P. Surface condensers for simple engines require more surface per H.P., the amount varying with the economy in use of steam.

* * *

A good condenser and a good air pump should show 25 inches of vacuum. This will make available 10 to 11 lbs. more mean effective pressure (M.E.P.) with the same terminal pressure, or stated another way, it will give the same mean effective pressure with a correspondingly less terminal pressure.

To get results and economy with condensers it is always necessary to set the air pump lower than the condenser.

CHIMNEYS AND STACKS

Chimneys and stacks should have a capacity considerably in excess of the normal needs of the plant, in order to provide for temporary overloads and for future increases in the number of boilers. Brick or sheet steel may be used in their construction, the choice being governed mainly by the relative cost of construction and maintenance, and often by location and architectural considerations. Brick chimneys, when properly designed and constructed, are quite permanent and need but little repairing. They should have an inner lining, entirely separate from the outer portion, and preferably extending to the very top or nearly so. This lining is made thinner than the outer wall, because it does not have to resist wind pressure. It serves to protect the outer wall from the heat, thus preventing the formation of cracks from uneven expansion and from the chilling action of rain. The lining should be made of fire-brick, to its entire height: and it should preferably be laid up with fire-clay. Brick chimneys, like brick settings, often leak air sufficiently to damage the draft to an appreciable extent. The same possibility should be considered in connection with steel stacks also, and their joints should be calked at all points, in order to keep the leakage down as much as practicable. This precaution is often neglected, and the efficiency of the stack is correspondingly reduced. Leaks in or around the smoke flue should be promptly detected and stopped, and special attention should be given to the points at which this flue enters the chimney or stack. Steel stacks are often made without any lining of brick, but such a lining is to be strongly recommended, because it tends to prevent corrosion of the stack on the inside, and it also reduces the radiation from the stack and in this manner improves the draft.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$28 00	$.....
1¼ in.	32 00	.....
1½ in.	35 00	28 00
1¾ in.	35 00	28 00
2 in.	40 00	28 00
2¼ in.	43 00	30 00
2½ in.	45 00	35 00
3 in.	52 00	40 00
3¼ in.	.....	47 00
3½ in.	62 00	48 00
4 in.	70 00	60 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$3 50	$4 50
Tank plates, 3-16 in..	3 75	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard	Lapweld	
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183.00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 60%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 75
Steel bars, base, Toronto ...	5 00
Steel bars, 3" to 4" base...	**6 00**
Iron bars, base, Montreal ..	4 55
Steel bars, base, Montreal..	5 05
Reinforcing bars, base	4 50
Small shapes	**5 75**

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 25	$ 6 25
Sheets, Black, No. 10.	5 25	5 25
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 85
Premier, 10¾ oz. ...	....	8 50

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.....	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1....	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws.....	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less...	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. bd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly 0	35
Solder, guaranteed 0	40
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums 5	20
White lead, pure, cwt. 16	20
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D," per lb..... 0	03
Rosin "G," per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' In. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd..$	0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless.....	0 55
Tubing, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 In., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer bead bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add	40, 10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper ...	17 25	19 00
Tin	60 00	58 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 50
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided ...$	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila..	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

BOOK REVIEWS

Steam Engines, By E. M. Shealy, the McGraw Hill Book Co.—This book on steam engines was written as a text book for correspondence students in the University of Wisconsin. It is the third of a series of three text books designed for those students who are pursuing a general course in steam engineering, the other two being "Steam Boilers" and "Heat." The fundamental principles underlying the operation of the steam engine are taught in as simple and non-mathematical a manner as possible. Enough of the practical features of steam engine operation has been given to illustrate the principles involved; that part of the course dealing with valve gears has been made more complete than other sections because it has been found that operating engineers usually do not understand the valve gear mechanism of their engines as well as they do other parts.

Contents: Principles of the steam engine, Corliss and other engines, parts of the steam engine, heat work and pressure, properties of steam, indicators, indicated and brake horsepower, action of steam in the cylinder, steam engine testing, the slide valve, the valve diagram, valve setting, shifting eccentric and the Meyer valve, reversing mechanisms, Corliss valve gears, governors, compound engines, condensing apparatus, lubrication, steam turbines.

For the engineer who wishes to obtain a reference work or for the student wishing information on the principles and operation of the steam engine this work should prove quite welcome.

The Practical Telephone Handbook, by J. Poole, 7s. 6d., Sir Isaac Pitman and Sons, Ltd., Amen Corner, London.—The present edition of this work has been completely revised and largely rewritten with the incorporation of much additional material relating to the later developments in telephone engineering. The contents have been brought in line with the British Post Office practice. The various subjects dealt with embrace the whole field of telephone engineering and the automatic telephone exchange is described in detail, great advances having been made in its use, particularly in England and on the Continent. This work is intended as a handbook for those having to do with the operation of telephones. exchanges, line construction, etc., and the subject matter has been prepared with this end in view.

The various types of telephone systems adapted to various uses including the now almost universally adopted central energy system are described in detail, together with much descriptive matter regarding the apparatus itself. The modern exchange, multiple switchboards, junction line working, trunk line working, party line working, and other systems are dealt with. The supply of power for the operation of the central energy plant is taken up in a chapter which deals with the apparatus used and its arrangement for the continuous supply of power. Pole line and underground construction are thoroughly dealt with.

One of the more recent devices which have made long distance telephony possible is the system of Pupin loading coils, which enable the inductive characteristics of the circuits to overcome capacity effects. Transmission line calculations are given in the section devoted to this phase of operation. Multiplex telephony and the use of phantom circuits are dealt with together with the use of submarine cables. As the subject of telephony needs for its elucidation at least an elementary knowledge of electrical science, and in order that the book may be of service to the general public, the author has considered it advisable to define the various electrical terms which will be met with in the descriptive matter, and to give a short sketch of the science. Telephone employees, for whom the book is chiefly intended, should find it of value and of interest from the standpoint of European practice as well.

A Handbook of Physics Measurements, in two volumes, by Ervin S. Terry, John Wiley and Sons, Inc., New York, and the Renouf Publishing Co., Montreal. Price $2.00 per volume.

The aim of these works is to furnish the student of pure or applied science with a self-contained manual of the theory and manipulation of those measurements in physics which bear most directly on his subsequent work in other departments of study and upon his future professional career. While primarily intended for the student in the universities, the text has a wider application and will prove of value to those in engineering pursuits who have occasion to use the principles of general physics in their application to optics, heat, harmonic motion, sound and electricity and magnetism. A useful portion of the first volume treats of the general principles underlying physics measurements and the theory of errors, required accuracy of measurements, approximate formula and the graphical representation of results are dealt with. The properties of matter are dealt with in the following chapter, together with the measurements employed. The remainder of the first volume is devoted to optics and to a set of physical tables. The second volume gives those measurements of quantities in vibratory motion, sound, heat, electricity, and magnetism, which experience has shown to be most available for college and industrial laboratories. Much consideration has been given to the particular determinations now demanded by science and industry. In addition to the standard experiments in heat, the mechanical engineer will be especially interested in the methods given for the determination of the economy effected by steam pipe coverings, the thermal value of coal and the thermal value of gas.

All the physics determinations in electricity and magnetism ordinarily made by students in electrical engineering are described in detail and in addition considerable space has been devoted to work on damped vibration and harmonic wave analysis. This work is of importance in the study of alternating current phenomena. As in the first volume each chapter consists of two parts. The first includes definitions, a description of the apparatus, the general theory of the methods and the derivation of the equations used in the determination of the quantities considered in the chapter. In the second part of the chapter each determination is described in detail with respect to the theory and manipulation of the experiment, and the computation of the result.

MECHANIC'S AND DRAUGHTSMAN'S POCKET BOOK

Sir Isaac Pitman and Sons, Ltd., London, have published a pocket handbook of the above title for use of draughtsmen, mechanics and others, who have frequent need of some reference work for the recalling of formulae, etc., used in every-day work. W. E. Dommett, the author, in his preface states that the work, notes and diagrams are not intended to replace text-books, but to act as a means for refreshing the memory in cases where the latter has become imperfect. Mathematical tables are given in compact form and include squares and cubes of numbers, square and cube root, temperature conversion tables, areas and circumferences of circles, trigonometrical functions, tapers and angles and logarithms.

The above tables are those usually found in works of this type, and in addition to these some extremely useful tables are given, which are seldom seen. These have to do with the coefficient of friction of various materials, revolutions of wheels or discs per minute, and the centrifugal force exerted by a rotating mass of one pound, at various speeds, etc.

Wire gauge tables, specific gravity and other weight tables, thread tables and other tables dealing with the properties of materials are included.

The sections dealing with trigonometry mechanics, statics and logarithms, together with that on mensuration, are of particular value, and while the book is of 125 pages, much information of real value has been condensed into a small space and the book should prove a welcome addition to the reference library of those who have occasion to use material of this nature.

WATCHING FUEL WASTES

Sometimes the managing head of a manufacturing concern is not alive to the needs of the power plant because he does not understand the dollars-and-cents possibilities that it offers. When the engineer cannot get what he knows the plant needs, he loses interest in the welfare of the department of which he is in charge. One rather extreme case of this came to the attention of a salesman for a house that manufactures power plant supplies.

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CYLINDER OIL
MANUFACTURED ONLY BY
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An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

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American Manufacturer Wants Representation in Canada

Our proposition should interest an established machinery supply house now calling on steam power plants in Canada. For particulars, write Box 161, Power House.

(H) P.H.

"See our chief engineer about the matter," said the general manager to the salesman. "We leave all matters of fuel economy to him."

"Leaves all such matters to me, does he?" said the engineer when the salesman called on him. "If he only did leave them to me there would be something doing. Last week I went to the office with a requisition for a feed water thermometer. I was turned down. He said we must 'economize.' I told him that was what I wanted to do and why I wanted the thermometer. I tried to explain that every 10 degrees added to the temperature of the feed water meant a saving of 1 per cent. in fuel.

"What do you think he said to me? He asked me if the thermometer would make the feed water any hotter!

"I told him that I could not heat water with a thermometer, but that the particular thermometer I wanted would tell me where I was 'at'—which was more than I knew at present. Did I get that

WANT COMPETENT ENGINEER TO LOOK AFTER SCHOOL BOILER PLANTS

"THAT there should be greater efficiency and safety from proper inspection of the boilers in the Toronto schools is the contention of many of those who have been following the case for some time. In the schools of Toronto there is consumed about 20,000 tons of coal per year, and the contention is that by proper inspection there could be a very material saving. In fact one of the trustees who is going into the matter very thoroughly makes the statement that it would be possible to pay $3,000 per year to an engineer to act for the board and then show a saving of $7,000 per annum, as well as having a greater margin of safety in the operation of the plants. The Toronto branch of the C.A.S.E. have taken the matter up and have assured Trustee Bell that he will have their sympathy and support in the matter.

The case, as stated to POWER HOUSE by one of the Toronto engineers, is as follows: At present, those in charge of the plants have nothing in the examinations they have to pass to show for efficiency, that is, proper combustion and general economy in the boiler room. The caretakers in most cases are paid so much per room for cleaning, etc., but in most cases they have to engage a fireman or engineer to run their heating plant during the winter months as they have no time to look after it themselves. Of course they are out to engage a man for as little as they can get him. In case the plant runs under 20 pounds pressure or is under 50 horsepower, any person can be taken on without papers, but above that size papers are required for the man who fires the boilers. The engineers contend that there should be a competent engineer to superintend these plants. The papers that are set at present have some twenty-four questions, and they cover only the rudiments of boiler and plant operation. In regard to the attitude of the C.A.S.E. in the matter, one of the officials of this organization stated:

"We have no axe to grind in the matter. We are interested because the matter comes directly into our field and because many of us are ratepayers with children attending school. The matter was discussed at one of our meetings and we decided that we would back up Trustee Bell because we felt that he is right in this matter. We would urge the appointment, and ask simply that it should be made on the merits of the case and entirely removed from any political or ulterior influence. It would also be well to have such an inspector of boiler plants acting separately from any other official, and he should be allowed to make his report directly to the Board of Education."

London.—The Canadian Government has signed agreements with Greece and Belgium, advancing $25,000,000 to each country for the purchase of Canadian goods. It is expected an agreement with France will be signed shortly.

Agreements with Serbia, Poland and Bohemia cannot be negotiated until the Peace Conference defines boundaries of these countries and guarantees stable Governments.

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Engineers, Manufacturers and Founders
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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

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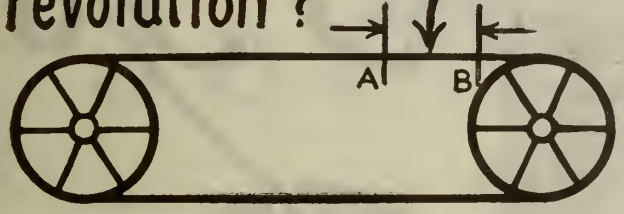
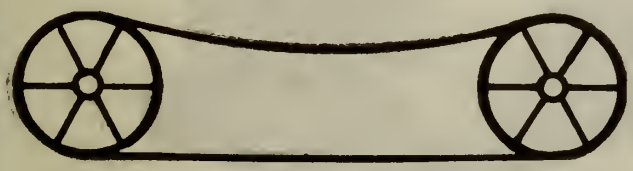
—a man who can give his entire time to selling a widely advertised power house device. An intelligent, convincing talker, a man not afraid of work, a man who expects good pay for good work, is the man we want. We will respect your confidence. In the first instance, write fully to Box 160, Power House.

(E) P.H.

Does your belt slip this much each revolution?



Do you know how much your belt slips? Have you ever tried to find out? Belt slip is a thing that every belt man should know all about.



Perhaps your present belt slip is a serious matter but you don't know it, because you have never studied your belt.

Listening and looking at a belt are not enough. Actual MEASUREMENTS AND COMPUTATIONS should be made.

Perhaps your belts are too tight. Tightness does not necessarily stop belt slip. By treatment with Cling-Surface and increasing the arcs of contact slip can usually be entirely eliminated.

CLING-SURFACE--- What It Is and What We Will Do For You

Let us diagnose your belt troubles. At least let us help you. Tell us the exact diameter of your driven and driving pulleys in inches; the thickness of your belt, inches; the revolutions per hour of your driven and driving pulleys; the width of belt, inches, and distance between shafts, feet. Give us ACCURATE information. We will compute your belt slip and tell you if Cling-Surface will improve matters.

Cling-Surface is a sensible, logical, engineering treatment. It is not sticky. It BENEFITS the belt. Lengthens life. Waterproof. Makes the belt pliable. Enforces intimate contact.

The sooner you write to us the better, for as soon as Cling-Surface is applied, coal, labor, time and money begin to be saved.

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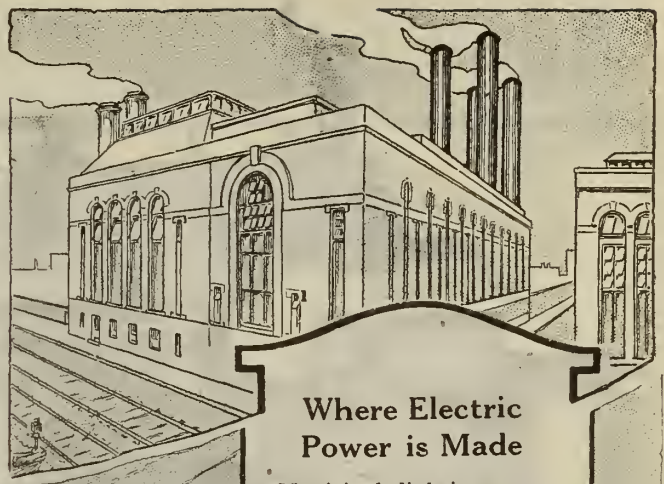
Send orders to above address and delivery will be made from Toronto or Montreal stock. F.O.B. those points duty paid



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Municipal lighting companies take no chances when buying equipment. As current must be supplied uninterruptedly, every precaution is taken against shut-downs.

Take corporations such as

Montreal Light, Heat & Power Co., using 24.
Cleveland Elec. Ill'g. Co., using 178.
Edison Elec. Ill'g. Co., Brooklyn, using 100.
Potomac Elec. Lgt. & Pr. Co., Washington, D.C., using 24.
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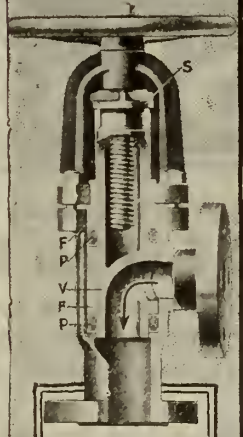
Worcester Elec. Lgt. Co., Worcester, Mass., using 36.

Each has its boilers equipped with from 24 to 178 YARWAY (formerly Simplex) "Seatless" Blow-off Valves—a choice that in effect, becomes a recommendation of the very highest character. In the YARWAY (formerly Simplex) there are no seats or discs to cut, clog or grind down. There are no pockets to gather sediment—no obstructions of any kind. The port is free and wide open. Packing is protected and will last for years.

Other good points may be learned by trying a YARWAY for 60 days. It may be returned if not satisfactory.

Write for one to-day, stating size of line and whether screw or flange, angle or straightway.



Operation:

In closing valve, shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

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It can be done—that's why so many in the United States are using the Jacklift and the platform system for handling heavy loads. And now the Jacklift is being made in Canada for Canadian manufacturers who wish to reduce their inside trucking costs.

The Jacklift and platform system in your plant means the easier handling of loads, the quicker movement of materials, less labor, greater economy and less possibility of accidents or damaged materials.

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High Lift

A clear lift of 2½ inches by four easy strokes of the handle operating an ordinary jack.

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Four times the handle movement means a lifting ratio of 1 to 35. A girl or boy can easily handle one of these machines with heavy loads.

Angle Lift

The handle will operate at any angle up to 90 degrees either side as easily as straight away. This is impossible with any other truck.

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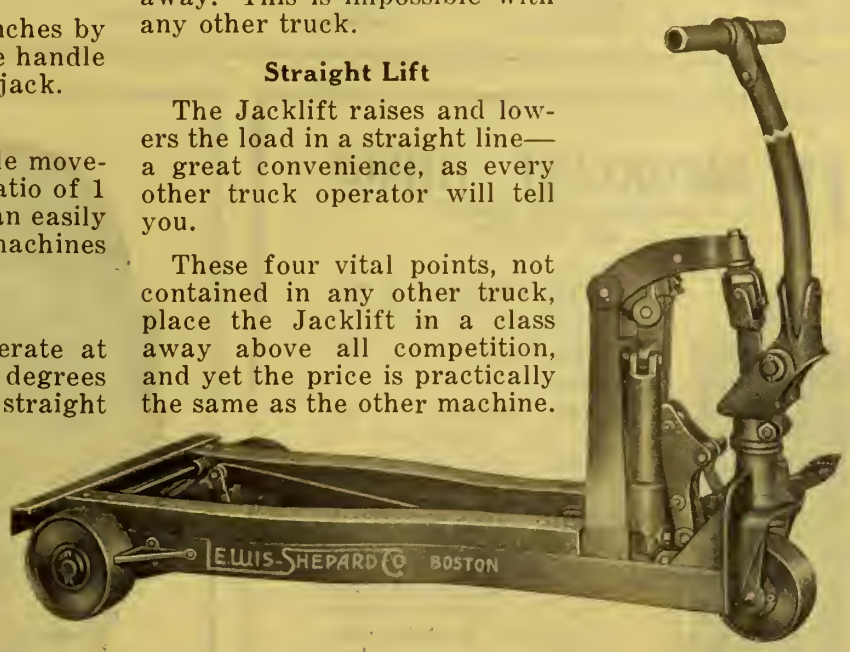
The Jacklift raises and lowers the load in a straight line—a great convenience, as every other truck operator will tell you.

These four vital points, not contained in any other truck, place the Jacklift in a class away above all competition, and yet the price is practically the same as the other machine.



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By the logical principle of the **BOILER METAL TREATMENT** is easily obtainable. Not only will **METLSKIN** remove old scale, but it also will prevent feed-water solids from adhering to boiler-metal.

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Why not familiarize yourself with this method of treatment? If your boilers carry as little scale as 1/32 of an inch **METLSKIN** will show you an actual cash saving on fuel-bills. Let us prove it.

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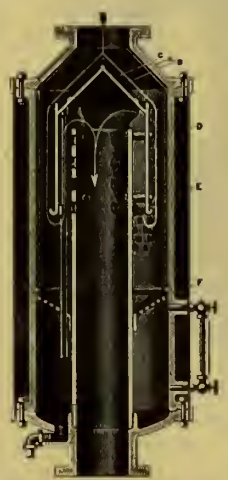
III IMPORTANT THINGS
TO CONSIDER ABOUT A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

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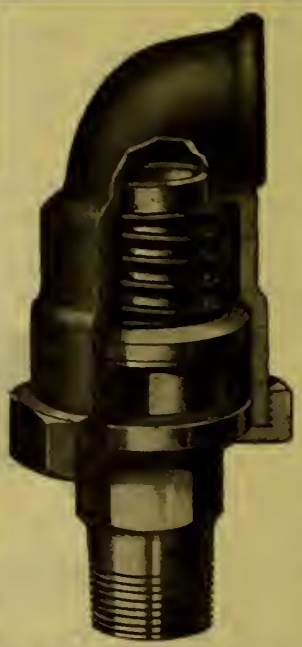

Tuxeda SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

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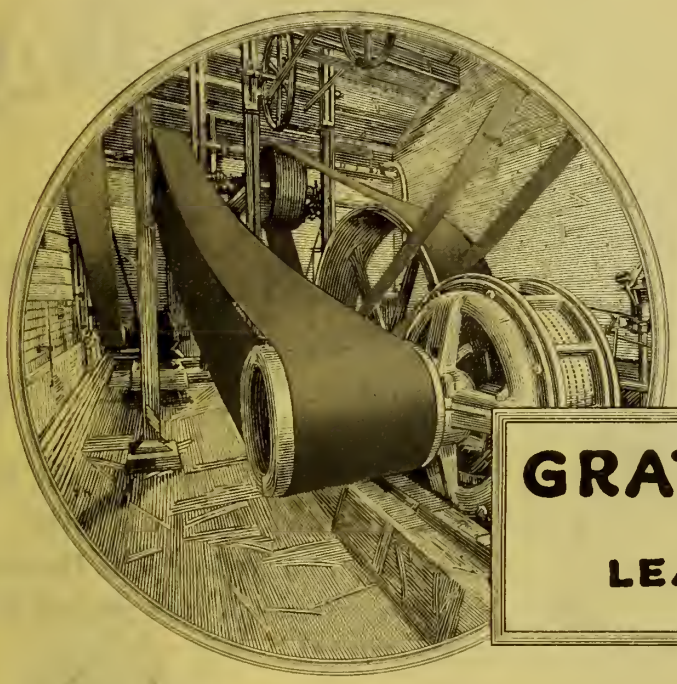

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Standardized Series
LEATHER BELTING
Tanned by us for belting use

HERE *is pictured a 75 foot Graton & Knight Heart Brand Belt in the plant of the Model Mill Company, Johnston City, Tenn. It is* 24 *inches wide, double-thick. It transmits* 241 *Horse Power. It has been in continuous hard service for five years. Its cost per week has been* $1.35, *or five mills per horse power, per week.*

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Leather is the right material for belting. It is firm. It is strong. It has permanent power of expansion and contraction. It is tough, but it yields in the *right* degree, at the right time. It is easily and repeatedly spliced or repaired. It stands mauling by shifters. Side-slapping won't fray it. Even after long use it can be cut into narrow belts and goes on with its good work.

Leather stands alone as to these characteristics. It is Nature's contribution to power transmission needs. No other known substance is like it in wearing qualities. And no other belting material successfully replaces it.

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Many of the best-belted plants ask us to specify the belting for every drive. Try the plan yourself. Then, when buying, call for "Graton & Knight Brand — or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration — the work to be done.

Write for new book about Standardized Leather Belting

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Every joint is packed with Durabla. There was not a leak on her trial trip.

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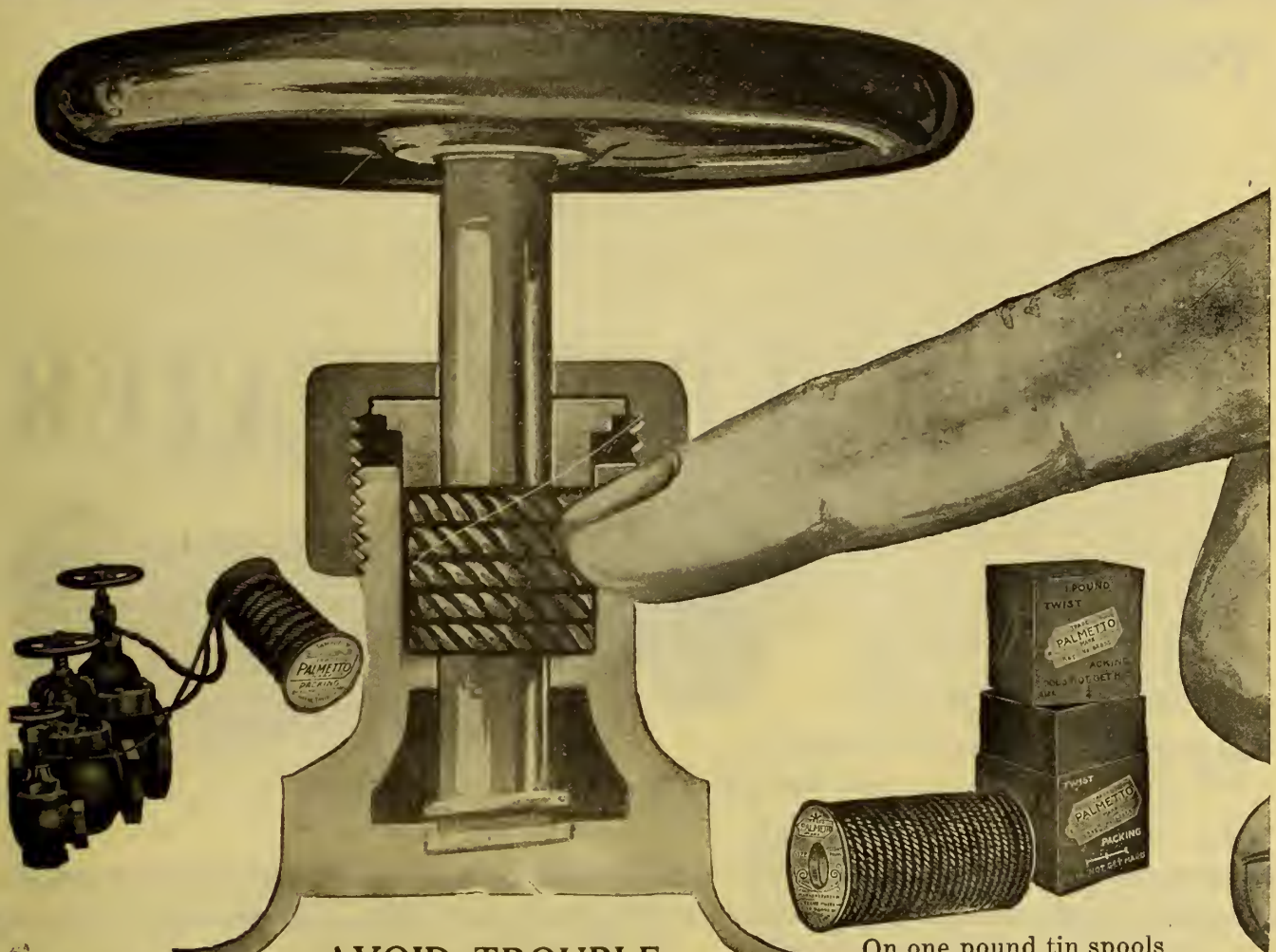

On one pound tin spools in a dust-proof box.

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by packing all the small valves with

TRADE MARK
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TWIST PACKING

as it has lasting qualities unknown to other packings. The quantity of packing in a globe valve is small, but the quality must be the best.

"Palmetto" Twist contains the graphite grease that keeps the stem well lubricated, allowing the hand wheel to turn easily at all times.

ANY SIZE VALVE CAN BE PACKED FROM ONE SPOOL OF "PALMETTO" TWIST—BY UNSTRANDING.

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Split Tubes
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Because in this Alberger Heater expansion stresses are positively overcome by the use of a divided tube head which takes care of the unequal elongation of the tubes in the various passes.

With this
ALBERGER MULTI-HEAD HEATER

your hot water cost will be cut down. You will be saved steam repairs—fuel space. You will need no extra storage tank because the water will he heated to the required temperature as fast as it is withdrawn.

You will need less fuel because the small diameter helically corrugated seamless pure copper tubes insure very rapid heating; they have heen proven to transmit 50% more heat than any plain tube heater of similar size.

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Capacities range from 200 to 200,000 gallons per hour.

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The Valve with a Backbone

The BEST for Boiler Feed Pumps

A perfect and permanent adhesion of rubber and steel. Gives **lasting support** against conditions that discredit all-rubber types, make all-metal a source of continual annoyance and emphasize the complexity of other combinations.

The **simplest** valve to instal. No extra equipment involved in interchange with other valves.

No pumping heat too great for our "Superhot" Grade.

Ask for special booklet.

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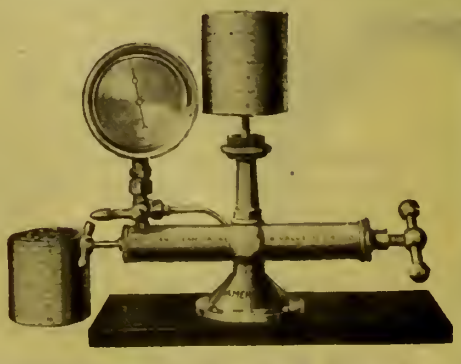
Simplifies Gauge Testing



Especially adapted to shop and engine room testing. Check your own gauges.

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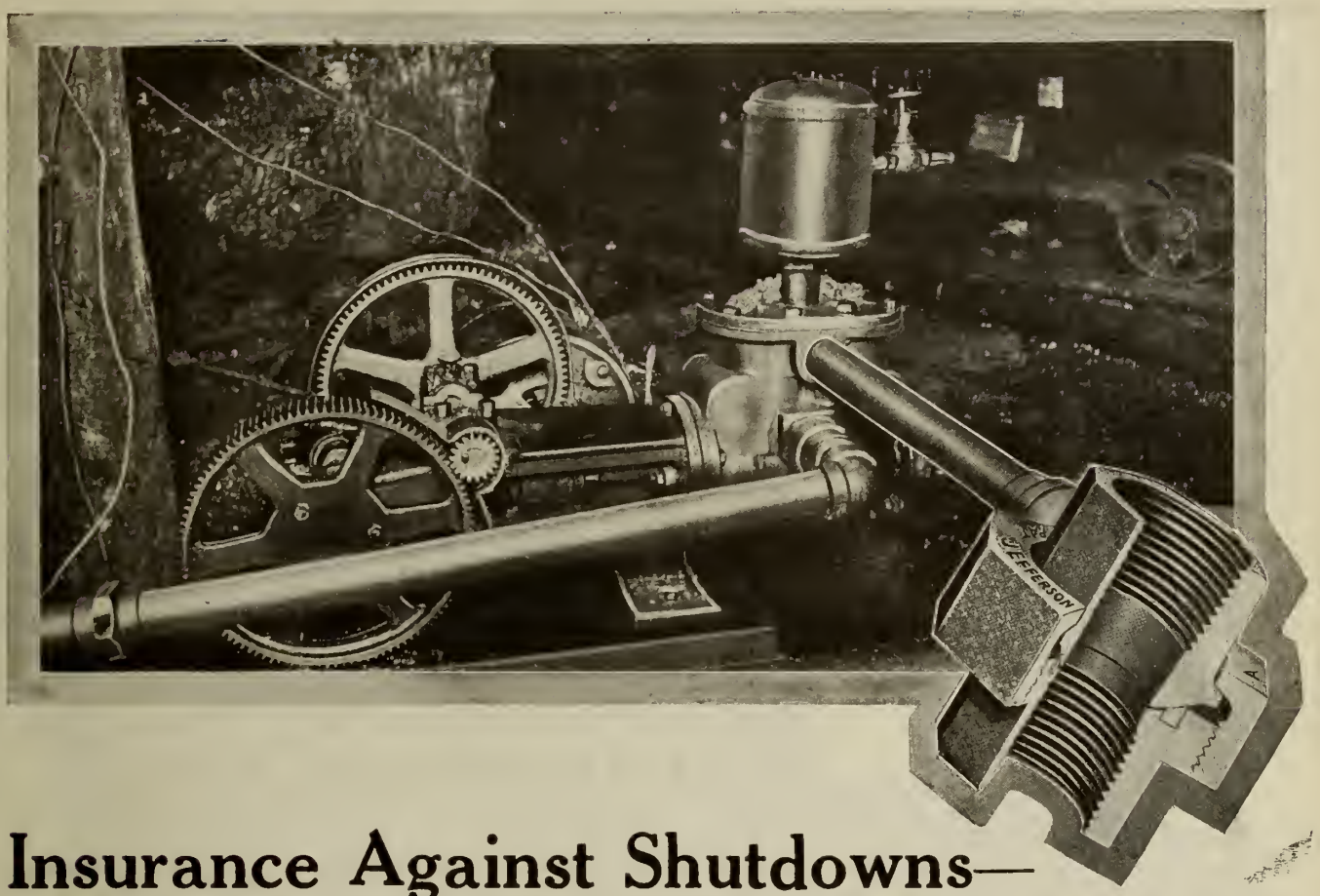

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JEFFERSON UNIONS

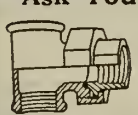
Backing up the engineer in his effort to boost production to top-notch records you'll find JEFFERSON UNIONS. Big production requires steady, uninterrupted service, steam lines that carry great variations in the load and air lines that deliver full pressure under all conditions of service.

JEFFERSON UNIONS are to-day, as in the past, meeting exactly every requirement of severe service. They are constructed extra heavy of the highest quality materials—a feature that insures the continuous perfect service so essential in the power plant.

Be sure to get JEFFERSON—the name on the nut protects you from the "just-as-good" variety and costly break-downs.

Ask your jobber to show you JEFFERSON Unions to point out where they are different. Our new Catalog, "UNIONS," describes the complete JEFFERSON LINE. Write to-day for your copy.

Ask Your Jobber About These Jefferson Specials



Union Tee, with union on the outlet. Made also with male end on outlet.

Male and Female Union. Does away with a nipple, and makes a short connection.

Union Elbow with 45° angle. Also made male and female.

JEFFERSON UNION COMPANY

Lexington, Mass.

P.H.

Williams "Agrippa" Chain Pipe and Fittings Wrench

THEIR narrow, single jaw, with saw-tempered teeth for file sharpening when worn, gives these wrenches unequaled facility for holding and turning cramped and irregular fittings, flanges, short nipples, etc., etc., because:—

They grip upon surfaces where ordinary tools cannot—"Their grip does not slip."
They do work which tools with broader jaw will not.
They give more and better service than any screw-adjusted wrench made.
They "start" rusted fittings when all else fails—just the service to be logically expected of a fully warranted tool.

Remember, each Chain, like those in our well-known "Vulcan" Wrenches, is "proof-tested" in a standard tension machine to two-thirds of its catalog strength, and is certified. We guarantee absolutely every tool that leaves our factories. 7 sizes for ⅛ to 12" pipe and fittings.

Your dealer will serve you. Ask for Booklet.

J. H. Williams & Co.

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If what you want isn't advertised in this issue, consult our Buyers' Directory. If it isn't listed in our Directory, write us and we will give you the information.

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TEN years ago the U. S. Rubber Reclaiming Co. of Buffalo installed a 50 H.P. Link-Belt Silent Chain Drive. That drive has been operating ever since, 24 hours a day carrying a 50% overload. If figured on the basis of a ten-hour day, that drive has been in operation 24 years.

Think of it. Twenty-four years of driving efficiency—unaffected by heat, cold or dampness, carrying 50% greater load than was intended—with never a slip, the load always cushioned and never a moments idleness for chain repairs. That's Link-Belt Silent Chain Drive efficiency and service. It will prove itself "flexible as a belt, positive as a gear, more efficient than either" in your plant. Let us prove it.

Our many years of Power House experience is at your service to help you save money in the transmission of your power. Write us. Ask for our Data Book No. 125.

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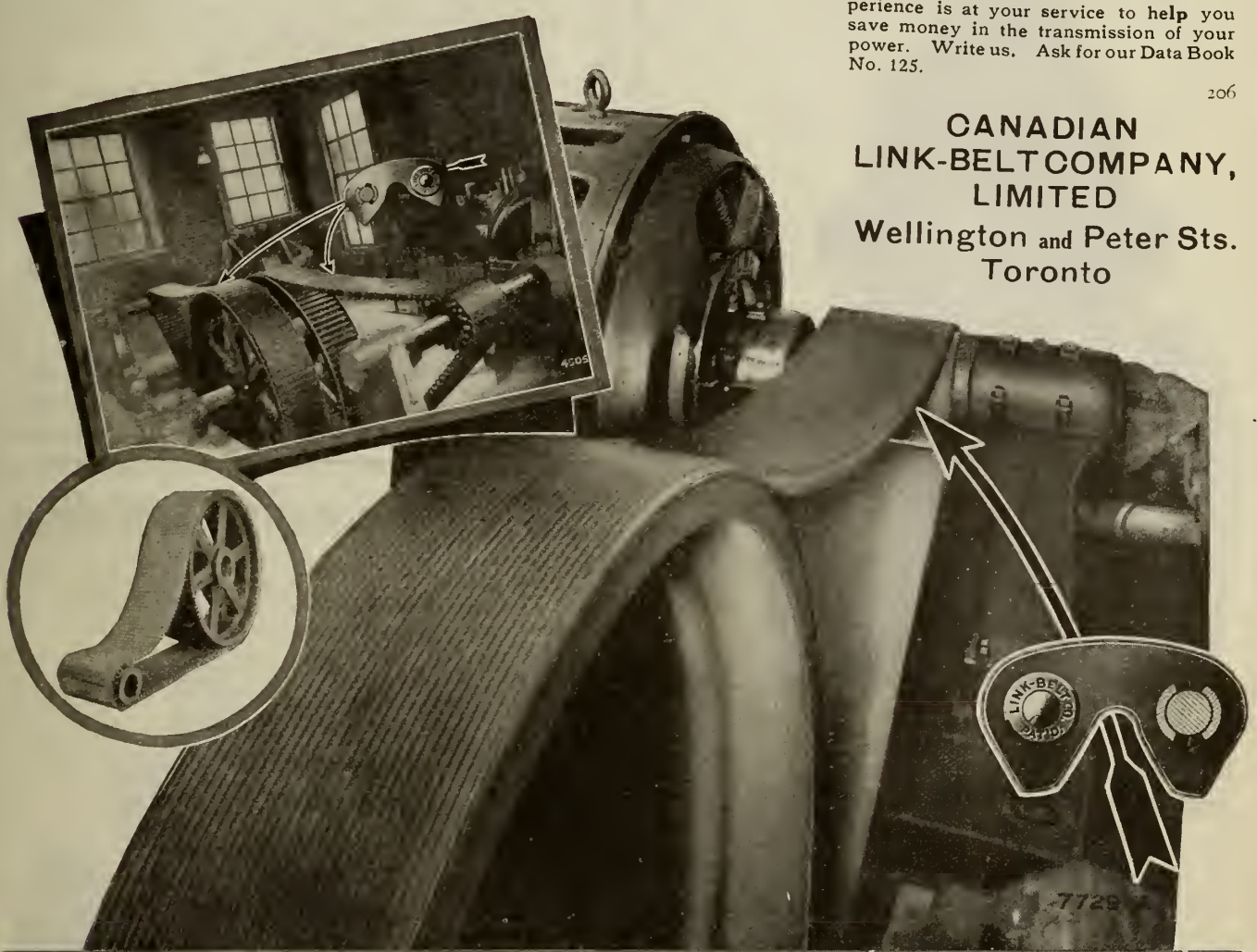

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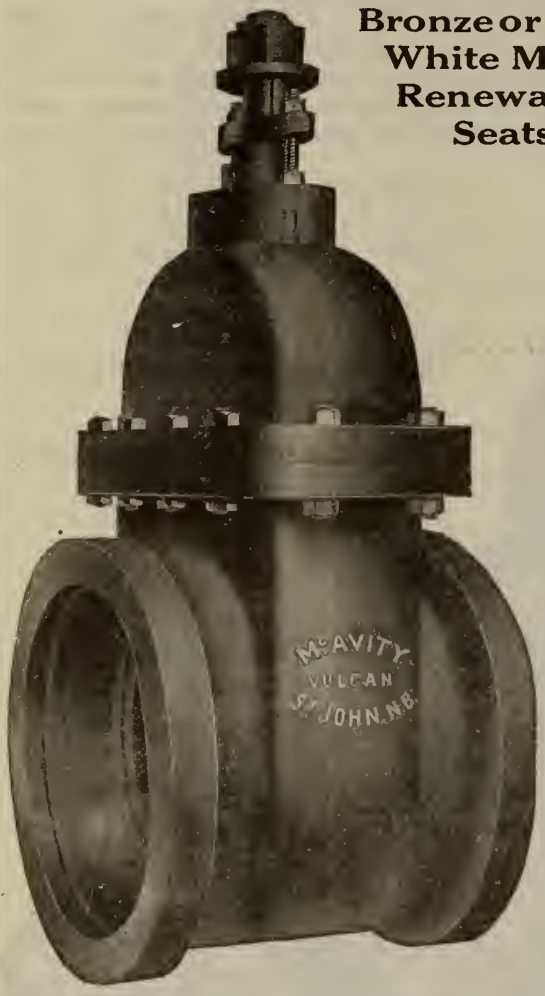

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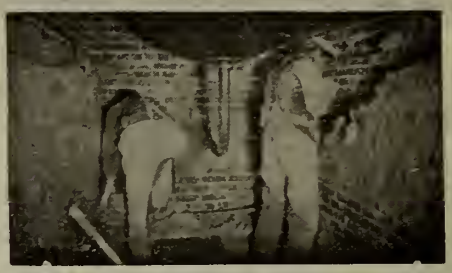

To Build a One-Piece Furnace Lining or Baffles Use the Pioneer and the Tried

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Simply stick it on in chunks, pound it it in place with a mallet and finish it off with a trowel, just like plastering a wall. Simple, isn't it?

Makes the entire lining a solid mass. No mortar or bricks to fall out.

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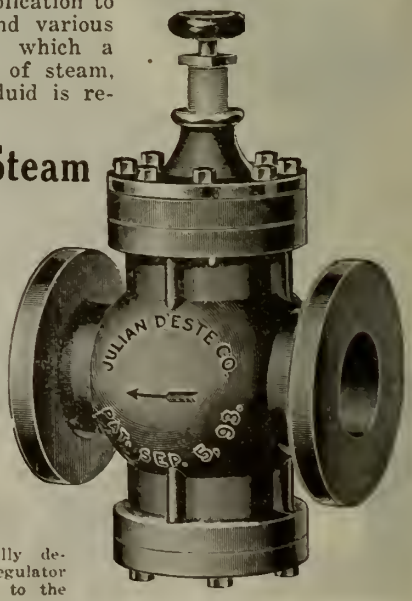
Improved Steam Pressure Regulator



has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip or leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

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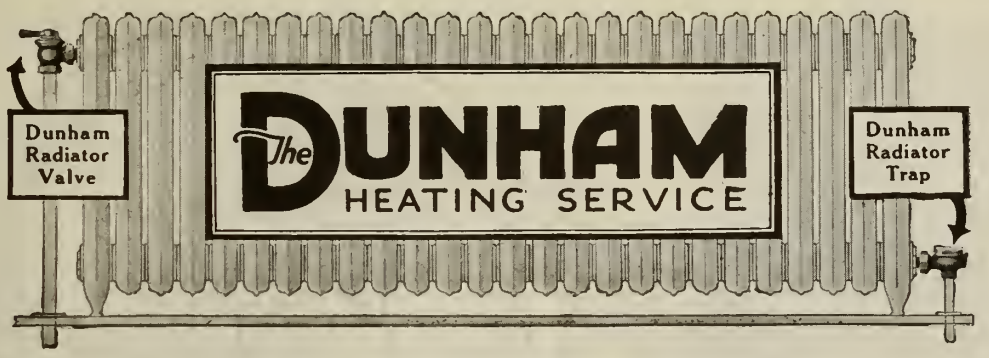

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The public wants better steam heating service—more comfort per ton of coal. This Company is in a most favorable position to meet this demand through its co-workers—the architects, heating and ventilating engineers, heating contractors and builders—to whom it offers practical co-operation that will increase their prestige as well as their volume of business.

Any man who uses, specifies or installs steam heating equipment will find it advantageous to learn more about Dunham Heating Service—the product of 15 years' knowledge of steam heating in all its phases.

C. A. DUNHAM COMPANY, LTD., Toronto, Ont.

Halifax Ottawa Vancouver Montreal Winnipeg Calgary

822 POWER Vol. 48, No. 23

Coal Saving by the Scientific Control of Steam Boiler Plants*

By D. Brownlie

THE author has been associated for about ten years with the investigation on scientific lines of the working of every description of steam-boiler plant, and in the present article it is proposed to give the average figures for 250 typical steam boiler plants, with the object of supplying accurate data as to the tremendous national economy that can be effected by the adoption of scientific methods in the boiler-house.

In the burning of coal for the generation of steam, the loss because of lack of scientific methods is hardly realized and, apart from the national point of view, offers to the individual firm a means of most substantial economy in running expenses.

It is not possible to find out what is the exact amount of coal used for the production of steam for purposes other than power, there being, for example, no statistics available showing the number of steam boilers at work in Great Britain.

The author proposes therefore to assume, until further information can be obtained by a proper engineering census of the country, that the total amount of coal used for steam generation in the United Kingdom is between 75 and 100 million tons per annum, being 60 to 70 million tons for power production and 15 to 30 million tons for purposes other than power, corresponding to 40 per cent. to 53 per cent. of the total coal used, and is of the opinion that the 250 boilers to be dealt with in the present article are really representative of all the boiler plants of the country, and the results of such a very large number of exhaustive investigations carried on continuously during [illegible] us to judge with co[illegible]

rine" boiler, 2 "vertical" boilers, and 3 "patent" boilers difficult to classify. It would be most interesting to know the exact number of each type of steam boiler at work in the country, although there is no doubt that the chief type in use is the "Lancashire."

Amount of Fuel Used—The average shows 20.9 lb. of fuel burnt per square foot of grate area per hour, referring, of course, to the average amount burnt per hour per working day, and not to the amount for any particular hour. This figure is considerably below what is possible on a boiler plant run on modern lines, which would burn something like 25 lb. to 30 lb. per square foot grate area per hour with the average quality of fuel. The boiler plants of the country are working under very easy conditions in this respect, and much more fuel could be burnt per boiler. Figures for fuel consumption depend largely on the quality of the fuel. Thus a good quality washed coal of, say, 13,000 B.t.u. and 7 to 8 per cent. ash could easily be burned economically at the rate of 35 lb. per square foot per hour, whereas purely refuse coals would only give [illegible] Coke of good quality can be burnt [illegible] per square foot grate [illegible] 15 pounds.

[illegible] to the effluent from some other works.

Economizers—Out of the 250 plants, 155 were fitted with economizers, the other 95 plants having no means of utilizing the waste heat from the boiler flues.

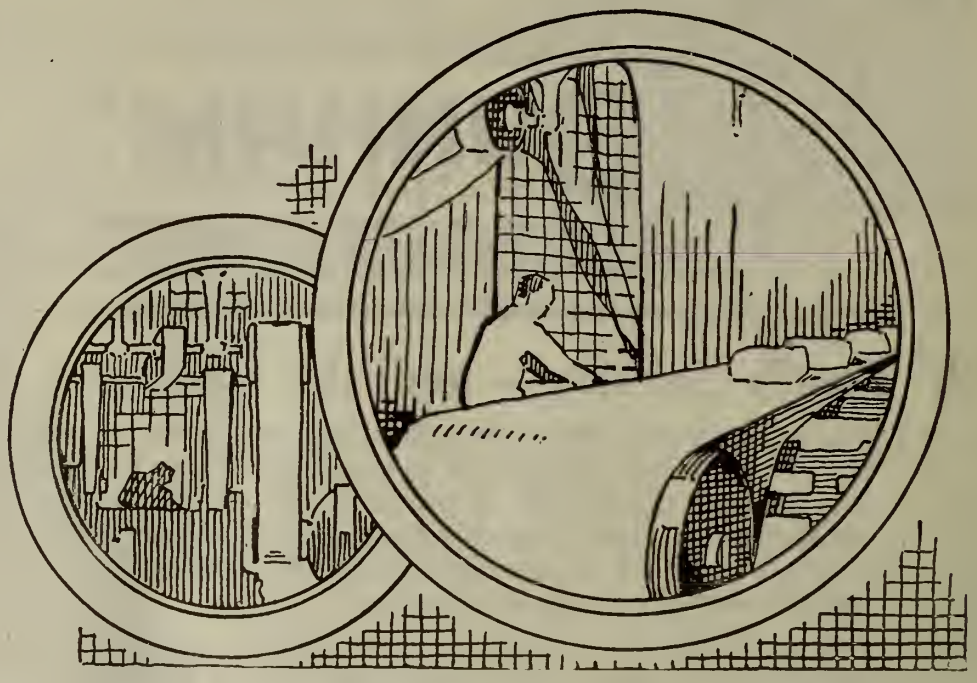
Taking the 155 plants fitted with economizers, the average saving is 11.4 per cent. of the coal bill. The highest figure found was 19 per cent. on a cotton-mill plant. The ordinary figure obtained on a well-managed plant is 15 to 20 per cent. saving, depending on the conditions.

Estimation of CO_2—Out of the 250 plants, 225 [illegible] not [illegible] CO_2 recor[illegible]

Consult Us—

Our Engineers will be glad to furnish information regarding Economisers for your plant.

GREEN'S ECONOMISER, LTD.
TORONTO



How Dominion Rubber System Belting Service Helps Belt Users

For more than fifty years we have specialized in the making of belting and the solving of problems in transmitting power and conveying materials economically.

We maintain a staff of belting experts for the sole purpose of helping Canadian Manufacturers to "speed up" production by cutting belting costs and eliminating power wastage.

These experts will, without charge, analyze your transmission and conveying equipment in its entirety and will recommend changes only where they are necessary to increase the efficiency of that equipment.

You are under no obligation to us in availing yourself of this service—the only return that we request is that you purchase Dominion Rubber System Belting when you have been convinced that the changes recommended by our engineer will be beneficial.

This special service is available through any of our branches.

Phone, wire or write the one nearest to you and let us prove to you that the kind of service we have given to Canada's largest industries and the kind we want to give to you, means more then just selling better belts.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
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Makers of
Dominion Hose, Packing and Industrial Rubber Goods and Dominion Tires, the GOOD Tires for every Purpose.

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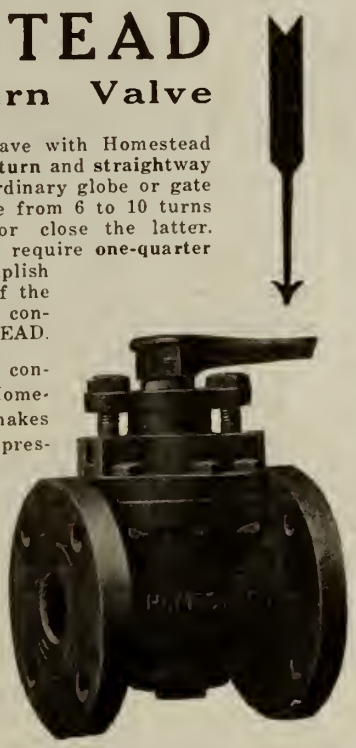
Just One Quarter Turn

Opens or Closes This HOMESTEAD Quarter Turn Valve

Think of the time you save with Homestead Valves with their **quarter-turn** and **straightway** opening, compared with ordinary globe or gate valves. It takes anywhere from 6 to 10 turns of the wheel to open or close the latter. HOMESTEAD Valves just require **one-quarter** of one full turn to accomplish the same result. Think of the time saved—think of the convenience of the HOMESTEAD.



Homestead Valves are all constructed with the patent Homestead Principle which makes them seatless while the pressure is passing through, thus they are operated easily and safely.

Made in Straightway, Threeway and Fourway patterns.

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First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

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And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

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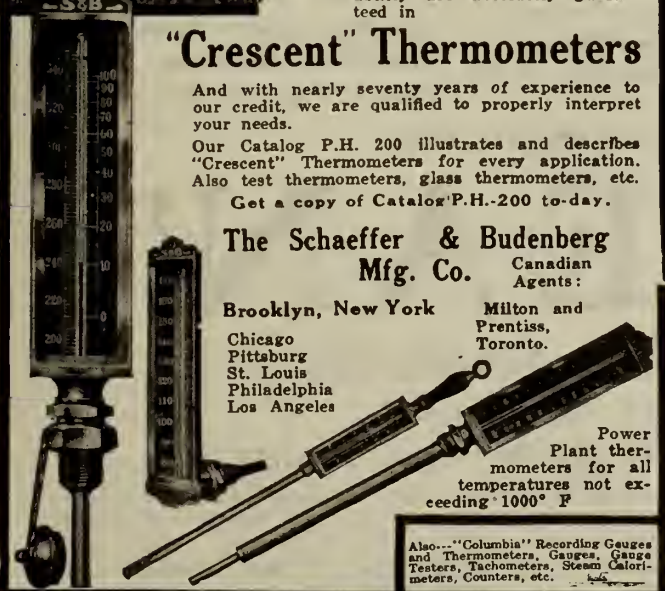
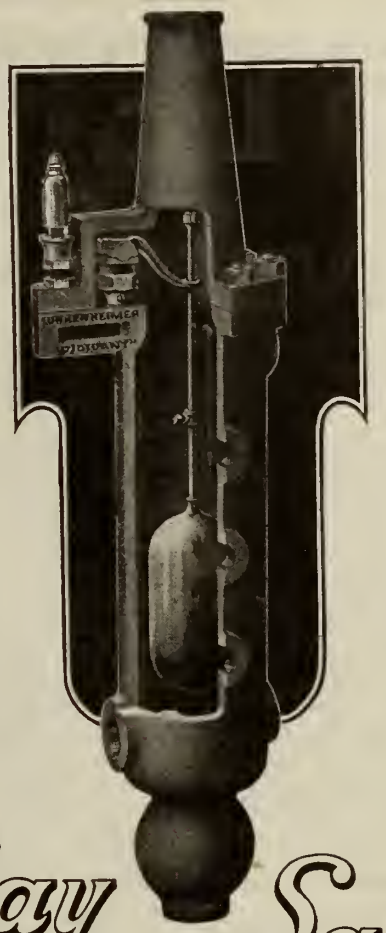


Power Plant thermometers for all temperatures not exceeding 1000° F

Also---"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.



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Guard against the possible destruction of life and property.

THE
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will protect the boiler against the dangers incident to low or high water levels by automatically sounding an alarm when the water level approaches either danger limit.

It thereby safeguards life and property, and by aiding in maintaining a uniform water level contributes to economy in the use of fuel.

It has demonstrated its reliability in service, and is specified where safety and economy are paramount

For working steam pressures up to 250 pounds; in a variety of sizes to suit all makes of boilers.

Specify LUNKENHEIMER "VIGILANT" and insist on its installation.

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★STEFANSSON'S
OWN STORY *of his*
FIVE YEARS *in the* ARCTIC

Over five years ago Vilhjalmur Stefansson, the famous Arctic explorer, was commissioned by the Canadian Government to lead a party into the uncharted space that extended from the north-westerly boundaries of Canada on to the North Pole. Shortly after the party got away the news came back to civilization that Stefansson and some of his party had drifted out into the Arctic seas on an island of ice and they were given up as lost. But Stefansson came back, safe and sound after four years of amazing adventures, during the course of which he made many discoveries of scientific and geographical value. Mr. Stefansson has written his story of this wonderful journey and exclusive Canadian rights have been purchased by MACLEAN'S MAGAZINE. It starts in the April issue and will continue for six months. It is a thrilling narrative—unquestionably the most important Canadian story of the year.

★ **Stefansson's story will be published exclusively in Canada in MACLEAN'S. The series of articles by him, now appearing in American and Canadian newspapers, refer entirely to his experiences on previous explorations and do not deal with the journey that he undertook for the Dominion of Canada and completed last year.**

Other Outstanding Features of April MacLean's

"Imperial Relations Must be Worked Out," by Viscount Bryce. An important announcement on the future construction of the British Empire.

"Reconstruction in Turkey," by Stephen Leacock. A humorous article on the present condition of things in Turkey as seen by Canada's great humorist, and applied to Canadian conditions.

"Bulldog Carney," by W. A. Fraser. A splendid novelette of the Canadian West, complete in this issue. Illustrated by Charles L. Wrenn.

"Opening the New Book," by J. K. Munro. An article on the situation at Ottawa created by the new Liberal leadership—smashing, impartial, fearless.

"The Sun Gazer," by Charles G. D. Roberts. A remarkable animal story. Illustrated by Artheur Heming.

"Canada's Fishmonger General," by Thomas M. Fraser. An article on a young Canadian who put Canadian fish on the diet of the British armies by a series of Barnum and Bailey advertising stunts.

"Bombing the Boche," by Lieut. J. Vernon Mackenzie. The second of the two articles that Mr. Mackenzie has written on the whirlwind campaign of raid reprisals which so frightened all Germany.

"The Transformation," by Frederic S. Isham. Illustrated by Hanson Booth. The second instalment of this sparkling new serial.

"Man and Wife," by C. W. Stephens. Illustrated by R. M. Brinkerhoff. The first instalment of a three part story of Canadian life by a new Canadian writer—a delightful love story with a background of business intrigue.

The Review of Reviews

The best articles from all publications the world over are selected and condensed for this department. Some of the articles in the April number are:

The Man Behind Bolshevism.
Could German Fleet have been Destroyed.
The Secret Plans of the Allied Command.
Too Much Wilson.
Is the ex-Kaiser Haunted?
Next Government Will be Labor.
New Life of Deposed Princess.
A New Kind of Socialism.
Are We Communicating With Mars?
The Cohort of the Damned.
Has War Wiped Out Disease?
The Red Terror in Russia
The Sultan Takes Hold.
Some Tricks of the Mediums.

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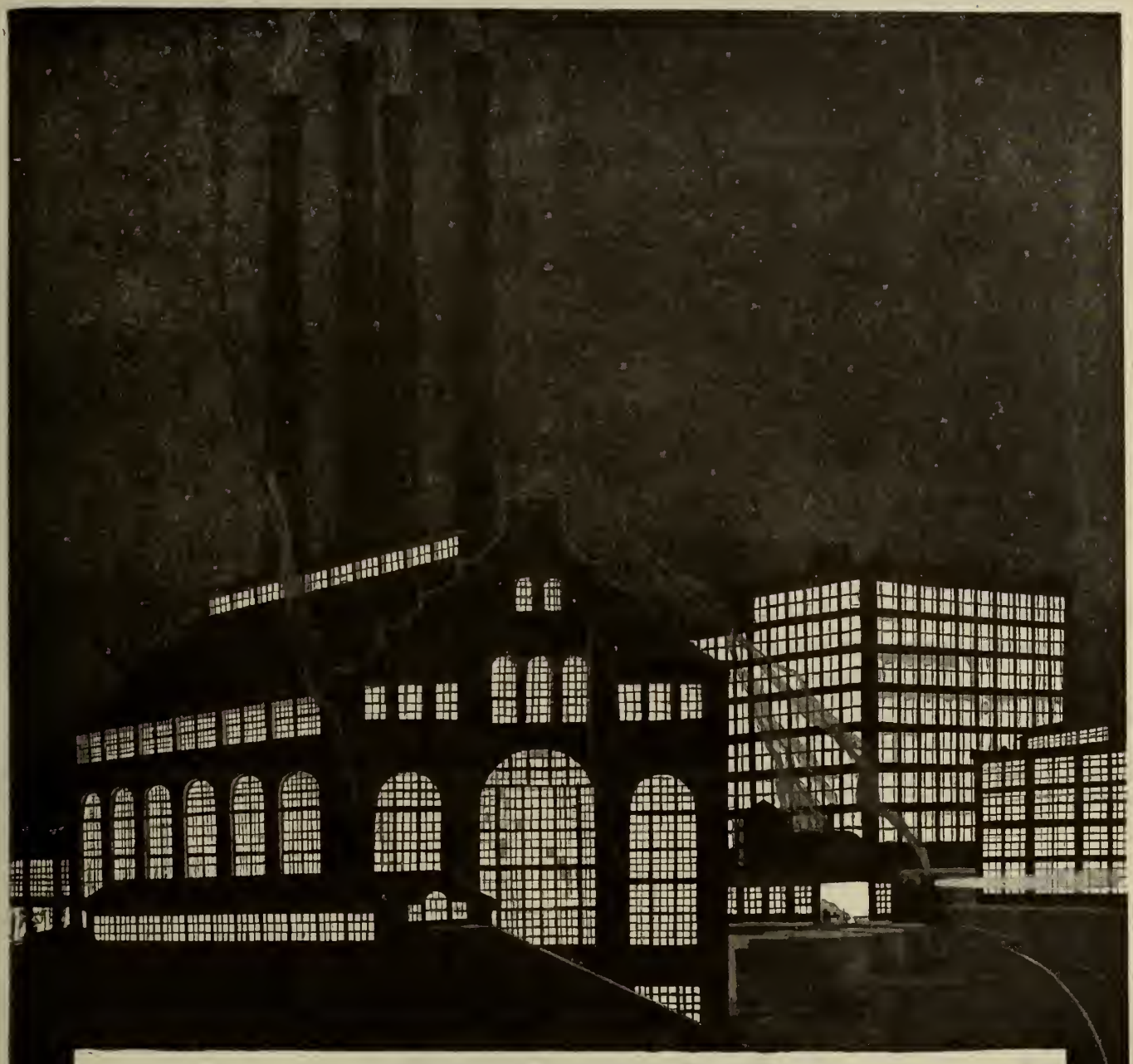

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No matter what the temperature, moisture, or pressure, no matter what's flowing in the pipe, or being handled by pump or machine, Vulcabeston never relaxes its watch, never corrodes, never loses its resiliency, never squeezes out. It simplifies your packing problems.

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THE JOHNS-PRATT CO. "VULCABESTON" RED FIBRE STAR **HARTFORD, CONN.**

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VULCABESTON

FOR DREDGES

FAIRBANKS-MORSE COMPANY
Seattle, Washington

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I was in charge of work at the above point, also the dredging work, Morevella, State of Menas, for almost ten years, and at all times MAGNOLIA METAL gave A1 results.

Yours very truly,
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EVERYTHING IS OVERHAULED AND REFINISHED BY US AND **GUARANTEED** AS GOOD AS NEW, BOTH ELECTRICALLY AND MECHANICALLY.

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Nearly all of the principal power, lighting and street railway plants in the United States are our customers.

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Fifty Subscriptions from One Firm

THE International Business Machines Company, of which Mr. Frank E. Mutton is vice-president and general manager, subscribed to 10 copies of THE FINANCIAL POST some months ago—these copies to go to their travelling salesmen. Now this company has increased the number of these subscriptions to 50 because the results of the experimental subscriptions have proved so satisfactory.

FRANK E. MUTTON

Mr. Mutton explained that the object of putting THE POST in the hands of the men of his company was to keep them intelligently acquainted with general business conditions in Canada. He said he knew no better paper than THE POST for the purpose. It would seem that his men have responded fully to effort made to keep them well informed about Canadian business affairs—so much so that the management have added 40 other men to the original 10 to receive THE POST.

When Mr. Mutton was with the National Cash Register Company as its Canadian manager, he was the king of all managers in the matter of sales records. In this position he achieved a big reputation built on solid achievements. He learned salesmanship in a school where competition was of the hottest kind, and where the competitors were brilliant men. Giving Mr. Mutton full credit for superior personal qualities and energy of the most ardent kind, it is taking nothing away from him when it is said that not a little of his success was due to his intimate and sympathetic knowledge of the other man's business. And he taught the men associated with him as salesmen to know the point of view and requirements of the men they called on to sell machines to.

As vice-president and general manager of the International Business Machines Company, Mr. Mutton is putting into operation an idea used by him in past days with brilliant results—he is causing his salesmen to know the business and requirements of their prospective customers. To establish points of contact swiftly and surely is one of the open secrets of successful selling.

In the case of **your** solicitations of customers and desired customers, it is excellent strategy to have your salesmen so well informed about business conditions generally, and about the interests of the men they canvass, that they will be able almost instantly to relate their proposals to the interests of the buyer. When a salesman shows himself intimate with the interests or business or objectives of the man whose order he wants, he is immensely strengthened as a salesman, and his percentage of successful canvasses goes steadily up.

Our definite suggestion to you is: Subscribe to THE POST yourself, and learn from its pages how your salesmen or executives can draw power from this newspaper. Then, having acquired the sought-for knowledge, subscribe to THE POST for each man in your service who can profit you by knowing what is in THE POST each week. If Frank Mutton and other prominent executives are making a success of THE POST as a salesman's aid, it is reasonable to suppose that other managers of salesmen and executives can likewise employ THE POST as a producing agent. And so we ask you to sign and forward the coupon below.

The MacLean Publishing Company, Limited,
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Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.

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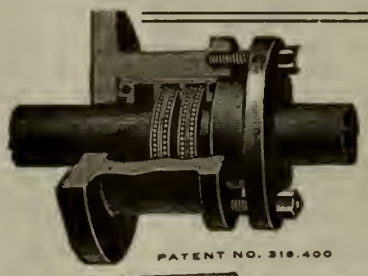

PATENT NO. 319,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	905,103
" "	775,194	" "	934,829
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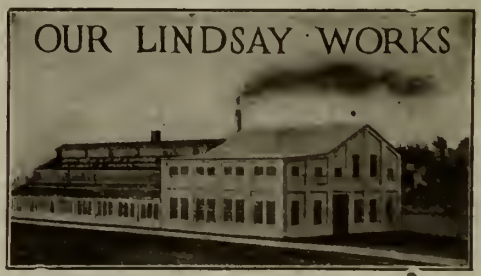

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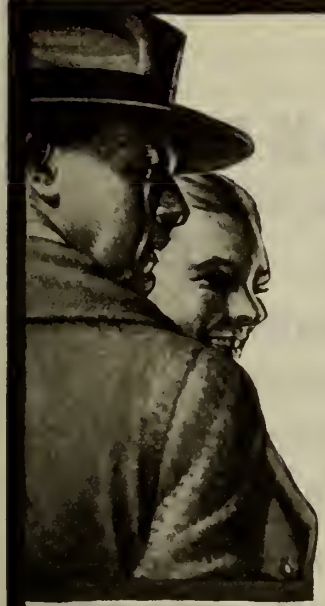

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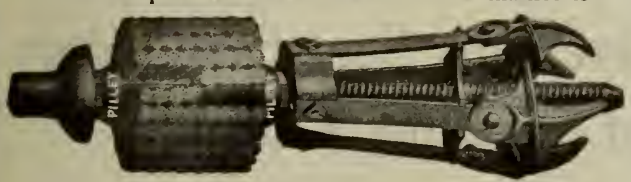

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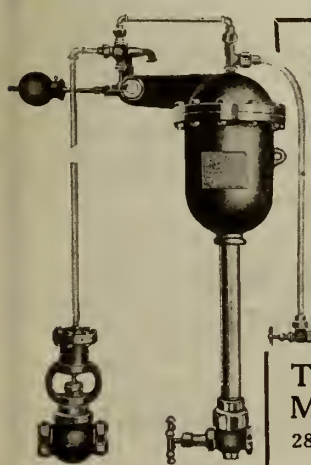

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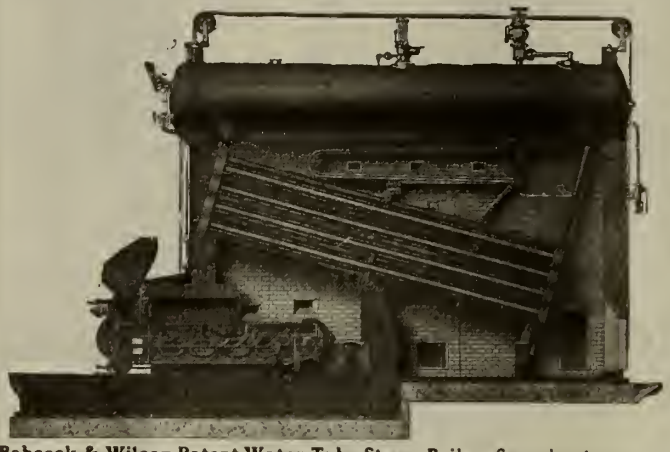

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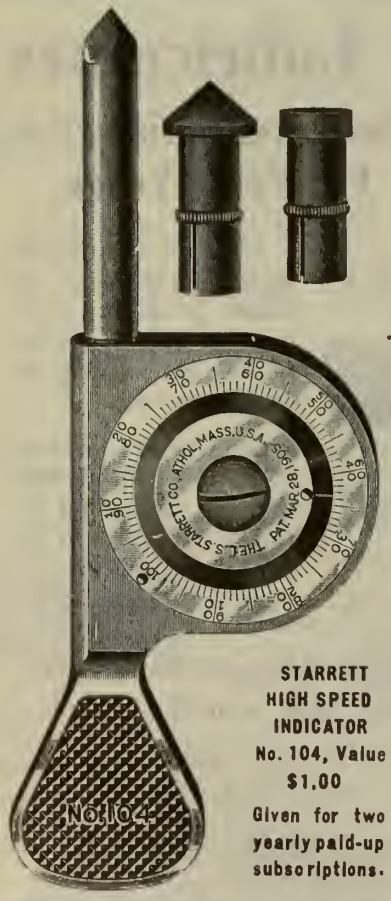

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Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DRAFT APPARATUS SYSTEMS, MECHANICAL
Green's Economiser, Ltd., Toronto.

DRAFT RECORDERS
Jas W. Hays Corp., Michigan City, Ind.

DRAFT GAUGES
Sanford Riley Stoker Co., Worcester, Mass.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

DRAFT GAUGES
Defender Automatic Regulator Co., St. Louis, Mo.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon, Holmes & Co., Sherbrooke, Que

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

EJECTORS AND SYPHONS
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Hamilton Mfg. Co., Wm., Peterboro, Ont.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

ENAMELWARE
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injeo or Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUPTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Sirocco Co., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Hamilton Mfg. Co., Wm., Peterboro, Ont.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLE-WAY
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, MARINE
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal, Que.

ENGINES, SAW MILL
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Canadian Griscom-Russell Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd.,
Goldie & McCulloch Co., Galt.
St. Catharines, Ont.
Kerr Engine Co., Walkerville.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.

ENGINEERING BOOKS
MacLean Publishing Co., Toronto.

EXHAUSTERS
Green's Economiser, Ltd., Toronto.

EXHAUST HEADS
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Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Alberger Heater Co., Buffalo, N.Y.
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FANS, VENTILATING
Coppus Engr. & Equip. Co., Worcester, Mass
Green's Economiser, Ltd., Toronto.

FEED WATER HEATERS
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Elliott Co., Pittsburgh, Pa.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburgh, Pa.
Yarnall-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chapliu, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Elliott Co., Pittsburgh, Pt.
Green's Economizer, Ltd., Toronto.
Laurie & Lamb, Montreal.

FIBRE, VULCANIZED
Beveridge Paper Co., Montreal, Que.

FILTERS
Bowser & Co., Inc., S. F., Toronto, Ont.
Laurie & Lamb, Montreal.

FILTERS, WATER
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
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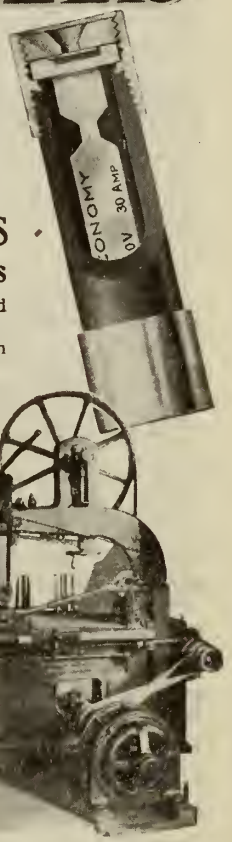

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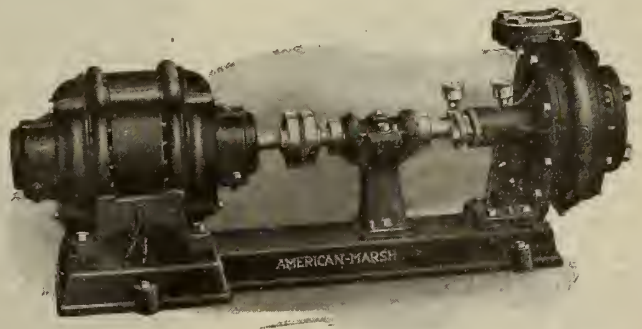
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.



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Mackinnon Steel Co., Ltd., Sherbrooke, Que.
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Jointless Fire Brick Co., Chicago, Ill.
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Beveridge Paper Co., Montreal, Que.
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Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.
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Uehling Instrument Co., New York, N.Y.
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Garlock Packing Co., Hamilton, Ont.
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GASOLINE METERS
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GASOLINE TANKS
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Imperial Oil, Ltd., Toronto.
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Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Wall, Montreal.
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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
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Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.
GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
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Can. Link-Belt Co., Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
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Laurie & Lamb, Montreal.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.
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Goldie & McCulloch Co., Galt.
Galt Foundry Co., Galt, Ont.
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Shell-Bar, Boloo Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.
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Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
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Penberthy Injector Co., Windsor, Ont.
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Elliott Co., Pittsburgh, Pa.
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Jas W. Hays Corp., Michigan City, Ind.
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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
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Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.
HEATERS, EXHAUST STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.
HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa
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Can. Link-Belt Co., Toronto, Ont.
HOISTING AND CONVEYING MACHINERY
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Can. Link-Belt Co., Toronto, Ont.
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Frick Co., Waynesboro, Franklin Co., Pa.
Hamilton Mfg. Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.
HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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Uehling Instrument Co., New York, N.Y.
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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
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Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.
INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.
INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.
INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
INJECTORS, AUTOMATIC AND AUTOPOSITIVE
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Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
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Can. H. W. Johns-Manville Co., Toronto, Ont.
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Johns-Pratt Co., The, Hartford, Conn.
INSULATORS
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Johns-Pratt Co., The, Hartford, Conn.
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Can. H. W. Johns-Manville Co., Toronto, Ont.
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KEROSENE PUMPS (SELF MEASURING)
Bowser & Co., Inc., S. F., Toronto, Ont.
KEROSENE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.
LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
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Green's Economiser, Ltd., Toronto.
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Albany Lubricating Co., New York City.
Canadian Economic Lubricant Co., Montreal.
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Bowser & Co., Inc., S. F., Toronto, Ont.
LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.
LUBRICATORS, FORCE FEED
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
METERS, STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Yarnall-Waring Co., Philadelphia, Pa.
MIXING VALVES
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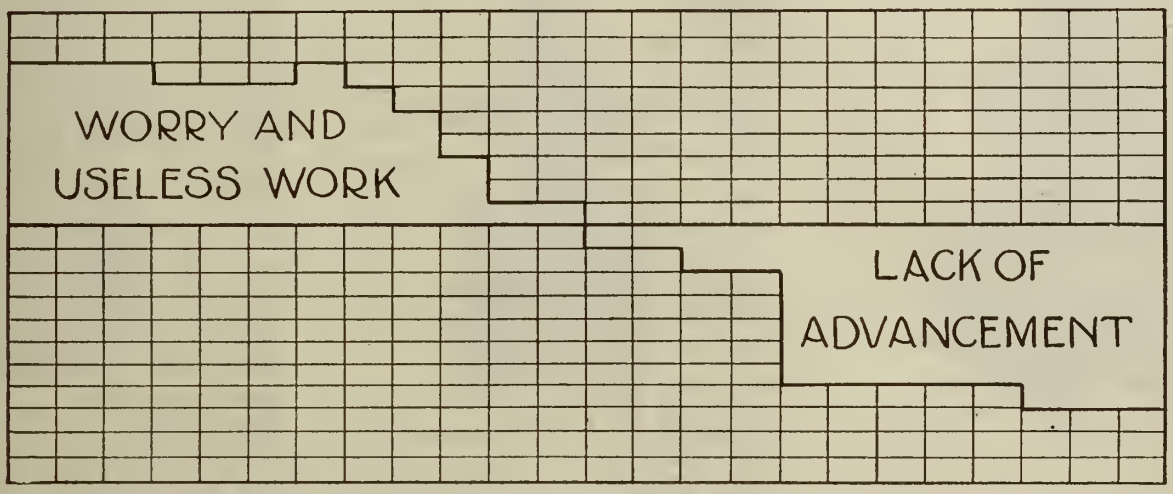

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A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
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Waterous Engine Works Co., Brantford.

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Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

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OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
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Can. Detroit Lubricator Co., Walkerville, Ont.
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OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
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Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

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Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Can. Economic Lubricant Co., Montreal, Que.
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING ENGINE
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

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Can. B. K. Morton Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

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Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

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Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

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Steel Mill Packing Co., Windsor, Ont.
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Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
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Thomson-Gordon, Ltd., Hamilton, Ont.
Vorhees Rubber Co., Ltd., Montreal.

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Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING PISTON
Crane Packing Co., Chicago, Ill.

PACKING, VALVE STEM
Crane Packing Co., Chicago, Ill.
Johns-Pratt Co., The, Hartford, Conn.

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Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE, CAST IRON
Wood & Co., R. D., Philadelphia, Pa.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

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Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Mueller Mfg. Co., H., Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

PULLEYS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Hamilton Co., Wm., Peterboro, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

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Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

PUMP STRAINERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Liberty Mfg. Co., Pittsburgh, Pa.
Smart-Turner Machine Co., Hamilton, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

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Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

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American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

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Graton & Knight Mfg. Co., Montreal.

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Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM TURBO
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Darling Bros., Montreal.
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American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

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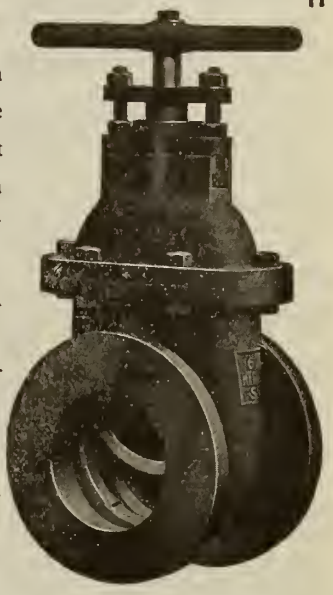

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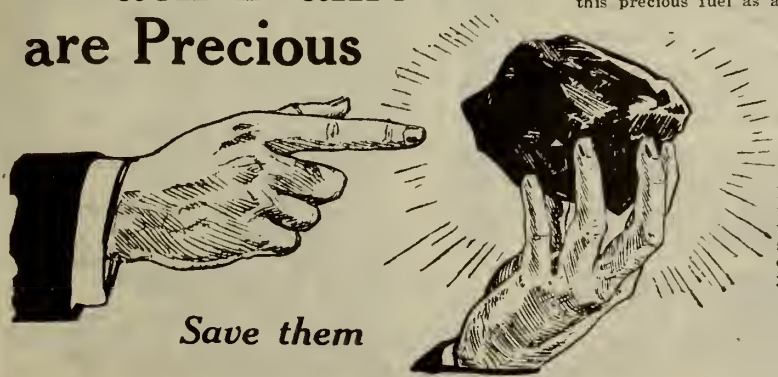

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Smart-Turner Machine Co., Hamilton, Ont.

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Linde Canadian Refrigeration Co., Montreal.
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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

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Taylor Instrument Co., Rochester, N.Y.

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Waterous Engine Works Co., Brantford.

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Galt Foundry Co., Galt, Ont.
Waterous Engine Works Co., Brantford.

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Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

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Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

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Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
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Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
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Penberthy Injector Co., Windsor.
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Anderson Co., Y. D., Cleveland, O.
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Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Dunham Co., Ltd., C. A., Toronto, Ont.
Elliott Co., Pittsburgh, Pa.
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Can. Morehead Mfg. Co., Woodstock.
Mason Regulator & Engineering Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

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STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.

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Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works, Brantford, Ont.

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Galt Foundry Co., Galt, Ont.
Green's Economiser, Ltd., Toronto.
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Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Elliott Co., Pittsburgh, Pa.

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Mackinnon Steel Co., Ltd., Sherbrooke, Que.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.

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Bowser & Co., Inc., S. F., Toronto, Ont.
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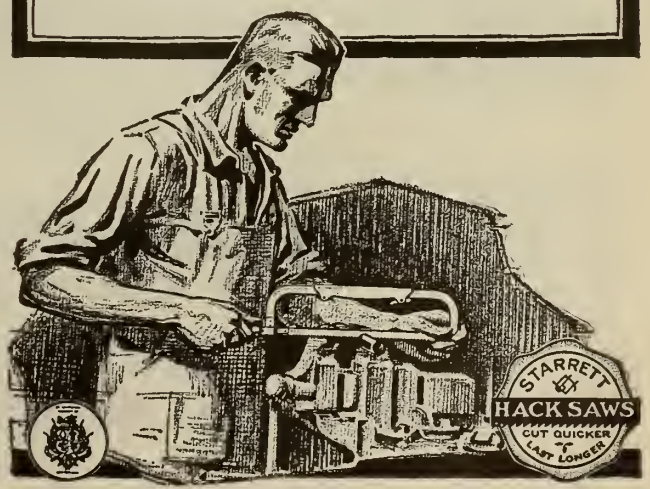

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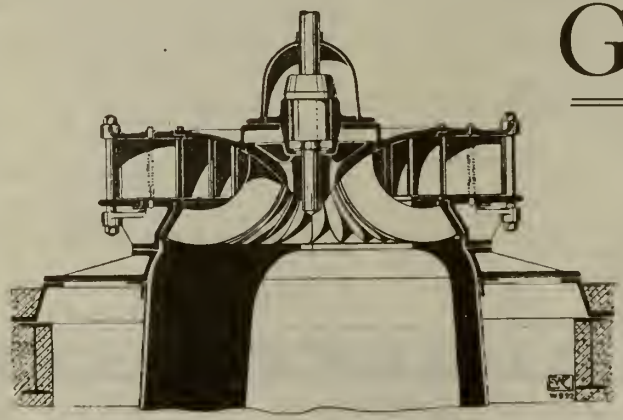

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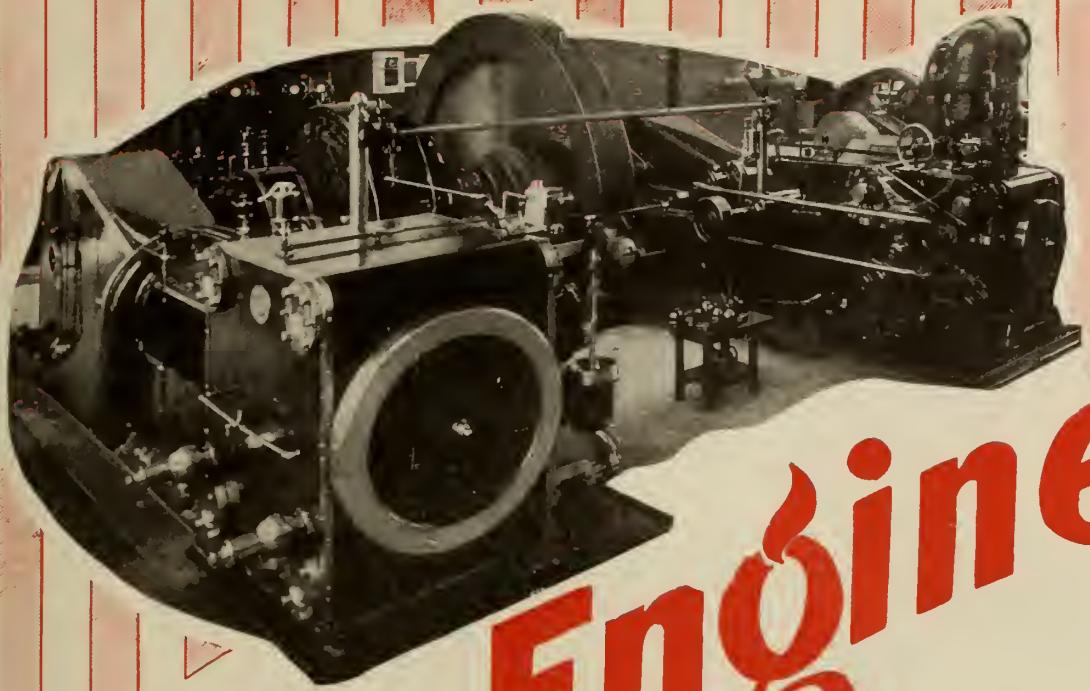

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Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

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Vol XII.—No. 5. Publication Office, Toronto—April 25, 1919 Published Semi-Monthly $1.00 per Year

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External View

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The "Check Superior," that overcomes **valve prejudice** on steam lines.
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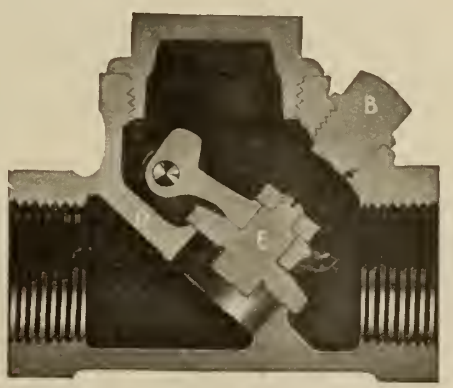

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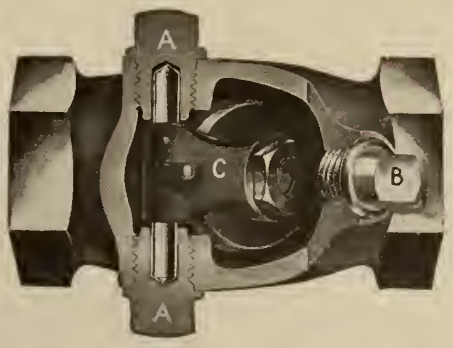

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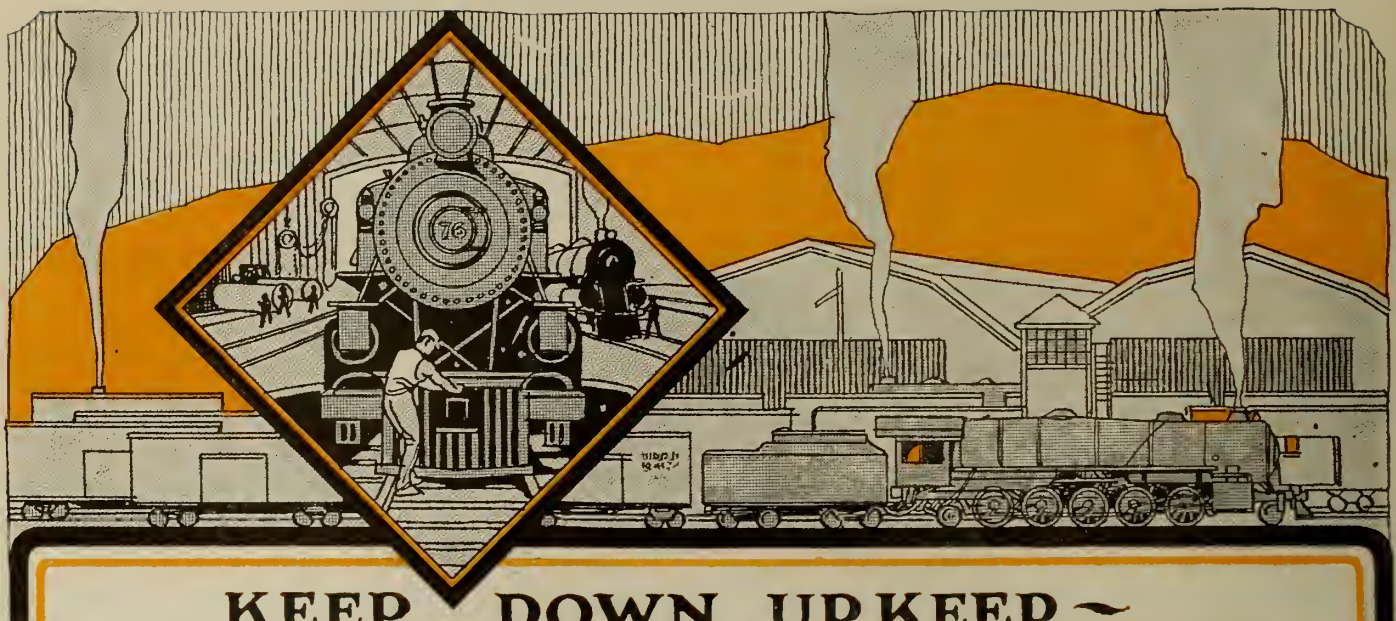

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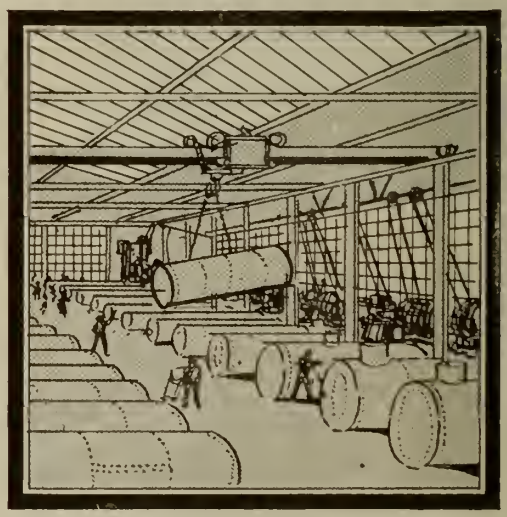

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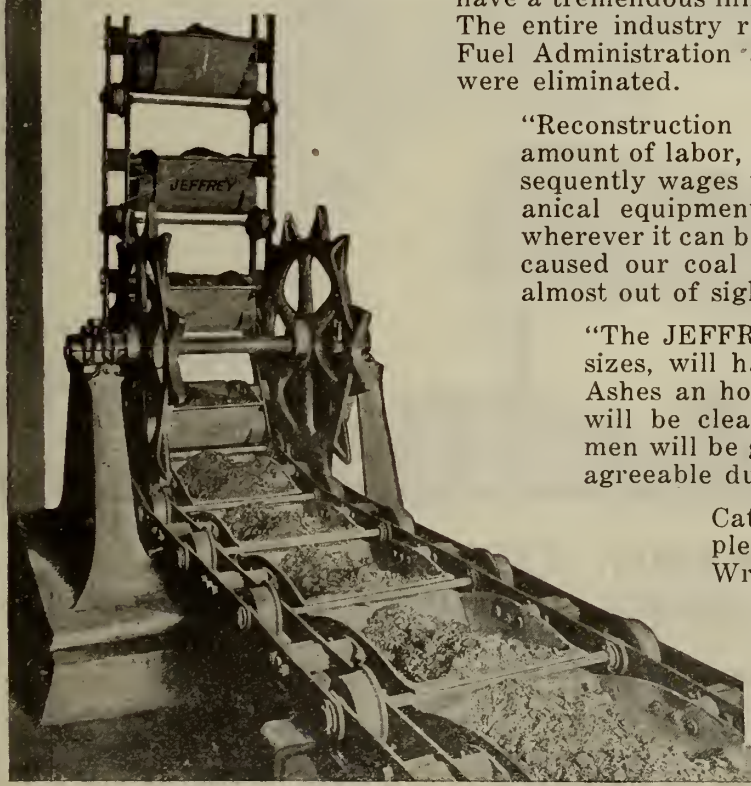

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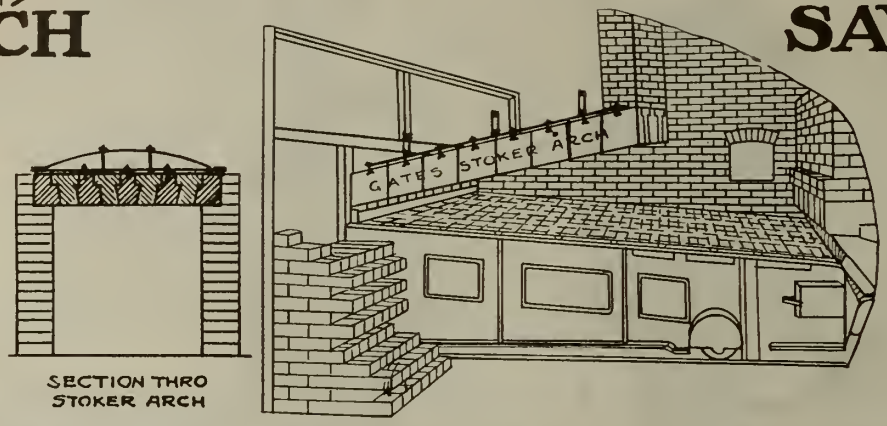
A MONEY SAVER



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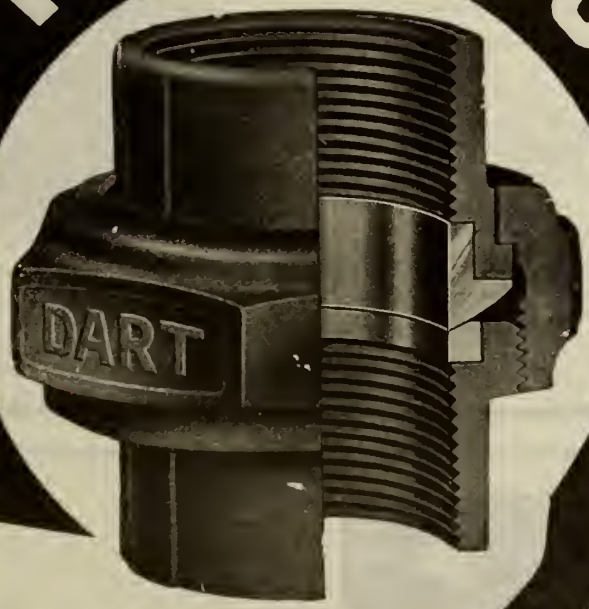

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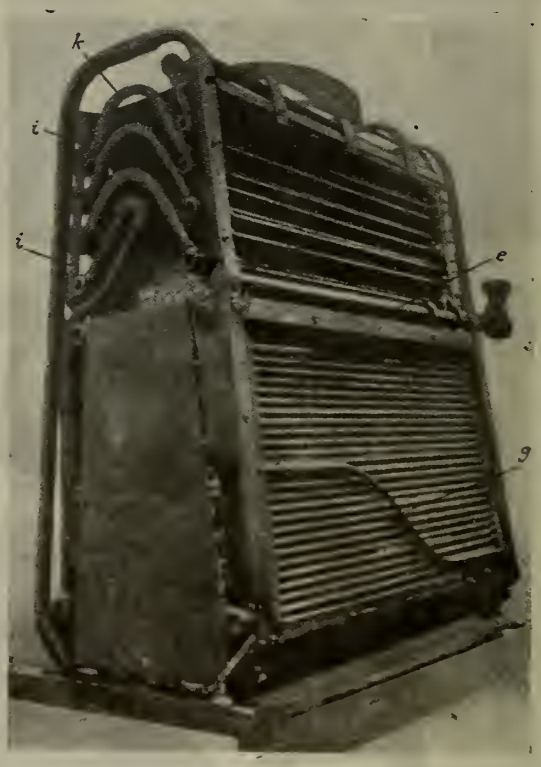
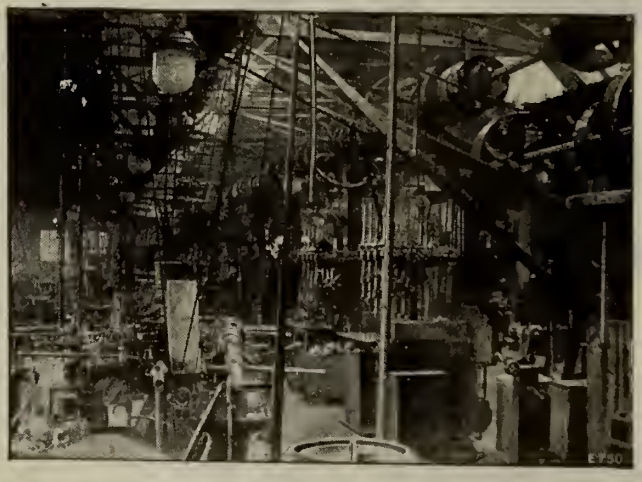


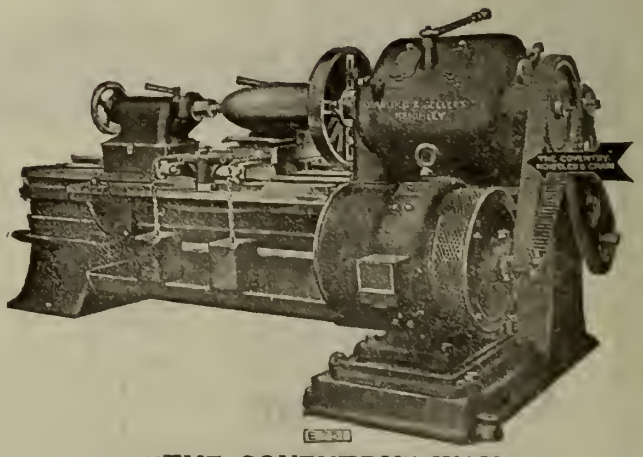
Head of Boiler Casing Removed.

Requires about one-seventh the space of the ordinary boiler.
No brickwork is necessary.
Tubes easily replaced under reduced steam pressure.



THE OLD WAY

Notice the space occupied by belts, pulleys and shafting, which darken the workshop and throw shadows on the work.



"THE COVENTRY" WAY

A bright factory means improved work and larger output, less likelihood of accidents. (Note compact arrangement of drive).

THE COVENTRY CHAIN CO., LTD.
COVENTRY, ENGLAND

Cables "CHAINS COVENTRY," Codes A.B.C., 4th and 5th Editions, and Western Union.

Outside

Protection for Pneumatic Tool Hose

—an outer jacket that ensures longer service and big economies.

HOSE that ensures longer service and big economies.

Pneumatic tool hose is important enough to deserve our preferred attention—and yours.

So we studied pneumatic tool hose performance to develop a hose that would give longer and better service; that would make the specifying of this hose matter of importance to you.

Goodyear Extra Service Pneumatic Tool Hose was the result—a hose that is doubly protected.

The inner tube is made of specially prepared rubber to resist air pressure effectively. Even after long use this hose remains elastic, active, unified.

The smooth white cover is made of extra tough rubber—rubber as tough as the tread of a tire. No wire winding — easily handled, and light in weight. Rough usage, knocks, abrasion — the things that make ordinary pneumatic tool hose a steady item of expense—are slow to impair the efficiency of Goodyear Extra Service Pneumatic Tool Hose.

Its different and better construction insures longer service and real economy.

A hose purchase may come up in your concern any day. Write or telephone the nearest Goodyear branch for a hose man to call with samples. No obligation—you are not expected to order. We just want you to know all about this **better** hose when you need hose.

GOODYEAR
MADE IN CANADA

PNEUMATIC TOOL HOSE

The Publisher's Page

TORONTO APRIL 25, 1919

"The Best Paper of Its Class"

POWER HOUSE is now safely launched on its semi-monthly journey, and from every part of the Dominion there are coming many letters of commendation and assurance. Here is one example:—

Donavon, Sask., March 5, 1919

Dear Sirs:

In answer to your inquiries re "Power House," I certainly am in favor of a semi-monthly publication of this paper. In my opinion it cannot be published too often.

As far as the subscription rate is concerned I shall continue to take "Power House" whatever it costs.

I might say that I have been several times around the world as an engineer in the British Merchant Service and it is the best paper of its class I have ever met.

I would very much like to see marine work discussed occasionally. Other than that I fail to see where "Power House" can be improved.

Believe me,

Yours truly,

PERCY S. HUNTER.

The editorial and advertising pages of POWER HOUSE are equally appreciated by the readers—this is clearly shown. Engineers have said: "I find the advertisements valuable to me, the information about the merits of the machines is interesting." POWER HOUSE, because of its stand for the upbuilding of efficiency in power plant equipment and service, quite naturally attracts owners, superintendents and the best engineers. It is a medium recognized as possessing leadership. It maintains a strong influence on those who direct the buying of power plant equipment. It is the one sure medium of publicity for the manufacturer.

THE VALUE OF MASON SERVICE

WE are prepared to supply the Engineering Equipment mentioned below and would further point out that we have a large experience in the practical application of our engineering equipment to actual service conditions. Our salesmen are practical engineers and sell from knowledge not from catalogue. Their suggestions are usually useful.

This is Mason Service.

THE MASON LINE INCLUDES:—

"Mason" Reducing" Valves (genuine).
"Mason" Pump Governors.
"Mason" Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Coppus Turbine-driven Boiler Feed Pumps.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Feed Water Filters.

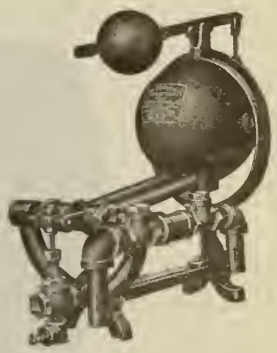
The Mason Regulator & Engineering Co., Limited

Successors to
H. L. PEILER & COMPANY

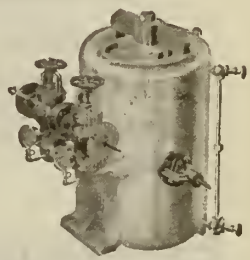
Montreal Office and Factory: 135-153 Dagenais Street

Toronto Representative:
The Arthur S. Leitch Co., 506 Kent Building

Bulletins and Full Information Gladly Furnished



New Bundy Return Trap



Reilly Multi-Screen Feed Water Filter

Mason No. 55 Pump Pressure Regulator

Mason Standard Bronze Reducing Valve

STANDARD RETURN TUBULAR BOILER

Horizontal Tubular
Vertical Tubular
Locomotive Types

BOILERS

We have registered designs to conform with various provincial codes.

Our BOILERS Are Installed in the Largest Industrial Plants.

Write Us for Boiler Information and Prices.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Office: Hall Machinery Co., Sherbrooke, Que.

The Safe and Certain Boiler Cleanser

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to install.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Shell-Bar Boico Supply, Ltd. 376 Dufferin Street Toronto

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Limited, Montreal; Adolphe Huot Reg'd., Quebec

O.K. for Time and Labor Saving in Any Plant

Steam Trap Losses

Should Be Classed as Unnecessary

Steam trap losses contribute largely each year to plant operating cost. In terms of lost time, too frequent adjustments, blowing off, steam leakage, they represent repeated waste. These have been entirely eliminated—and time losses changed into steam savings—where the Johns-Manville Steam Trap is used.

This trap has but three parts—a body, bushing, and hollow ball. When there is no condensate to discharge, steam pressure in the trap holds the ball against the discharge orifice—the only point where there's unbalanced steam pressure. As water flows into the trap, the ball is rolled up, the unobstructed orifice is exposed, and water is discharged. This discharge is continuous as long as water flows to the trap. If air is present it is drawn out through vortices formed at the discharge orifice.

There are no levers, counterweights, springs, or other "fixin's." It is the most simple and efficient trap made, and absolutely tamper proof. Ask our nearest branch for special bulletin—it can solve your trap troubles.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

And also through

Asbestos

and its allied products

JOHNS-MANVILLE Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

Canadian Johns-Manville Co. Limited

Montreal Toronto Vancouver Winnipeg
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JOHNS-MANVILLE Steam Trap

LINDE
REFRIGERATING MACHINERY

Is known and recognized the world over as

The Standard Refrigerating Machine

We have carefully studied Refrigeration under all conditions in Canada for the past 25 years and know what is best for the Canadian Manufacturer.

Our Machinery is "Made in Canada"

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896

What They Say About Power House

"I certainly am in favor of a semi-monthly publication. In my opinion it cannot be published too often. I have been several times around the world as an engineer in the British Merchant Service and POWER HOUSE is the best paper of its class I have ever met."—Mr. Percy S. Hunter, Donavon, Sask.

"I would like very much to get POWER HOUSE twice a month. For Canadian engineers it is unexcelled."—Mr. A. R. Troke, Paris, Ont.

"New subscribers who do not really know the value of POWER HOUSE might demur at paying a high price for it, but personally speaking, I would not object to paying double price for double service. I never miss reading the advertisements. They are real interesting to anyone in this line."—Mr. Fred E. Reesar, Municipal Electric Light Plant, Markham, Ont.

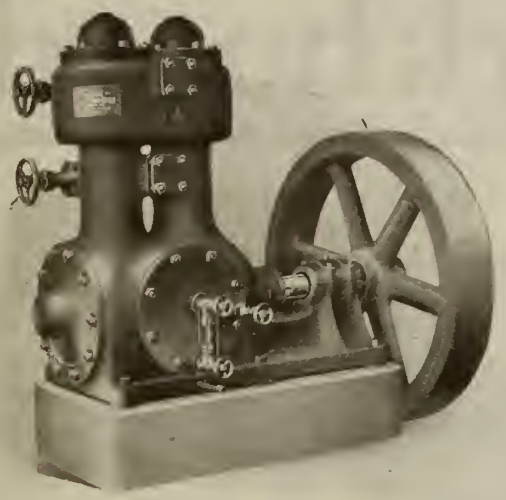
"I feel that a semi-monthly magazine will also be a great step in our favor inasmuch as we can now look forward to a friend and adviser's call twice a month instead of once. I take a number of magazines myself, but there is none I look forward to receiving like my old friend and adviser, POWER HOUSE."—Mr. L. E. Wight, Drumheller, Alberta.

"I favor the change to semi-monthly. It is worth twice the money to a Canadian engineer when compared to other magazines published in the U.S.A., upon which I am basing this suggestion."—Mr. Fred R. McNeil, Shawinigan Falls, Q.

"I am very pleased to hear that POWER HOUSE is to be published twice a month as I have been a reader of it for several years. The change will be a great help to engineers."—Mr. W. E. Dale, Vancouver, B.C.

and Hundreds More Say the Same

Quality Products Leave No Regrets



York Ice-making and Refrigerating Machinery is not made to fit the price. We have a standard of quality and service which has been maintained ever since the York Organization was started.

It is betraying no secret to say that many owners of ice-making and refrigerating plants have expressed to us, by word and letter, their keen regret at having turned down a York contract because the price seemed too high.

Price is a poor gage to use in buying such important equipment as Ice-Making and Refrigerating Machinery. Confidence is a better one. You know from your own experience that business born of confidence begets new business.

No customer can truthfully say that the York Organization ever tried to take advantage of him. It is on this basis that we have been selling our products, and it is for this reason that we have been successful.

An inquiry from you will be appreciated. You are not obligated to buy York equipment until you are satisfied as to its quality and our good intentions.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 304 Craig St. West | CALGARY 605 Second St

Temptations

In these days of high prices, the temptation is often strong to put off repairs and improvements until the last minute, and then try to save money by purchasing materials cheaper in first cost but of doubtful efficiency. Either policy is liable to prove disappointing and costly in the end.

The time to get ready for next season's business is not when the hot weather is upon you, but right now when the load on your cold storage rooms is light. The sooner you make your repairs and improvements, the better. Materials are scarce and transportation is very uncertain at best.

And nowadays the best is still the cheapest. You can get cold storage insulating materials that will be cheaper than Nonpareil Corkboard in first cost, but in the long run—after they have become moisture-soaked, worthless as heat-insulators and have to be replaced—they are many times more expensive.

Fruit storage room insulated with Nonpareil Corkboard, Altschul Bros. Company, Lima, Ohio.

If you are not already familiar with it, there are many facts about Nonpareil Corkboard Insulation that will interest you as a business man. The 152 page, illustrated book and samples of the materials will be sent, free of charge, on request.

Armstrong Cork & Insulation Co., Limited

504 McGILL BUILDING MONTREAL, QUEBEC, CANADA

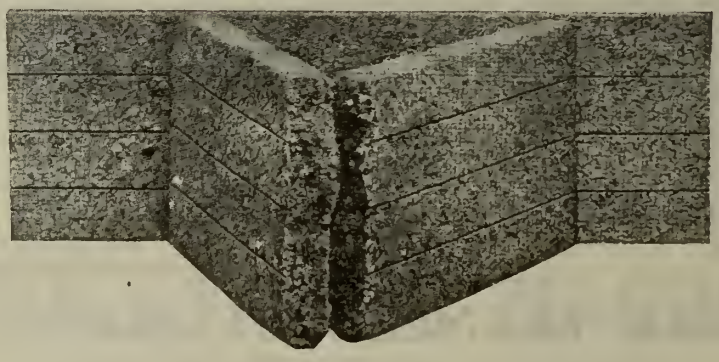
Branches in the principal cities of the United States and Canada. Also manufacturers of Nonpareil Cork Covering for all cold pipes.

Nonpareil Corkboard Insulation

For Cold Storage Rooms

Pure Corkboard

Made in Canada



A New and Important Source of Supply

All buyers know that the sources of supply of pure Compressed Corkboard and Granulated Cork are few—too few —and the output entirely inadequate at times—an unhealthy situation for the buyers.

Therefore, you have special interest in this *new* and *important source of supply,* large in volume, fine in quality and right in price.

It offers you added *security* both as to *cost* and *deliveries.*

Pure Corkboard is now a necessity to the refrigerating industries, which use many millions of square feet yearly in the insulation of more than eighty per cent. of new construction and repair work.

We are prepared to handle your complete requirements, either for material only or installed in your building. Write us to-day and we will gladly give you full information and quotations.

Canadian Corkboard Co., Limited

Head Office: 17 Adelaide St. East, TORONTO

Works at Port Colborne, Ont.

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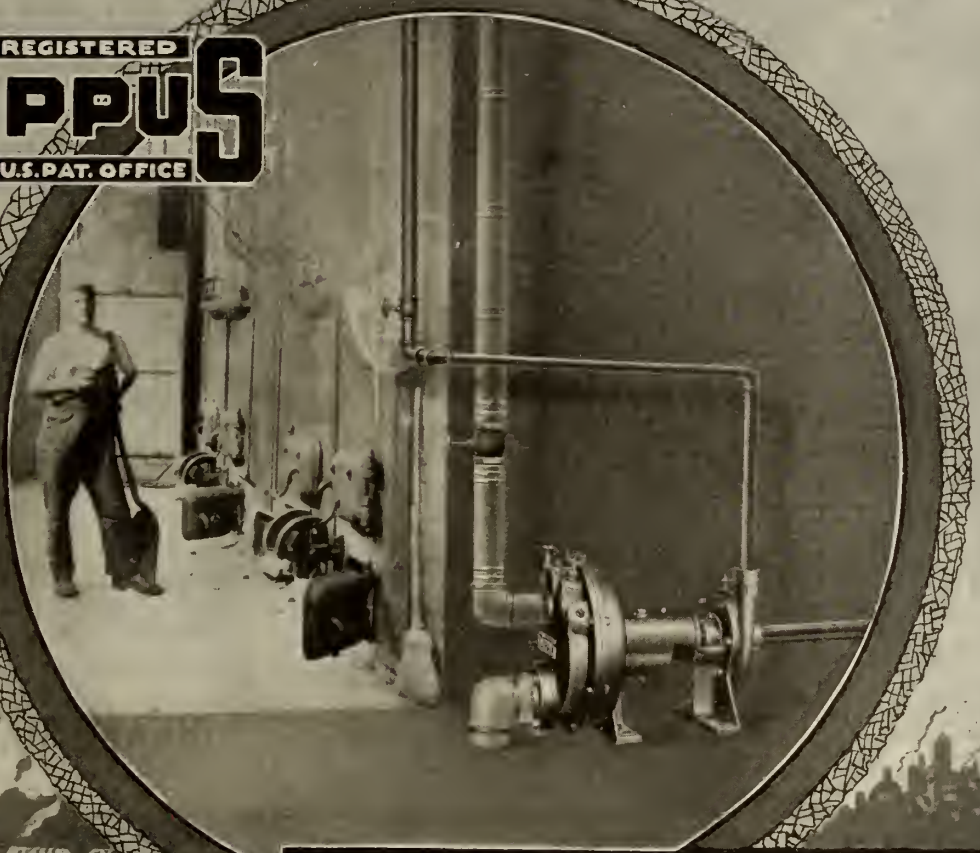
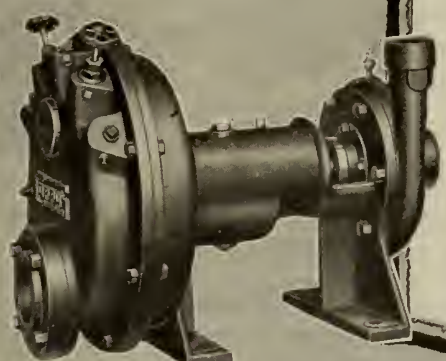
COPPUS
U.S.PAT. OFFICE





What Is Your Repair Bill?

Did you ever stop to figure up how much your present feed pump is costing you per year? Do you realize that there is a pump which can cut down your cost of boiler feeding?

The ordinary boiler feed pump constantly needs expensive repairs—and is always giving trouble on account of leaky valves and pistons. With the

COPPUS TURBO FEED PUMP

there is no steam leakage—because there are no valves. With a COPPUS Turbo Feed Pump repairs are negligible—because there are few moving parts. In a COPPUS Centrifugal Turbo Feed Pump the depreciation is unusually low—because there is practically nothing to wear out except ball bearings and wearing rings.

Then, too, the COPPUS Turbo Feed Pump is very economical in steam consumption, and absolutely automatic in regulation. A self-oiling system and an excess pressure regulator minimizes the attention required.

These are some of the reasons why the COPPUS Turbo Feed Pump is rapidly becoming the choice of efficient engineers everywhere. Write for Pump Catalog H5, and let us show you how "COPPUS equipment can save you money."

THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

Manufacturers of COPPUS Turbo Blowers and COPPUS Power Turbines

341 PARK AVENUE WORCESTER, ASS.

Agents for Montreal: Mason Regulator & Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Building.

COPPUS Centrifugal Turbo FEED PUMP

HEATING BY HOT WATER & HOT WATER SUPPLIES

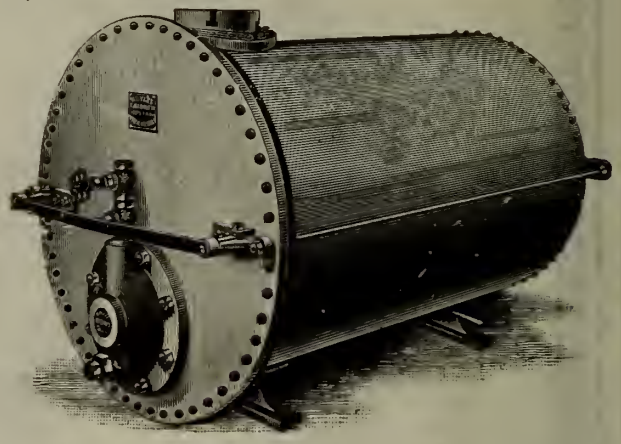
Instantaneous Heater, with connections for Fresh and Salt Water and Steam

HIGHEST EFFICIENCY GUARANTEED

ROW'S PATENT CALORIFIERS are strongly recommended for heating water in bulk for supplying a number of Baths and Lavatories. Also for HEATING CIRCULATIONS for PUBLIC INSTITUTIONS, HOTELS, etc.

ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

ROW'S PATENT
CALORIFIERS
FEED WATER HEATERS
RADIATORS
Suitable for Hot Water or High Pressure Steam
STEAM and GAS KETTLES
EVAPORATORS
CONDENSERS


ROW'S PATENT CALORIFIER. STORAGE PATTERN.

ROYLES LIMITED, ENGINEERS AND SPECIALISTS **IRLAM, MANCHESTER** ENGLAND

Dominion Belting Company, Limited
Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

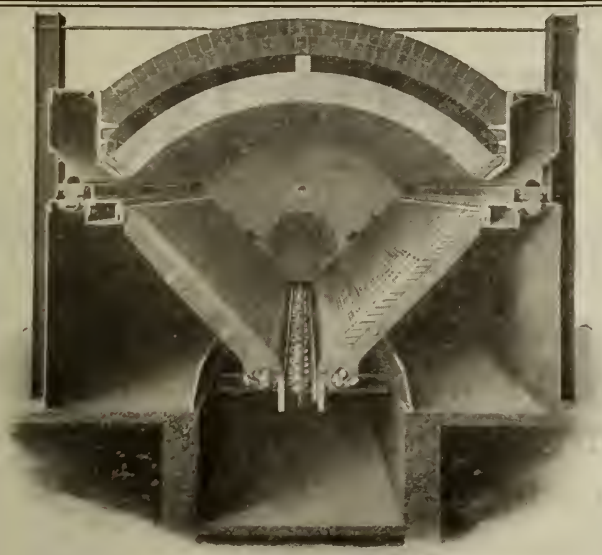
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal



Sectional View of Murphy Automatic Furnace

The Murphy Furnace is designed to extract the utmost energy out of fuel, efficiently and smokelessly, with minimum attention of the operator.

While, of course, bituminous coal produces the most economical results, the Murphy Furnace, however, will burn such fuel as slack, lignite, sawdust or even refuse efficiently enough to keep a plant operating during emergency. The construction of

MURPHY AUTOMATIC FURNACES

is such that they feed the fire from two sides (not one) giving double the coking area. The coal is fed—the fire cleaned—the ash discharged—continuously and automatically.

Boilers fired by Murphy Furnaces do not require auxiliary forced draft (a large initial saving). The excellent air distribution—57% air space—makes the stoker exceedingly efficient and gives the power plant that true form of economy which comes only through continuous automatic operation.

The Murphy operated plant can truthfully say that they obtain all the necessary steam—with plenty of reserve capacity—without "one penny for draft."

You will be surprised to know how easily the Murphy Furnace can be installed under any type of boiler from 50 horsepower up. Our catalog HM-4 gives you details. Send for copy to-day.

For information on Riley Underfeed Stokers for large boilers, see last month's advertisement—or send for Riley Stoker Catalog HR-4.

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

Pop! -never fails

THE reliability of Lunkenheimer Pop Safety Valves has been demonstrated through many years of satisfactory service, on all types of boilers.

Rigid tests under live steam and their careful adjustment to meet the individual service conditions, is assurance that they will efficiently perform the functions for which they are intended.

Their remarkable durability, due to correct design and high "quality" materials, is a source of economy in many boiler plants.

Users KNOW. A trial CONVINCES.

Write for booklet No. 502-DC

THE LUNKENHEIMER CO.
"QUALITY"
Largest Manufacturers of High Grade Engineering Specialties in the World
CINCINNATI Boston
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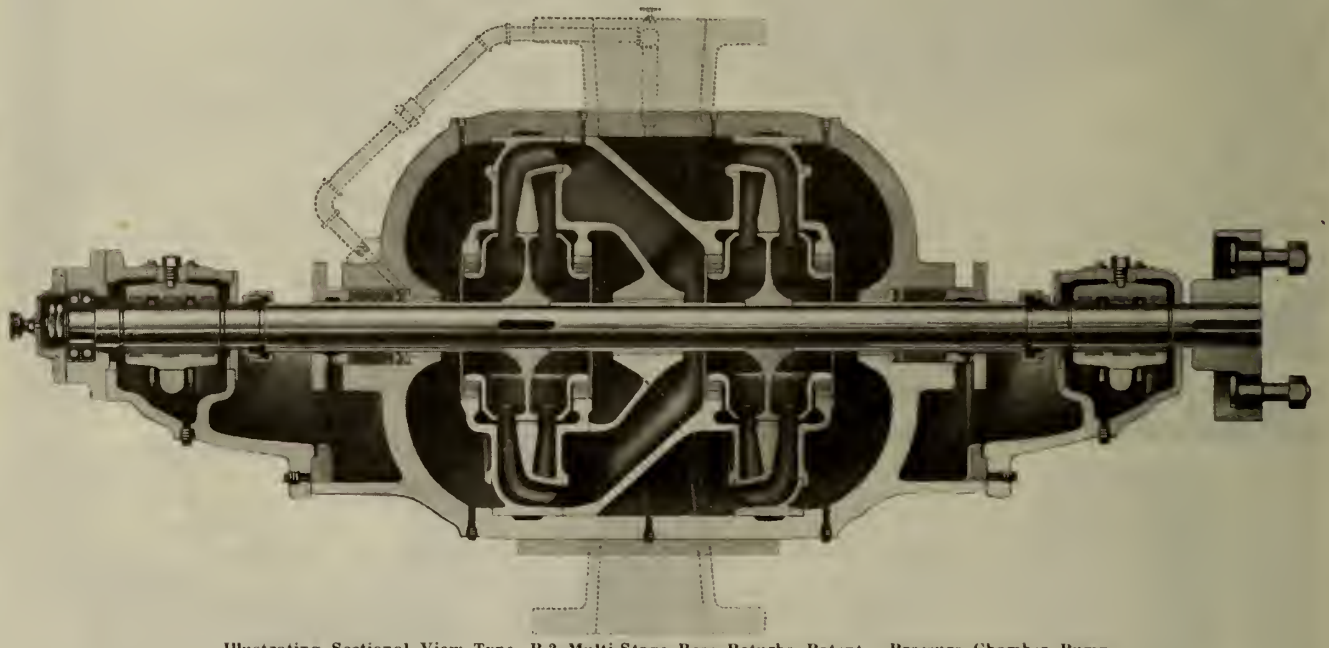
4-13-43 London

REES RoTURBo

Pumping Machinery

Is in use all over the World in Waterworks, Mines, Power Stations, Irrigation Works, Pulp and Paper Mills, Salt, Chemical and General Industrial Plants where highest efficiency, reliability and the best class of Engineering are demanded.



Illustrating Sectional View Type, B.2 Multi-Stage Rees Roturbo Patent Pressure Chamber Pump.

REES RoTURBo Pumps provide a high and sustained efficiency over a wide range of duties. This means a very noticeable saving in power costs.

The Self-Regulating feature of RoTURBo design is responsible for this saving, and this same feature protects your Prime Mover from overloads on a decreased pressure head, eliminating expensive delays and costly repairs.

Our RoTURBo Pump and Condenser Catalogues, full of valuable information, are yours for the asking.

Sole Canadian Manufacturers

The Goldie & McCulloch Co., Ltd.

Head Office and Works, GALT, ONTARIO, CANADA

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Suite 1101-2,
Bank of Hamilton Bld'g

Western Branch :
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Winnipeg, Man.

Quebec Agents :
Ross & Greig,
400 St. James St.,
Montreal, Que.

British Columbia Agents :
Robt. Hamilton & Co.
Vancouver, B.C.

POWER HOUSE

Established 1907 Published Semi-monthly

The Toronto Plant of The Wm. Davies Co.

Recent Extensions Result in Greatly Increased Capacity. Up-to-date Ice Plant a Feature of the Plant Design.

By W. F. SUTHERLAND
Editor POWER HOUSE.

CANADIAN industries were a material factor in the supplying of munitions to the Allies and of equal importance has been the part payed in the provisioning of not only the armies but the people of the allied nations. The export trade thus built up necessitated large addition to the cold storage warehouses and equipment of practically every firm dealing in meat products. The extensions recently completed by the William Davies Co. have involved rather extensive alterations to certain portions of the Toronto plant, and have necessitated the addition of much new equipment. New loading docks and car icing platforms have been built, and a new cold storage warehouse constructed; this latter also houses a meat market for city trade. Together with these changes new refrigerating machinery has been installed. The old and new units of the mechanical equipment form the basis of this article, the various cooling rooms and warehouses being treated in a future article.

Absorption Plant

The absorption system, which forms the older portion of the equipment, is of much interest not only on account of its being one of the few in Canada, but also on account of the length of time which it has been in service. Three units are installed, all made by the Carbondale Machine Co., Carbondale, Pa. The 40 and 75 ton sets were installed in 1890, 29 years ago, while the 100 ton set is 8 years old, having been installed in 1911. These three absorption units have been in amost continuous operation since their installation, allowance being made of course for the lighter winter requirements of the plant.

The generators are of the horizontal type and are supplied with live steam from the boilers. The analyzers and exchangers are placed vertically above the generators, while the rectifier is placed outside. The condenser absorbers and brine coolers are on the main floor level, alongside the generators of each set. This system is very economical in operation, as the cooling water required is raised to about 90 degrees F., while passing through the condenser, and thus admirably serves for washing hogs. The condensate from the generators is returned to the boilers by means of Cole return traps. In passing it may be mentioned that all hot water returns from cooking, rendering and other plant pro-

ABSORPTION PLANT; THREE UNITS ARE SHOWN.

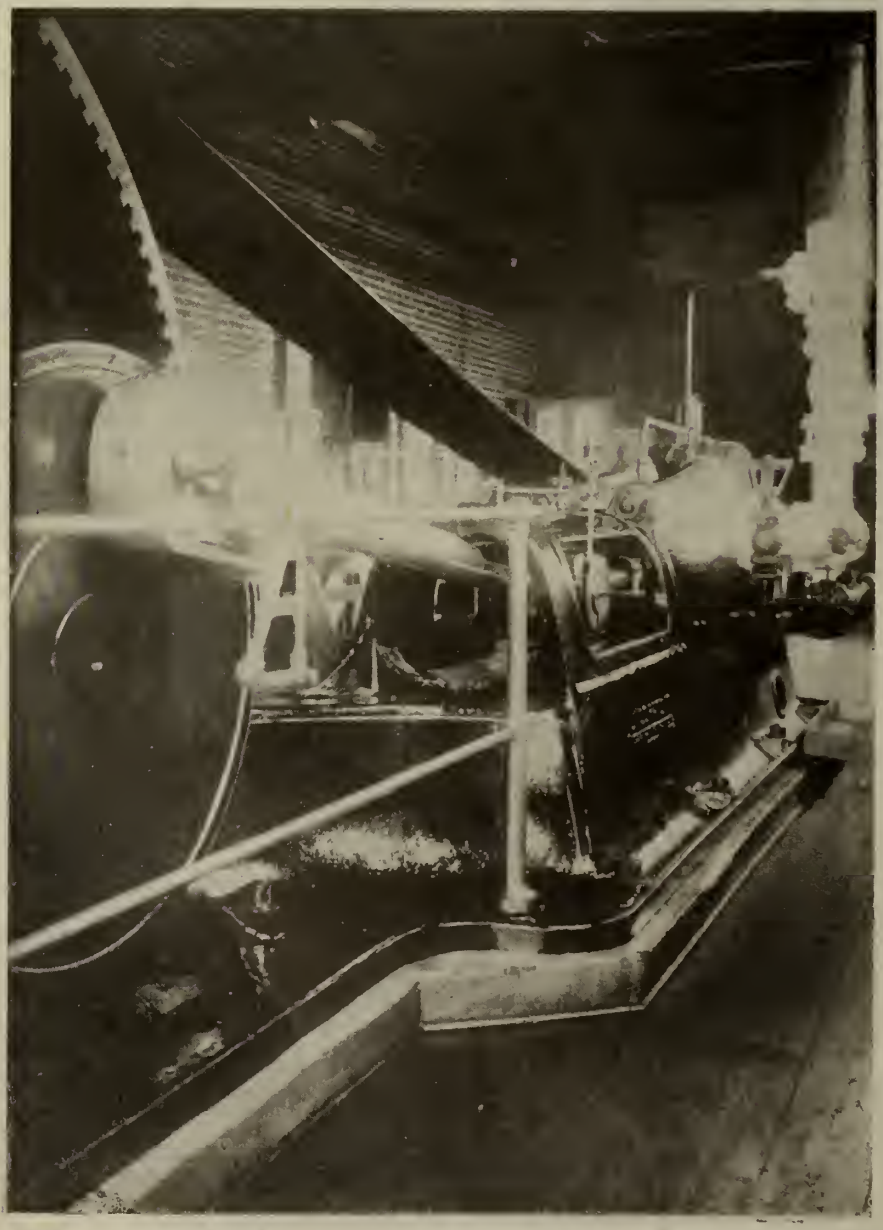
cesses as well as from the heating system are returned to the boilers by means of these traps, fourteen in all being used.

The ammonia pumps, which are the only moving part of this system, are all belt driven from a line shaft and are so arranged that any pump can be operated on any one of the three units.

The brine from the brine coolers is circulated by means of two Deane pumps, one for the low temperature brine, and one for the high temperature brine.

The low temperature brine is kept at about 10 degrees and is used for freezing, while the high temperature brine for chilling is circulated at about 15 degrees F. These pumps have also seen a good many years' service, sixteen and fifteen years respectively. Coupled with the power driven pumps are two booster pumps of 250 gallon capacity each; these pumps are of the duplex steam type of Martin make. They serve to provide a means of controlling the circulation of brine and also act as

CAR ICING DOCK.



LINDE COMPRESSOR IN ICE MACHINE PLANT

auxiliaries in the case of failure of the power driven pumps. In addition to this equipment another 500 gallon Martin pump is also installed for emergency uses.

Other Stand-by Equipment

Since power is now purchased from central station supply the old steam equipment is now little used, but fills a valuable place as stand-by equipment in the event of power failure. In the supply of power to the engine room equipment a Doty engine is used when needed. This engine is of 75 h.p., of the Corliss type and has been in service fifteen years. A Goldie & McCullough Ideal engine of 50 h.p. is also installed and is direct connected to a C.G.E. 110 volt generator for the supplying of the lighting requirements when needed.

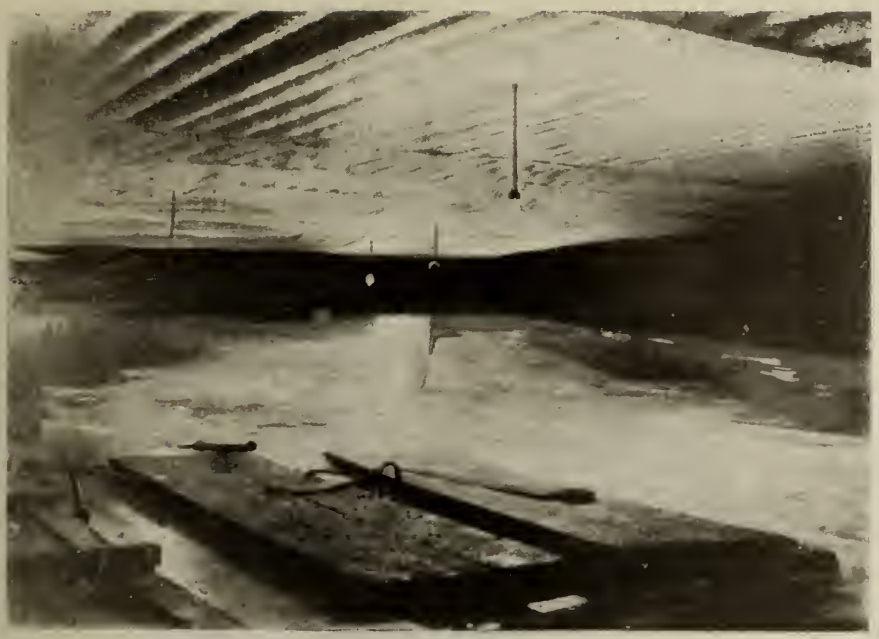
The power required for various uses around the power plant, such as the operation of the brine and ammonia pumps on the absorption system, is ordinarily supplied by a 50 h.p. Lancashire motor, belted to the line shaft. In passing is may be mentioned that this type of motor is used almost entirely throughout the plant.

Compression System

In the older portion of the plant, which has been dealt with up to the present, a Linde Canadian compression system is also installed. This system has a capacity of 125 tons of refrigeration per 24 hours. The Linde compressor is driven by a 175 h.p. Lancashire motor by means of a 28 inch Beardmore belt. As will be noticed in the accompanying illustration the motor has been placed on a concrete foundation some distance above floor level. This has been done since the Don River overflows its banks with unpleasant results so far as electrical equipment is concerned.

Boiler Room

The boiler room of a packing house supplies steam almost entirely for various processes carried on in the dressing



ICE STORAGE ROOM; NEARLY FULL.

and cooking of meats. Steam for power generation is in this case not required except as a stand-by service. Three Erie City boilers are installed, one of 500 h.p., and the other two of 330 h.p. each. Detroit stokers are fitted to each and the coal is conveyed to the furnace hoppers by means of a Jeffery bucket conveyor system.

The feed water is heated in a Cochrane heater and its supply is controlled by means of McDonough feed water regulators.

The Ice Plant

In the packing business much depends upon the proper care of the dressed meats when loaded for shipment. The modern refrigerator car, which plays such an important part in the shipment of perishable goods, needs ice in large quantities for its proper functioning, and the artificial ice plant is a necessary part of every packing house. The ice plant of the William Davies Co. forms part of the extensions recently completed and is a self-contained unit in every way.

The compressor illustrated in one of the accompanying illustrations is a Linde Canadian machine of 125 ton refrigerating capacity. It is driven by a 200 h. p. Lancashire 3 phase, 25 cycle motor by means of a 28 inch Beardmore belt. In addition to the making of raw water ice it also serves to cool part of the cold storage warehouse recently erected. A production of 56 tons of ice per day has been maintained in addition to the cooling of a portion of the storage warehouse and meat market.

The raw water ice plant is served by a Curtis pneumatic ice crane, the cakes being placed in the hot water stripping tank, after which the cakes of ice are hoisted either into the ice storage or are conveyed directly to the car icing platforms shown. The ice storage room has a capacity of approximately 3,000 tons, and is insulated by means of Armstrong cork, a nine inch thickness being used.

Provision has been made for ice crushing and salting equipment together with an overhead carrier system for ice buckets.

MOTOR DRIVE IN ICE PLANT

BOILER ROOM

THE SHORT BELT DRIVE FOR AIR COMPRESSORS

COMPRESSED air is a necessity in most plants. In the machine shop the air chuck is becoming more and more common, air hoists are used for heavy work in the machine shop and the foundry, and in the yard. In the majority of plants that use compressed air the installation of the compressor is usually a problem. In many plants the air compressor has to be squeezed somehow into an existing power-house where space is at a premium, and the question of the compact air compressor becomes very acute.

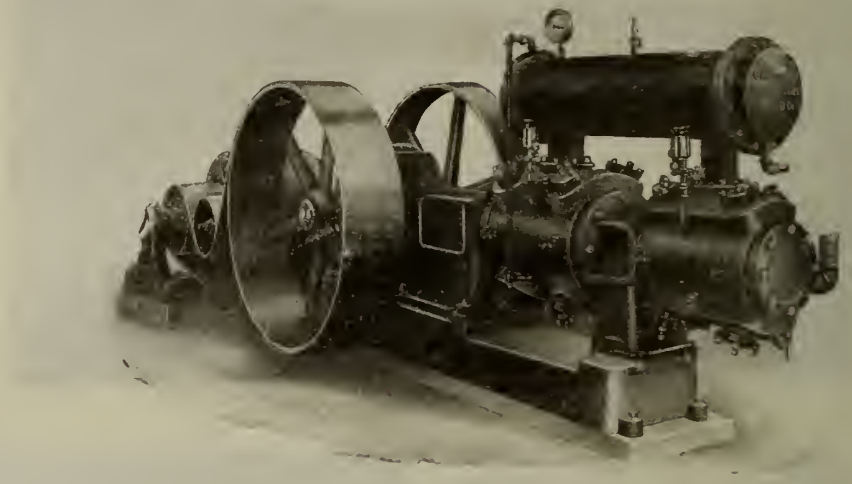
The steam-driven compressor by the very nature of its construction takes up very little room, but the steam driven type is not so common nowadays, and is usually found where steam is already generated for some other purpose. Now the ordinary belt drive for any type of machine takes up quite a floor space, and the compressor 8 feet long needs almost three times its own length for the ordinary belt drive. For the larger sizes the drive by direct-connected motor solves the space problem, but this form of drive is best suited to compressors large enough to require a motor of 100 H. P. or more, so that the direct driven compressor is not much help to the man who wants to get a small compressor into a corner "two by twice."

The short-belt drive solves the problem for him. The principle of the short-belt drive is best explained by a reference to the illustration; it consists simply of a light idler pulley riding on the belt between the compressor and the motor. But there is an important difference between the idler pulley of the short-belt drive and the ordinary idler; in the short-belt drive the idler is carried on arms mounted on the compressor frame, these arms are free to move up and down to a limited extent. Now the objection which at once leaps to the mind is that this idler pulley will increase friction to such an extent that other benefits will be of little use. However this objection is not so formidable as it looks. If the idler were rigidly fixed the friction would be objectionable, but it is not fixed, and the very slight added friction does not weigh against the advantages of the drive. So much is this the case that at least one large short-belt drive is required for large mill power transmission of all descriptions.

As to the advantages:—in the first place the short-belt drive saves space; a 10 x 8 inch Canadian Ingersoll-Rand EL-1 air compressor with short-belt drive takes up only 11 ft., 0 in x 3 ft., 0 in.—belt, motor, and all. The outlay on belting is reduced, and the increased contact angle on belt wheel and pulley adds a good deal more to the efficiency of the drive than is lost in idler friction. Lastly the belt needs no extra initial tension—many a good belt has been stretched too much for its first run;—and the idler automatically looks after tension.

Where compressors are concerned both chain and gear drive are not only very expensive, but they are too rigid, and consequently wear quickly, so that they are not very serious competitors of the short-belt drive—and the short-belt drive is noiseless.

In the installation care should be taken to follow carefully the maker's instructions regarding alignment. The correct location for the idler is just where it would be in the sag of the belt if there were no arm to restrain it. The belt should be slack enough so that it will wrap around the small pulley at least 180 degrees and preferably more usually made up endless by the manufacturer and given a special treatment to make it pliable for this service. With this type of drive it is considered advisable to use belt dressing very sparingly.



SHORT BELT DRIVE

SHORT BELT DRIVE

In gauging the setting of an expansion valve in starting up a refrigerating system, remember that a short coil in a cold room will evaporate very little liquid, while a long coil in a hot room will evaporate quite a large amount. If the suction pressure remains the same and the room or brine temperature goes up, the expansion valve must be opened more, and if the temperature goes down and the suction remains the same, or nearly so, the expansion valve must be pinched back a little.

* * *

Never use any more oil for an ammonia compressor than is absolutely necessary. If it is a horizontal machine and oil is supplied to the lantern in the middle of the stuffing box that is all that is required. Enough will leak through the packing and be carried into the cylinder with the rod to keep the cylinder sufficiently lubricated. About a quart every 24 hours supplied to the lantern will be plenty for a 100-ton machine. Very small machines will require a little less and larger machines a little more. Ammonia itself is slightly lubricating, especially if a little liquid is carried back with the gas.

* * *

The proper condenser pressure in an ammonia compression system is largely determined by the temperature of the condenser water, the size of the condenser, and the amount of water available. If the condenser is kept clean and free from oil on the inside, and scale on the outside of an atmospheric condenser, or the inside of the water pipes of a double-pipe condenser, and the condenser is large enough for the work and kept free from air, the condenser pressure should be such that the corresponding temperature of the saturated gas will be from 10 to 15 degrees higher than the condenser water supplied to the condenser. For example if the temperature of the cooling water is 60 degrees the temperature of the ammonia gas in the greater part of the condenser should not be above 75 degrees at the highest, which would correspond to a pressure of about 126 pounds.

The Selection and Care of Ammonia Compressors

Points to be Remembered When Choosing Machines, and Information of Value Regarding Their Operation

By J. F. PATTON

THE success of any mechanical refrigerating plant depends upon the ammonia compressor. It is the heart of the system and too much care cannot be given to its selection. Many types are on the market, each having its advantages and disadvantages, and before a selection is made, a competent engineer should be consulted as the questions involved are decidedly technical in their nature.

It is, however, very easy to decide

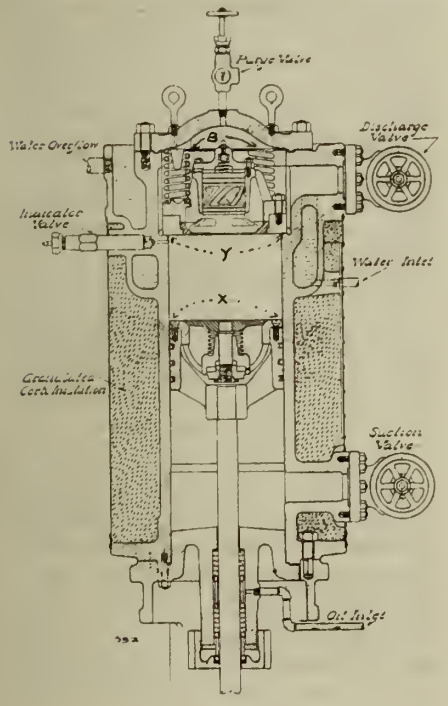


FIG. 1.

that the construction should be, 1st, of very substantial design so that occasional severe strains or overloads will not result in breakage; 2nd, that the piston should be as light as is consistent with safety and should fit the cylinder and valve seats as closely as possible; 3rd, the stuffing box arrangement must absolutely prevent ammonia leakage under any and all conditions, and should be designed to facilitate adjustment when starting and stopping; 4th, the suction and discharge valves must respond instantly to the pressures to which they are subjected and must be so arranged that it is not possible for a valve to fall into the cylinder in case of accident; 5th, all working parts must be accessible and easily adjusted, in no case requiring dangerous work on the part of the operator; 6th, all bearings must be of ample area so that ease of operation and proper alignment may be attained without excessive heating; 7th, design should permit handling either dry or saturated gas.

Compressors are classed as vertical or horizontal, single or double acting. It may be noted that the vertical type requires only a little more than half the floor space required by the horizontal; the weight of piston and moving parts in the cylinder is well balanced, thus guaranteeing uniform wear on cylinder walls; clearance may be slight because wear is all downward and the valves may be kept tight very easily because they seat in a horizontal plane.

On the other hand, a horizontal machine requires less head room than the vertical, usually has less moving parts, which reduces friction and liability to accidents, and all parts are located near the floor line which results in easy operation, as all strains are resisted by the supporting foundation, and as the engineer has no steps to climb, it is likely that the machine will receive better attention than would one of the vertical type. Finally, the horizontal type will perform equally well with wet or dry gas and its construction permits the use of a straight crank shaft which is not so likely to break as with one or more offsets.

Fig. 1 shows a sectional view of the York, a vertical, single acting compressor, with a false or safety head. The gas enters at the bottom of the compressor and passes up through the balanced suction valve in the piston, is compressed on the upward stroke to the condensing pressure and passes out through the discharge valve in the centre of the safety head. The piston and the bottom of the safety head are faced off square and as they come in contact, a complete discharge of gas is effected.

The use of the safety head guarantees against the breaking of the compressor in case of damaged valves, as it lifts and allows the obstruction to pass through or keeps on lifting until it attracts the attention of the operator, when the machine may be shut down without damage as would be the case if solid heads were used. In the case of an overcharge of liquid ammonia, there is a hammering

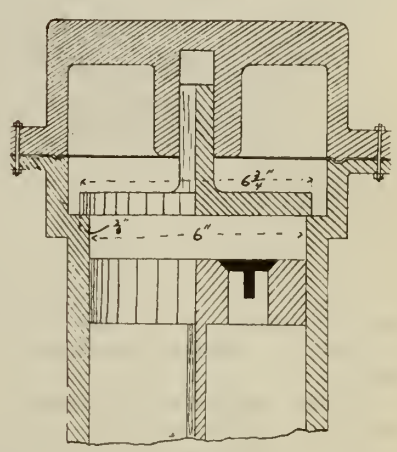


FIG. 2.

of valves and false heads as they rise to allow the liquid to pass.

In a machine of this type it is imperative that the screws shown at X Fig. 1, be absolutely tight. These hold the suction valve in position and frequently they will back out slightly or they may become battered so as to be useless as well as dangerous.

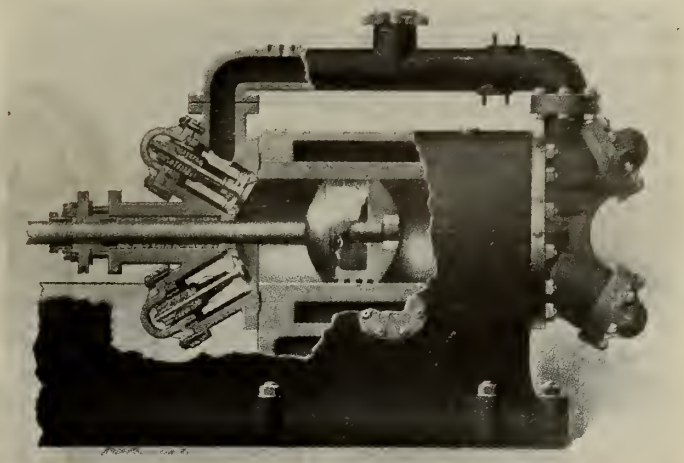


FIG. 3.

It is also necessary that the head and seat at Y make a good, pressure tight joint. This should always be tested on an over-

haul, a good method being to wipe the seat dry, mark each surface with a soft pencil, and rotate the head a few times. If the marks are not obliterated, the head must be ground in.

The springs as shown at B must also be kept tight as these hold the safety

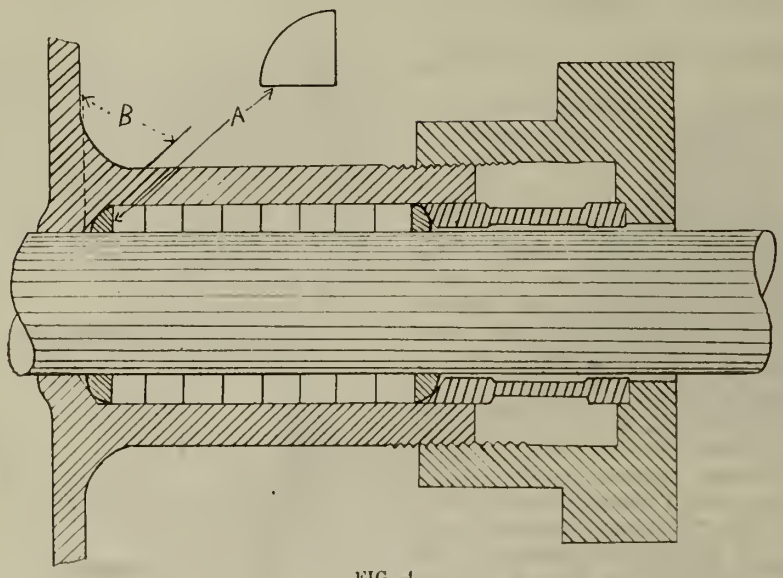


FIG. 4.

head in position, and if they are weak the head will rise and the machine will pound.

The discharge valve, of ample proportions to reduce the lift, is made of steel and is held in place by a cage which is easily removable for inspection. The steel seat for the discharge valve is forged into the safety head, multiple valves being provided in the larger sized units.

Note the unique method of jacketing. The entire lower part is insulated with cork, the upper part only being water jacketed. The suction valve is practically floated on its seat by a specially designed spring so that it opens to admit gas immediately at the beginning and remains open through the entire downward stroke. The suction pressure in the cylinder, therefore, is practically the same as that in the suction main; changing the tension of the valve springs should never be attempted without the use of an indicator as a hit or miss method will be sure to give poor results. For an illustration, refer to Fig. 2, which shows a simple valve for a six inch cylinder with a valve seat of 3-8 in. face, giving a bearing surface on top of the valve of 6 3-4 inches in diameter. Assuming a working pressure of 150 lbs., there will be a total pressure of 4977+lbs. on top and 4241+lbs. on the under side or an unbalanced pressure of 636+ lbs. This is taken care of by the spring action and it is readily seen how an incorrect spring tension can cause a considerable loss.

The oil inlet shown at the bottom of the figure connects an oil reservoir, not shown, with an oil well situated between the two sets of packing in the stuffing box. This permits the piston to travel back and forth through oil which effectually seals the packing and lubricates the rod as well.

There is no need of pumping oil into the cylinder of a machine of this type. The average ammonia compressor gets entirely too much oil. As it works in a closed system after it has been in operation for a short time, traces of oil circulate around the system, and as ammonia itself is slightly lubricating, this should be sufficient, especially when it is understood that some of the oil is carried into the cylinder by the piston rod.

The practice of shooting oil into the cylinder shoud be avoided as it is a clear waste of oil as well as a detriment to the system, as the excess oil is likely to form an insulating coating just where such a thing is not wanted. Only the very best grade of oil should be used in a compressor. In some systems, the temperature range is over 300 degrees F., and the oil must remain fluid under all conditions.

A good test is to draw off a sample of ammonia and into this place a small amount of oil in a tin can. If the oil remains fluid, it will be satisfactory so far as low temperature is concerned, as the temperature of the ammonia will be 28 degrees below zero.

To test for high temperature, heat a sample to about 300 degrees F. If it does not vaporize it is satisfactory for compressor work.

In all single acting machines, the stuffing box can easily be kept tight as it is subjected only to the low suction pressure, but in a machine such as is shown in Fig. 3, the stuffing box is one of the most important parts, and one where good design is absolutely essential if trouble is to be avoided. In this box, positive and uniform adjustment is obtained by dividing the packing into three parts, separated by two cages. A babbited ring is placed in the bottom of the box, closely adjusted to the piston and forming the bottom bearing for the packing. This may be replaced should it be necessary to turn down the rod.

The packing rings are next and then the first cage. The result is a chamber which is connected to the suction manifold by a pipe, through which any high pressure gas which passes the first set of packing is returned to the suction manifold. This leaves the second and third sets to work against evaporating pressure only.

The outer cage serves as an oil reservoir, oil being supplied by means of a pump. The outer packing rings are held in place by a gland, which is secured by three or more studs and nuts. All the bolts of the gland are connected by gears so that it is impossible to tighten one without tightening all.

In certain older type machines the stuffing box bottom was bevelled, as was the packing face of the gland, and considerable trouble was experienced in fitting square packing. This may be eliminated by using a ring such as is shown at A, Fig. 4. The angle, as shown at B, varies according to the designer but if a rounded ring is used, a square face is produced against which the packing may be tightened.

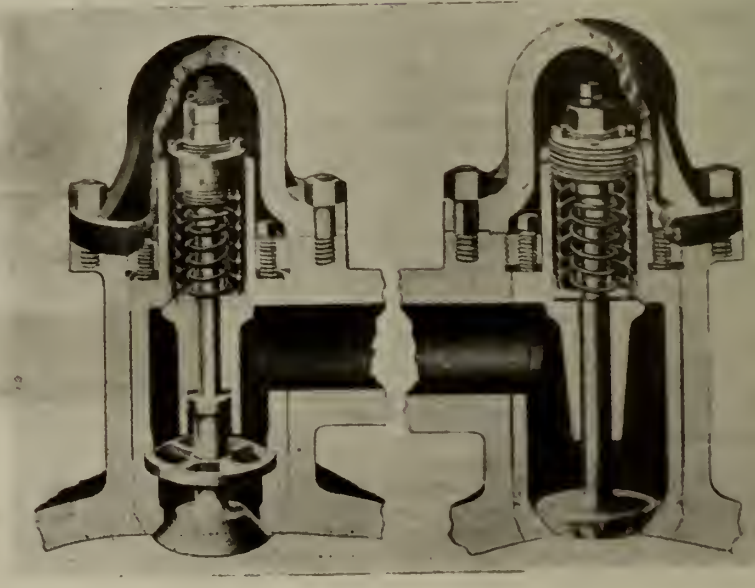


FIG. 5.

The fourth essential point mentioned in the beginning of this article, valve design and action, is of extreme importance as efficiency cannot be obtained if the valves leak or fail to work properly.

In designing a valve, it is necessary to know the amount of gas which must be passed through, and its velocity. It is customary to base the area of the suction valve on a velocity of 4000 feet per minute, and the discharge valve on 6000 feet.

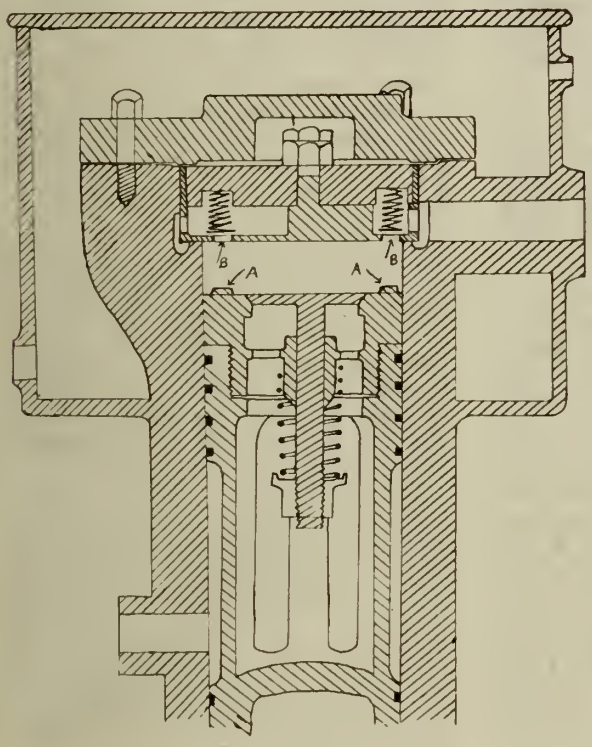


FIG. 6.

Table 1 gives the number of cubic feet of gas which must be pumped per minute at different suction and condenser pressures to produce one ton of refrigeration in 24 hours.

As an illustration, assume a ten ton compressor with back pressure of 13 lbs. and condenser pressure of 200 lbs. The table shows that 4.40.x10 cubic feet of gas must be pumped per minute. This amount may also be found by multiplying the area of valve opening by the velocity of the gas. It is therefore evident that the area can be found by dividing the amount by the velocity, in this case (4.4x 10) ÷ 4000–.011 square feet, or 1.584 square inches, corresponding to a diameter of 1.42 inches for the suction valve and 44÷6000–.00733 square feet, or 1.05552 square inches for the discharge valve. This corresponds to a diameter of 1.15 inches.

While valves proportioned in this way have been found satisfactory, it is usually advisable to have a lower velocity through the suction valve and very good results have been obtained with only 3000 feet per minute which calls for considerably larger valve opening than does 4000 feet.

Fig. 5 shows typical suction and discharge valves. The valve is ground to a seat in a cage which is inserted in the cylinder head. This in turn, is ground to a perfect seat, making an absolutely gas-tight joint. In some machines this joint is made by cutting a recess in the head and a corresponding shoulder in the cage and using a lead gasket. This makes a durable joint so long as the lead is not forced out, but as this often occurs, this type of joint is not reliable, and the ground joint as shown in Fig. 5 has come into general use. In the suction valve, shown at the left, the valve stem is smallest above the collar so that any break will occur above this collar, and there is no possibility of the valve falling into the cylinder. The collar works in a dash pot, which materially steadies its operation.

Ordinarily, the capacity of a refrigerating machine is stated in tons, one ton being the heat equivalent of 2,000 lbs. of ice at 32 degrees F., which has been melted into water at the same temperature or the amount of heat which must be abstracted from 2,000 lbs. of water at 32 degrees F. to freeze it into ice. The latent heat of ice being about 142 B. T. U., one ton of capacity is equal to 142x2000—284000 B. T. U. This is, however, misleading as no standard temperature at which this work shall be done has been adopted and a tonnage rate is merely nominal and actually misleading in some cases.

It is evident that the capacity of a compressor depends on the number of pounds of gas it will handle in a unit of time. The weight of gas depends on the efficiency of the compressor and the pressure at which it enters the compressor.

As the density of ammonia gas varies with the absolute pressure, a machine working under a suction pressure of 30 lbs. will have greater capacity than when working under 15 lbs. pressure. A low suction pressure is therefore essential, but the temperature at which the ammonia enters the coils must also be considered, as in calculating the net refrigerating effect of one pound of ammonia evaporated at a given back pressure, it is necessary to deduct from the latent heat of evaporation the energy used in coiling the ammonia itself. A good practical rule on this is that the ammonia should enter the coils at a temperature but little higher than that of the water flowing away from the condenser. It is usually considered advisable to reduce clearance as much as possible as any decrease in clearance increases efficiency. The economy of the compressor lies in its filling at the nearest possible point to the evaporating pressure and then compressing and discharging at the lowest possible pressure, as much of the contents of the cylinder as possible. If the piston does not travel to the end of the cylinder, the compressed gas remaining when the back stroke begins re-expands, and the gas from the suction line will not be taken into the compressor until the pressure in the cylinder falls below suction pressure. This may cause a serious loss not only of capacity, but also of power consumed in conforming gas not used. Many devices have been tried in order to reduce clearance—one of these being shown in Fig. 6.

There is a projecting ring A on the outer end of the piston. This fits into a groove B in which the valves are arranged. This practically eliminates clearance, but in modern, high speed machines it is not always advisable to do this, but to strive for a high efficiency of both, compressor and prime mover combined.

Cubic Feet of Gas to be Pumped per Ton

Temperature of Gas in Degrees F.	Corresponding Suction Pressure, Lbs. per Sq. In.	Temperature of the Gas in Degrees F.								
		65°	70°	75°	80°	85°	90°	95°	100°	105°
		Corresponding Condenser Pressure (Gauge) Lbs. per Sq. In.								
	G. Pres.	103	115	127	139	153	168	184	200	218
-27°	1	7.22	7.3	7.37	7.46	7 54	7.62	7.70	7.79	7.88
-20°	4	5.84	5.9	5.96	6.03	6.09	6.16	6.23	6.30	6.43
-15°	6	5.35	5.4	5.46	5.52	5.58	5.64	5.70	5.77	5.83
-10°	9	4.66	4.73	4.76	4.81	4 86	4.91	4.97	5.05	5.08
- 5°	13	4.09	4.12	4.17	4.21	4.25	4.30	4.35	4·40	4.44
0°	16	3.59	3.63	3.66	3.70	3.74	3.78	3.83	3.87	3.91
5°	20	3.20	3.24	3.27	3.30	3.34	3.38	3.41	3.45	8.49
10°	24	2.87	2.9	2.93	2.96	2.99	3.02	3.06	3.09	3.12
15°	28	2.59	2.61	2.65	2.68	2.71	2.73	2.76	2.80	2.82
20°	33	2.31	2.34	2.36	2.38	2.41	2.44	2.46	2.49	2 51
25°	39	2.06	2.08	2.10	2.12	2.15	2.17	2.20	2.22	2.24
30°	45	1.85	1.89	1.89	1.91	1.93	1.95	1.97	2.00	2.01
35°	51	1 70	1.72	1.74	1.76	1.77	1.79	1.81	1.83	1.85

TABLE 1

A THREE HUNDRED TON AMMONIA COMPRESSER

THE accompanying illustration shows a refrigerating machine with Poppet valve steam engine, having a refrigerating capacity of three hundred tons, at Fall River, Mass. The compressors are of the horizontal water-jacketed safety type, with Poppet valve high-pressure steam cylinder and Corliss valve low-pressure steam cylinder. This plant is operated with a steam pressure of 175 pounds per square inch and the superhead of 150 deg., with steam consumption in actual performance being less than 10 pounds per 1 h.p. hour.

In some installations it is desired to operate plants only part of the time during 24 hours, and by introducing a brine storage tank of sufficient capacity it is possible to cool down a comparatively large amount of brine during the time the machine is operated, which may be circulated the balance of the time for maintaining the temperature as nearly as possible. The same results may be accomplished in another way by the direct expansion system.

With the direct expansion system special congealing tanks are used which are designed to keep the temperature from rising too high when the machine is shut down. These tanks are shallow pans, which are erected in any convenient location on the walls of rooms or refrigerator boxes. They are filled with light solution of brine, in which is submerged an ammonia coil. The brine is frozen during the time when the machine is operated and the melting of the frozen brine when the machine is shut down, absorbs the heat which leaks through the walls, floors and ceilings. It is of interest to note that there are two principal types of brine coolers in vogue at present, the shell and tube design, and the double-pipe style, and both of these methods are quite sufficient.

When comparatively small rooms or tanks must be refrigerated and the amount of surface in each coil is very small, the regulation of a direct expansion system becomes very difficult and the brine system should therefore be adopted. Such conditions are experienced in hotels, hospitals, dairies, ice cream plants and apartment houses. Here the question of proper regulation and control becomes paramount and the economy of the direct expansion system cannot be successfully utilized. The brine system is also made use of where a circulating medium is necessary in open tanks or vats for doing the refrigerating work.

The process of refrigeration is used in a large variety of applications other than those above mentioned, of which the principal are breweries, cold storage plants, abattoirs and packing houses, department stores and chocolate factories, fur storage, drinking water cooling systems, beer storage depots, fruit pre-cooling plant and steel tempering systems.

As shown in the photograph the heart of every refrigerating equipment is the ammonia compressor, the successful performance of which is absolutely necessary to obtain the desired results. It is therefore of great importance to select the most dependable and economical design of compressor which the market affords. The horizontal safety compressor offers the unusual combination of safety in operation and the highest degree of economy. The valves are located in the bottom and not in the heads, which eliminates any possibility of an accident.

Another question which should be given consideration at the same time as the ammonia compressor is the kind of motive power which will best suit the local conditions. The cheapest method of operation will naturally be the most attractive. Current from hydro-electric stations may be obtained in a few localities at less than ½c a kilowatt hour. Electricity will be hard to compete with by any other forms of power in such places. Close proximity with coal mining districts will offer this fuel at low prices and steam power will prove advantageous. The cost of fuel or crude oil in about two-thirds of the United States and the great success of high-grade oil engines are reasons why this power has been adopted in so many recent installations.

There are hundreds of plants in operation with all types of motive power, including simple tandem and cross-composed Corliss steam engines, Poppet valve engines, using superheated steam, oil engines, water turbines and electric motors. Crude oil engines have also been utilized in all sizes of plants up to 800 tons refrigerating capacity, and are acknowledged as a form of power of the same dependability as first class steam engines.

The compression side of a refrigerating plant constitutes the machine, engine room connections, with oil and scale separators, liquid receiver and the ammonia condenser. The work of refrigeration is merely the extraction of heat, which must be absorbed and carried away. To absorb it refrigerating surfaces are required of a design and proportion to suit the conditions and work to be accomplished. The most common form is pipe arranged in coils in the rooms, refrigerator boxes, tanks and coolers. There are two methods which are in extensive use known as the direct expansion system and the brine system.

The direct expansion system is the most economical method and is used in the majority of plants. Ammonia circulating pipes are installed directly in the rooms or tanks where the work is to be done, and the ammonia is expanded directly into these pipes. The question of leaks is never considered a factor owing to the perfection in the construction of such piping systems.

The brine system is an indirect method of refrigeration which was in use before the direct expansion system was first introduced. Instead of directly expanding ammonia in pipes in the rooms, the ammonia is utilized in submerged coils, shell coolers and double-pipe coolers for cooling brine, and this brine is a circulating medium which is conveyed through the refrigerator pipes in the rooms or tanks for carrying off the heat.

The double-pipe coolers are usually made of 2 in. and 3 in. pipe, with the brine passing through the inner pipe and the ammonia expanded in the annular recess between 2 in. and 3 in. pipes. These are usually twelve pipes high, 20 feet long, and in every case they are proportioned to the quantity of brine which must be handled and the range that is necessary to do the best work. Brine coolers of the overflow or submerged type are also used in some

300-TON REFRIGERATING MACHINE.

instances, but the two styles above mentioned are adopted in almost every instance.

There are quite a few plants which have adopted the indirect method of air cooling for refrigerated rooms or boxes. By this system air is circulated over the ammonia coils in a bunker room and introduced into the cold rooms through ducts. Sometimes the air coolers are arranged with brine flowing over them. There is also a brine spray system which cools the air by passing it through the spray. All of these systems fall under the heading of "indirect methods." There are two advantages to indirect refrigeration. The first is the rapidity with which products may be reduced in temperature on account of the forced draft, and the other is the absence of coils in the rooms, eliminating the presence of frost or moisture and assuring the greatest cleanliness.

While at first glance these two advantages are very important, the indirect method has never been universally adopted, because in the the average case the disadvantages more than offset any advantages. The very bad feature is the fact that the rapid circulation of air increases the shrinkage of goods to a large degree. It has been found that the shrinkage of meat would be as much as 100 per cent. more in 48 hours when the indirect method is used as compared with the direct system. Apples, eggs, and other similar products which lie in cold storage for several months, not only suffer greatly from this excessive shrinkage, but also lose a good part of their flavor. The danger of introducing air which has passed over odoriferous products in other rooms is considerably increased. Not long ago, 50,000 eggs were destroyed through such an occurence.

It may be of interest to consider some of the advantages of the direct method. By properly distributing pipe coils in cold storage rooms, it is possible to insure a certain natural circulation of the air, which will reach products stored in the room at every point. This natural circulation causes no undue shrinkage, maintains a perfectly even temperature, and on the whole is more simple to handle than an indirect plant. Of course in installations such as fur storage rooms there is no loss through shrinkage, and the indirect system may prove more satisfactory on account of the absence of coils in the rooms and the elimination of any possibility of dripping.

It is obvious that in large plants, or even in equipments of moderate size, it is advisable to install two refrigerating units, as part of the time one of the units can be shut down and furthermore, in case of an accident to one unit the other could take care of the plant until repairs are made.

GOVERNOR FAILED AND CAUSED FATALITY

VANCOUVER.—Evidence given by W. H. Padden, chief engineer at the Robertson-Hackett mill, where James Bogle lost his life recently through the bursting of a fly-wheel, showed that failure of the automatic governor regulating the speed of the engine, was responsible for the catastrophe.

The witness stated that he discovered the driving belt of the governor on the floor of the engine-house, but did not attach any importance to this, as he expected the governor to act and automatically shut off the steam. Instead the engine commenced to "race," and Bogle, who was his assistant, ran to the valve near the wheel in order to stop it. By this time, however, the speed had increased to such an extent that the tensile strength of the wheel rim was insufficient to stand the strain, and it went to pieces, the unfortunate man being struck and instantly killed by the flying fragments.

Witness managed to make his way through the escaping steam to the top of the boilers, where he shut off the main valves.

Portions of the wrecked wheel flew a distance of forty feet, crashing through the room occupied by the saw-filer, who narrowly escaped injury.

Padden, who was the only witness of the accident, was unable to explain the cause of the failure of the governor, but said that about ten years ago a piece of valve rim became imbedded between the ports of the governor and prevented it working, the engine speeding up in that instance, but being fortunately checked without disaster. He believed that in the present instance something must have become dislocated inside the governor and caused an obstruction which prevented it from closing.

Witness explained that periodically he examined and tested the governor by taking off the belt and satisfying himself as to its working condition. He had done this about three months ago.

The jury returned a verdict to the effect that James Bogle died as the result of being accidentally struck by portions of the wrecked wheel.

The Paragon Electric Co., Old Colony Building, Chicago, has issued a pamphlet entitled, "Grounding Facts." This publication is descriptive of the grounds manufactured by this firm in the cone and cylinder shapes. In addition to the material of this nature given in the pamphlet much valuable data are included on the subject of grounding electric circuits in general.

Don't try to economize on packing by attempting to run it after it has been burned or become hard enough to lose its resilience. Packing is a small item compared to turning up the rod. Besides it is a lot more trouble and you can generally find more profitable use for your time than to stick around nursing a stuffing box full of worn-out packing.

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* * *

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* * *

"You ask what I think of POWER HOUSE twice a month, I for one would think it would be a benefit to all. I have always said it was a great drawback having it come only once a month. I have taken POWER HOUSE since the first copy was printed. I always look for it. **POWER HOUSE is a great help to the beginner,** and it will make some of the old fellows stand back and take notice."—Mr. H. Kendrick, Studebaker Corp., Walkerville, Ont.

* * *

"Re the publication of POWER HOUSE twice a month, I for one would be very pleased to get it that often. As regards the subscription price, if we get two copies a month instead of one, I should judge two dollars a year would not be out of the way."—Mr. J. Collier, Medicine Hat, Alberta.

* * *

"I would be delighted to have POWER HOUSE twice a month, as I think it is one of the best magazines printed.—Mr. J. A. Cooper, Montreal, West.

* * *

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The Proper Lubrication of Air Compressors

The Lubrication of the Air Compressor Has Been a Subject of Frequent Debate, and For This Reason the Following Article, Published Through the Courtesy of the Compressed Air Society, is of More Than Usual Interest

By H. V. CONRAD

SATISFACTORY lubrication of air compressor cylinders is attained by securing (1) the reduction of friction to a minimum and (2) elimination of carbonization of the oil as far as possible.

For the proper reduction of friction, oil chosen should have sufficient body to sustain the weight of the moving parts and to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

The objections to air cylinder oils which allow more than the very slight amount of carbonization which appears unavoidable, are, of course, well known, but may be briefly stated for the purpose of clarifying what follows:

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation but hard and flinty later. Such deposits accumulate on the cylinder pipes and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

1. The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder.

2. The use of oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily and, therefore, remain too long upon the hot cylinder walls, etc., thus baking down to sticky carbon deposits.

3. The use of too great quantities of oil, which has the same effect as the use of too heavy an oil, as far as the carbonization is concerned.

4. The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonization aside from the sticking of air valves and choking of the air passages is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapor" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large depending upon how much carbon had been allowed to accumulate in the compressor and piping to the receiver. If these are kept properly cleansed at all times there should never be a time of any danger.

This oil vapor is given off from a lubricating oil at a certain temperature called its "flash point" just as steam rises from water at a certain point.

Heat of Air Compression

The selection of an air cylinder lubricant is, of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table No. 1.

This table gives the final temperature in the cylinder at the end of the compression stroke, for single stage, also for two stage (or compound) compression, when the free air entering the cylinder is 60 degrees F.

Table No. 1—Cylinder Temperature at End of Piston Strokes

Air Comp. to	Final Temp. Single Stage	Final Temp. Two Stage
10 lbs. gauge	145 deg. F.	
20 lbs. gauge	207 deg. F.	
30 lbs. gauge	255 deg. F.	
40 lbs. gauge	302 deg. F.	
50 lbs. gauge	339 deg. F.	188 deg. F.
60 lbs. gauge	375 deg. F.	203 deg. F.
70 lbs. gauge	405 deg. F.	214 deg. F.
80 lbs. gauge	432 deg. F.	224 deg. F.
90 lbs. gauge	459 deg. F.	234 deg. F.
100 lbs. gauge	485 deg. F.	243 deg. F.
110 lbs. gauge	507 deg. F.	250 deg. F.
120 lbs. gauge	529 deg. F.	257 deg. F.
130 lbs. gauge	550 deg. F.	265 deg. F.
140 lbs. gauge	570 deg. F.	272 deg. F.
150 lbs. gauge	589 deg. F.	279 deg. F.
200 lbs. gauge	672 deg. F.	309 deg. F.
250 lbs. gauge	749 deg. F.	331 deg. F.

Variations from these temperatures will occur in actual practice due to water jacketed air cylinders and radiation, tending to lower the temperature at the higher pressure. But at, say, 50 pounds pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed and also if it is not water jacketed.

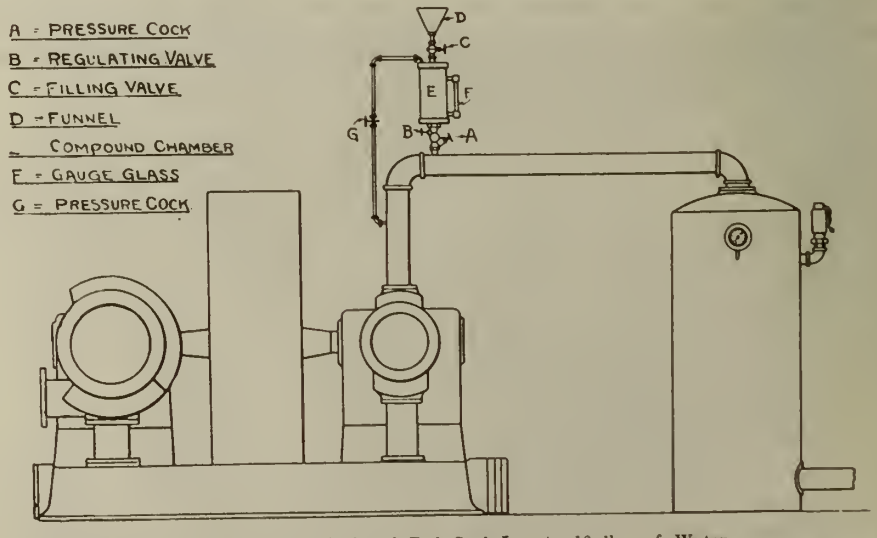
Relation of Oil Flash Point to Cylinder Temperature

The natural inference of the reader after noting the temperatures in Table 1, is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case and it need only be carefully noted that the study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

Qualities of Cylinder Lubricating Oils

For average normal conditions, the oil should be a medium bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

Quite a range of oil composition is permissible for lubricants approved for



COMPOUND—Mix 1 lb. of Red Seal Lye to 18 lbs. of Water.

To use Compound: Close Cock "A" and "G," open Valve "C" and fill Compound through funnel "D," when chamber "E" is filled close Valve "C," open Cock "G" and "A" and regulate feed by Valve "B"; use about 70 drops per minute.

DEVICE FOR CLEANING CARBON IN AIR DISCHARGE LINE AND RECEIVER OF AIR COMPRESSORS

this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having a paraffin base, as distinguished from those having an asphaltic base.

From a strictly operating standpoint —so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinder oils, provided that both have been properly filtered in the process of manufacture to remove the carbon forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light, fluffy nature and easily cleaned out, whereas that deposited by the paraffin base oil is very adhesive and characterized by the hard, flinty nature.

Paraffin Base Lubricating Oils

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air cylinder lubricant recommended for average duty, the following table is presented:

Table No. 2—Physical Tests of Paraffin Base Oils

	Minimum	Average	Maximum
Gravity, Baume	28 to 32 deg.	25 to 30 deg.	25 to 27 deg.
Flash Point, Open Cup	375 to 400 deg. F.	400 to 425 deg. F.	425 to 500 deg. F.
Fire	425 to 450 deg. F.	450 to 475 deg. F.	475 to 575 deg. F.
Viscosity (Saybolt) at 100 deg. F.	120 to 180 sec.	230 to 315 sec.	to 1500 sec.
Color	Yellowish	Reddish	Dark Red to Green
Congealing Point (pour test deg. F.)	20 to 25 deg. F	30 deg. F.	35 to 45 deg. F.

It is suggested that these oils within the range expressed by the minimum figures be used for light duty of low-pressure and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin base lubricant intended for use in "all standard air compressors," should meet the physical tests imposed by the average range of figures given in the middle column of the above table. The above wording "standard air compressors" is to be interpreted as including the following types of machines:

(a) Low pressure up to 100 lb. compressors, which may be either small sized single stage units, or larger sized compound machines.

(b) High pressure compressors which are constructed with the proper number of stages, so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his literature that a high flash point of oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should possess a flash point as high as 500 degrees unless abnormal conditions of high temperature prevail. Such high flash point oils have an unusual tendency to produce carbon deposits.

Asphaltic Base Lubricating Oils

This group of oils is considered separately for the reason that the lower limit of gravity stated in the above table, viz., 25 degrees baume, eliminates the entire group from consideration—which is not the intention of this article.

As a guide for the selection of a suitable oil, the following table is given:

Table No. 3—Physical Tests of Asphaltic Base Oils

	Minimum	Average	Maximum
Gravity, Baume	20-22 deg. F.	19.8- 21 deg. F.	19.5-20.5 deg. F.
Flash Point, Open Cup	305-325 deg. F.	315-335 deg. F.	330- 375 deg. F.
Fire	360-380 deg. F.	370-400 deg. F.	385- 440 deg. F.
Viscosity (Saybolt) at 100 deg. F.	175-225 sec.	275-325 sec.	475- 750 sec.
Color	Pale Yellow	Pale Yellow	Pale Yellow
Congealing Point (pour test)	0 deg. F.	—0 deg.F.	—0 deg. F.

For general all around use, it is conceded that the recommendations given in Tables No. 2 and 3 above cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

Proper Quantity of Lubricating Oils

The quantity of lubricating oil to feed to the air cylinders of the compressors, cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of the cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table No. 4 is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

Table No. 4—Quantity of Air Cylinder Lubricant Required per 10 Hour Day.

Diam. of Cylinder Inches	Size of Cylinder Inches	Displacement per Minute Cubic Feet	Piston Speed Feet per Minute	Sq. Ft. of Cylinder Wall Swept by Piston	Drops of Oil per Minute	Drops of Oil per 10 Hours	Sq. Ft. Oiled per Drop	Number Pints Oil Required per 10 Hours.
8	8x 8	120	344	718	1	600	718	.0375
12	12x12	320	408	1230	2	1200	613	.0750
18	18x18	880	496	2340	4	2400	585	.1500
24	24x24	1730	550	3450	6	3600	575	.2250
30	30x30	2940	600	4700	8	4800	590	.3000
36	36x36	4550	644	6070	10	6000	607	.3750
42	42x42	6700	696	7600	12	7200	633	.4500

*Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 degrees Fahr.

It will, of course, be carefully noted and clearly understood that the results in the last column of Table No. 4 are based upon the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. It is understood of course that these figures are offered merely as an approximate guide and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering contributes the following:

"The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

Periodical Cleansing of System

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it.

For the removal of carbon, the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of one part of soap to fifteen parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump, or through the regular lubricator at a rate about ten times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made. After using soap suds, open the drain cock of the air receiver, and of the inter-cooler in the case of compound machines, to draw off any accumulated liquid. Oil should be again used for half an hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene,

gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

Cleaning Air Receiver and Piping

It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and the air receiver. A practical method of cleaning these is shown in cut attached, where a receptacle made of 6-inch pipe is shown set on top of discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixture of one pound of Red Seal Lye and eighteen pounds of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve of the receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two or depending on how much accumulation may be in the receiver.

The proper quantity of oil to be fed to steam cylinders is much greater than to air cylinders due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops, and taking an average of about 6,500 drops, and four times as much oil as air cylinders of same size and working at same piston speeds, as given in Table No. 3, the recommended amounts to feed the steam cylinders or their equivalents are given in the following.

Table No. 5—Quantity of Oil for Steam Cylinder Lubrication.

No. Drops per Min.	Size of Cylinder Inches	No. Pints Oil Required per 10 Hours
4	8 x 8	.4
8	12 x 12	.75
16	18 x 18	1.5
24	24 x 24	2.25
32	30 x 30	3.0
40	36 x 36	3.75
48	42 x 42	4.5

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

Observations on Changing Tested Oils

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collects on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubrications to the local experts of any reputable lubricating companies, and to be governed by their recommendations, which, however, should be based on the foregoing statement.

Is the Heating of Feedwater by Steam Economical?

Live-Steam Heating Used For Many Years in Marine Practice With Good Results—Discussion of Advantages to be Derived and Circumstances Under Which Live Steam Heating is Advisable

By E. STANDIFORD

FEW questions connected with the steam boiler have been more hotly contested than the heating of feed water by means of live steam. On the one side theorists have argued from thermo-dynamic laws the impossibility of securing economy by the heating of feed by the condensation of steam drawn from the boiler; on the other side practical men point to the many installations of live-steam heaters in which economy is secured.

A large body of marine-engine builders and shipowners have for many years used some system of live steam-heating with results which were and are apparently satisfactory. At the same time it does not admit of question that there is nothing to be gained directly by live-steam heating, and in order to reconcile the obvious contradiction we must assume that something not yet understood goes on inside the boiler.

A careful experiment was made upon an experimental boiler of a locomotive type; the shell being 3 feet 6 inches in diameter, and contained 47 3-inch tubes, 6 feet 10 inches long. The firebox was 3 feet 5½ inches by 3 feet 3 inches by 4 feet 8 inches deep; the grate area was 7.5 square feet and the heating surface 315 feet.

The feed water was supplied by a pump worked from the cross head of the main engine. When supplied cold it entered the boiler through an opening in the side; when the live steam feed heater was in use the cold feed entered at the top of the boiler and passed through the heater before finally escaping into the water space of the boiler. The heater was constructed especially for the tests; it consisted of three shallow tin-plate dishes superposed and connected to each other by distance pieces; the feed water admitted by the feed pipe to the bottom of the upper dish overflowed into the second. A central overflow pipe maintained a constant depth of about ⅝ inch in this dish and overflow took place through this pipe into the bottom dish, from which it overflowed and dropped into the water space of the boiler.

The heater was supported in the steam space by longitudinal stays. It was made as large as could be conveniently got into the very constricted space available, but could with advantage be made larger, the feed water not remaining in contact with the steam for a sufficiently long interval of time to enable it to attain full boiler temperature before mixing with the water in circulation.

The temperature immediately before overflow was measured by means of a mercury thermometer placed in a pocket through the boiler crown which rested on the bottom of the lowest and largest tray. The steam produced was used for driving a brake-load experimental engine whose load could be maintained constant or varied as required. The whole plant was especially equipped for testing, and all the measurements of coal and water consumption, temperatures of water, steam and flue gases, etc., were made with great accuracy. Four tests were carried out, the first two having the heater in operation but with very different loads on the boiler, the other two without the heater, but with rates of evaporation similar to those in the first pair.

In all the tests the temperature of the water entering the boiler was 40 degrees Fahr., and the temperature of the steam 339.6 degrees Fahr. In the light-load trials the feed water left the heater at a temperature of 313.8 degrees Fahr., a gain of 273.8 degrees; in the heavy-load trials the gain was 255 degrees. Probably a conservative estimate would place the increased efficiency due to the use of the heater under exactly identical conditions of working as 5 per cent. in the light power trial, and 8 per cent. in the heavy power trial, and had the heater been sufficiently large to enable the feed water to be heated up to full boiler temperature, these gains could have been increased to at least 6 and 9 per cent. respectively.

With a view to throwing some light on the reason why such a method of feed heating should lead to more economical working, a series of experiments were afterwards carried out on an open cast iron vessel about 8 inches in diameter

and containing about three inches of water; this was heated up by means of a ring of gas jets giving a flame whose mean temperature was 2,000 degrees. The temperature of the water side of the plate was measured by means of a platinum-iridium thermo-couple placed in intimate contact with the plate, a shallow depression being made in the plate to receive the point of the couple.

The temperature of the water was taken by means of a mercury thermometer. It was found that the difference in temperature between the plate and the water gradually diminished from 70 degrees to 0.5 degrees. In these experiments the water was stirred vigorously during the whole period of heating, and it confirmed what has been brought out by other experimenters that, under given conditions of heat transmission the difference between the temperature of the water and of the water side of such a plate is very much greater when the water is being heated up to boiling point than when it is in ebullition, and this although the water is circulating vigorously over the hot surface.

In these experiments, too, however great the ebullition, it was found impossible to increase the temperature of the water side of the plate to more than 213 degrees Fahr., and in the great majority of cases the temperature was, as nearly as could be measured, identical with that of the water. As a result of these experiments I found it would appear reasonable to assume that over the tubes, in the neighborhood of the feed inlet to a boiler, the temperature of the water side of a plate, and, therefore of the fire side of the plate for a given rate of heat transmission was appreciably lower; as much as 40 degrees Fahr. lower and at least 20 degrees Fahr. lower with the heater in operation than without it. At first sight it would appear that such a small difference is totally inadequate to account for any appreciable difference in heat transmission and hence in the efficiency, for since the temperature of the gases has a mean value of about 1,200 degrees Fahr., the mean difference between the temperature of the gases and that of the tube surface will be about 850 degrees Fahr., and a difference of 20 degrees Fahr. in this, assuming heat transmission to vary as difference of temperature, would only affect heat transmission by a little over 2 per cent. Assuming the heat transmission from gas to plate to vary as the square of the temperature difference, this increases the effect, say roughly 5 per cent.

Investigations on the transmission of heat to the water jacket of an internal-combustion engine, however, appear to indicate that, as in this case, so in the case of a steam boiler, a much greater proportion of the heat is transmitted by direct radiation than has hitherto been assumed; hot gases even when in a non-luminous state having been shown to possess the property of radiating heat in a marked degree, up to about 40 per cent. of the total heat interchange apparently taking place by radiation.

Experiments also indicate that the transmission of radiant heat at such temperatures that occur in the hot gases is proportional to the difference of temperature raised to the Nth power where N apparently has a value approximating to 3.5. Adopting this value, a drop of 20 degrees Fahr. in the tube temperature would give an increased transmission by radiation of practically 9 per cent.

Even though the great proportion of heat is transmitted by conduction from gas to metal it appears however that a cooling of the metal surface is likely to be more effective than a corresponding increase in the temperature of the hot gases. As is well known, transmission of heat by conduction from stratum to stratum of a hot gas is a mass phenomenon, and depends on the velocity (therefore greatest near the centre of a tube where velocities are greatest) on the difference of temperature and increases directly as to density.

Owing to the rapidity of the motion heat is readily transmitted from the central filaments in such a tube to those nearer the walls, but with considerably

BELT LACER.

less ease in the immediate neighborhood of the walls where the motion is comparative by sluggish. In the neighborhood of the walls however the gas is cooled down to a temperature approximating much more nearly to that of the cool surface, its density is considerably greater than in the center of the tube and is greater as the tube surface is cooler, so that any cooling of this surface has a double effect in increasing the rate of transmission.

On the whole it would appear that these differences in the rates of heat transmission, though severally small, when acting cumulatively offer a possible explanation of the gain in efficiency undoubtedly obtained in series of tests by the use of the live-steam feed heater. The reason for the greater gains in efficiency in the case of the more heavily worked boiler is probably due to a greater portion of the heating surface being occupied in heating up feed water rather than in the process of evaporation in such a boiler than in one more lightly worked. With feed water at 40 degrees Fahr. over 25 per cent. of its total heat is given to the water during this process of heating up, and the proportion of the whole heating surface affected by this must be roughly proportional to the weight of cold feed per minute. From this and other considerations it may be expected that such a heater will be found to be most effective; (1) In a given boiler when this is most heavily worked; (2) when no economiser is fitted to take advantage of the heat rejected in the flue gases; (3) where the boiler is fed with cold water; and (4) other things being equal, in a boiler in which the heating surfaces are somewhat incrusted.

A NOVEL BELT LACER

By Frank C. Perkins

The accompanying illustration shows a unique and effective belt lacer in operation. It is stated that this machine laces any width or thickness, and laces a 6 inch belt in three minutes. It saves man-time, machine-time and money, and makes a durable, flexible lacing.

The photograph shows the toggle construction of the new lacer and why it is possible to develop over 50 per cent. more power for pressing hooks in flush with the surface of a belt than with older types of devices. It is made of crucible steel, malleable iron, and tool steel, and all of the working parts interchangeable.

The clipper hooks are carded, long and short ends alternating. This card is easily removed after the hooks have been locked into the tool. The cards contain 37 hooks, each enough for a 6-inch belt, and with rawhide pins, one for each laced joint. In lacing belts narrower than 6 inches, it is only necessary to cut each edge of card with scissors furnished, bend slightly back and cut through centre. This can be done without displacing any hooks.

This lacing is flush with the belt on both sides. No holes are punched, nothing taken out to weaken it and no fibre is cut to allow belt to ravel. The hooks are zig-zag so that the pull is distributed over a large area of belt. The hooks are made from a special steel wire of an analysis that combines great tensile strength with rigidity and wearing qualities. Actual tests have proven that each hook will stand a pulling strain of 60 pounds, equal to over 400 pounds per inch of belt.

There is no ladder needed; as one of the greatest advantages of lacing belts with this device is the fact that the work is done right beside the broken or stretched belt, without removing the belt from the shaft. The lacer is set on the floor or a box, and a row of hooks of the proper width is then placed in the tool. The squared end of belt to be laced is then inserted, and, by depressing the levers the hooks are deeply embedded into the end of the belt, flush with both surfaces, leaving a uniform row of loops extending across the belt end. When the other end is similarly treated the two ends are brought together round the face of the lower pulley in such a way as to intermesh the loops. A rawhide or fibre pin is slipped through these loops and the job is finished.

The Making of Artificial Ice from Raw Water

Pure Ice is Made by the Raw Water Ice Plant at an Economical Figure—The Article Describes Some Steps in the Process of Raw Water Ice Making

By JAMES W. PATTON

NOT so many years ago the common idea was that "ice was ice"; whether cloudy or clear, pure or contaminated was never considered by the consumer. The product of the neighboring pond was readily sold, regardless of the fact that before freezing it was the dumping ground of the entire vicinity. However, agitation, due to increased knowledge on the part of the consumer and health officials, increased competition and other causes forced a change, and in order to be saleable the ice company's product had to be clear and transparent in appearance as well as chemically pure. The distilled water plant was the first result of this change in public opinion, and for many years engineers considered that it was necessary to install and to use a very expensive system in order to make a saleable product. The distilled water system was the only recognized standard type and continued in almost universal use until a few years ago, when a demand for a cheaper product forced another change. In order to obtain the distilled water a certain quantity of steam is necessary, and this of course led to the use of the steam engine as the standard form of power, as this could be used in the production of the distilled water; as it was found that the amount of exhaust from a simple Corliss engine driving an ice plant was just about sufficient for the purpose. It is evident that under these conditions of manufacture the more efficient type of power plant could not be considered as oil engines, gas engines, or electricity would not furnish the required amount of steam.

When the demand for a cheap ice, which was also pure, became general, a radical change was made, and the raw water ice plant was the result. This system makes it possible to manufacture ice from ordinary water without the expense and care incidental to the operation of the older type plant. Fig. 1 shows a standard type gravity distilling apparatus in which the water, after being condensed in the steam condenser passes through the reboiler, flat cooler, filters and storage tank into the cans, gravity being the motive power. It is plainly evident that at the best this is a complicated system, expensive to install and requiring skilled attendants. In plants where all the ice is made from distilled water, only about 80 per cent. of the steam produced by the boilers can be saved for filling the cans, therefore it is necessary to equip the plant with engines which will produce the necessary power with less steam than is needed for filling the cans, otherwise fuel economy will not be obtained. This makes it necessary to install an evaporating plant, and the economy of the entire plant is an average of the economies of the steam-producing apparatus, the evaporating machinery and the boiler plant. Raw water ice making is the natural companion of economical motive power as all modern developments have been toward reducing the cost of a ton of ice, and unless the entire plant is economical in its operation it is useless to install a cheap motive power. Obviously the elimination of one series of operations is a step in the right direction, and the ideal plant of to-day is the one which uses raw water frozen in the removable type of cans. Water, in freezing, will throw off impurities which can be removed in no other way except by boiling and condensing. An illustration of this is in the well-known Plate system, where the impurities are retained in

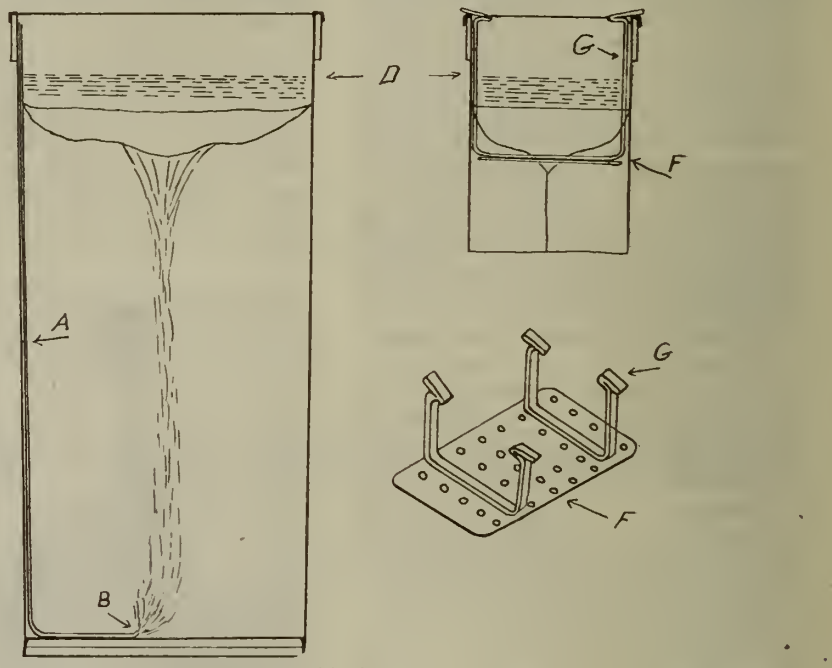


FIG. 2

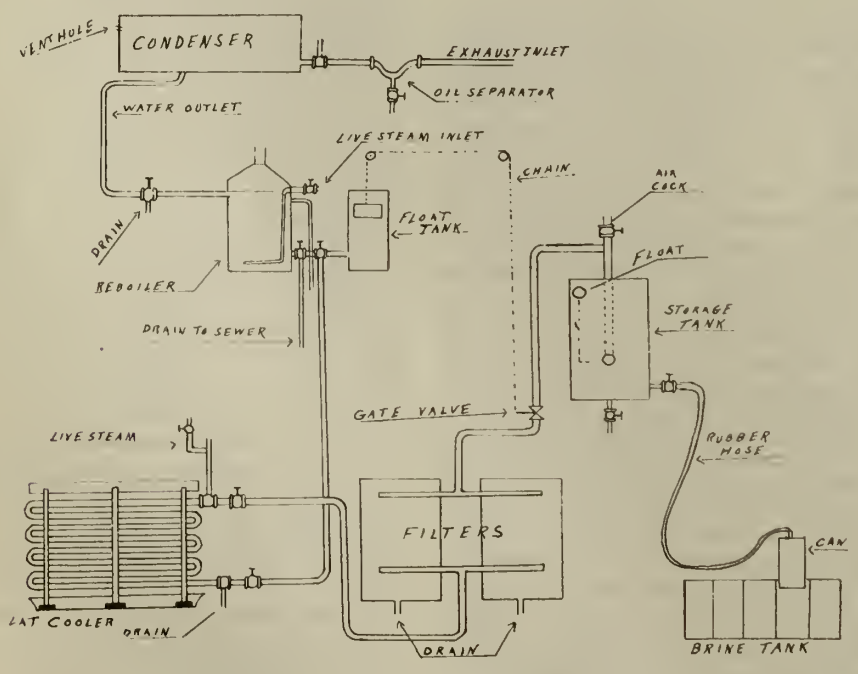


FIG. 1

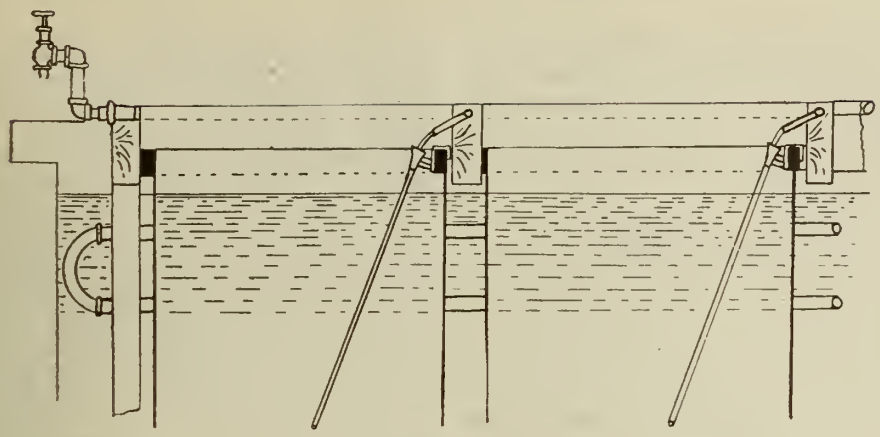


FIG. 3

the water between the cakes of ice until this water becomes so heavily charged with these impurities that it is necessary to drain it off and refill the space with fresh water. Practically all ordinary drinking water may be made into merchantable ice if properly filtered, and even in cases where the water is not drinkable the cost of the slight chemical treatment necessary is not prohibitive. The agitation of the water during the process of freezing is the key to the situation, as any method which will produce this motion of the water will produce marketable ice provided the water is not allowed to freeze while it is so full of impurities that they are frozen into the ice itself. If ordinary water is frozen in the can without treatment the result is a block of white opaque ice, this being due to the presence of air, but if the water is agitated during the freezing the small air bubbles are made to rise and do not cling to the surface of the growing ice.

There are several types of agitator on the market, and as may be expected, each type has its advocates, but in a general way, raw water plants may be classified as low or high pressure, with another special system which combines the two. The introduction of air at about 2 lbs. pressure is usually sufficient to agitate the water in the can, but during the process of freezing in this low pressure system, ice often collects at the end of the air tube and sometimes obstructs the passage.

The water in the centre of the can near the bottom is always the last to freeze, and in all systems the end of the air tube reaches that part, in some cases drop tubes being used, which hang over the can in a perpendicular position, while in other cases the pipe is led down the inside of the can as shown in Fig. 2. When this method is used it is not necessary to lift out the tube when the can is pulled and it is not in the way if it is necessary to pump out and refill the core, but the fact that the location of the pipe subjects the air passing through the tube to the brine temperature, causing freezing up, is a decided disadvantage. This frequently forces the installation of air coolers, which naturally add to the difficulties of running such a plant.

In Fig. 2 the air pipe can be seen at A, the air entering the water at B, passing upward along the surface of the ice as it forms, causing an agitation on all of the freezing surfaces which keeps the impurities from freezing into the ice. When the ice begins to close up, the air still blows upward between the surfaces until the space becomes so small that in many cases the remaining water is blown out into the unfrozen space above.

In other cases, the water between the freezing surfaces, after becoming heavily charged with impurities, is pumped out and the space refilled with pure

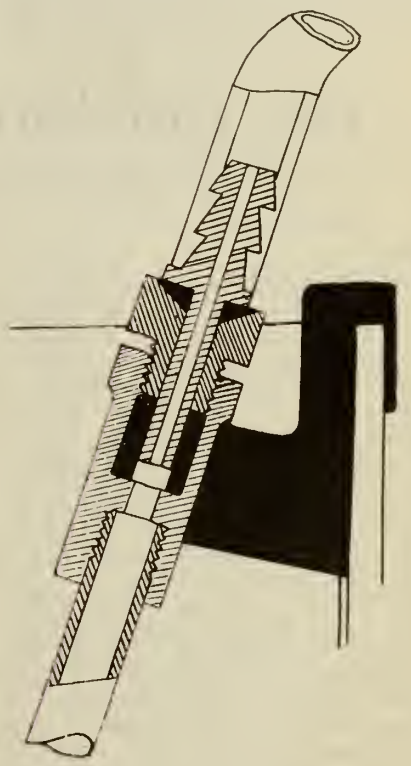


FIG. 4.

water. It may be noted, however, that if it is necessary to refill with distilled water, this necessitates a distilling plant of some sort, which is, of course, an added expense.

The space usually occupied by the unfrozen water is shown between the top of the ice block E, and the water level D. This water is usually thrown out when the can is pulled. Here again there is a disadvantage, as when the core is drawn and refilled, if distilled water is not used, the ordinary water may contain impurities and not being thoroughly agitated, they may freeze in the ice. In any event, cakes of uneven height are formed, and, to obviate this, grids as shown at F are used. These are perforated and are frozen into the ice at any desired height, being held by the straps G.

After the can has been pulled, the grid may be easily removed, together with the ice above it, but here again we

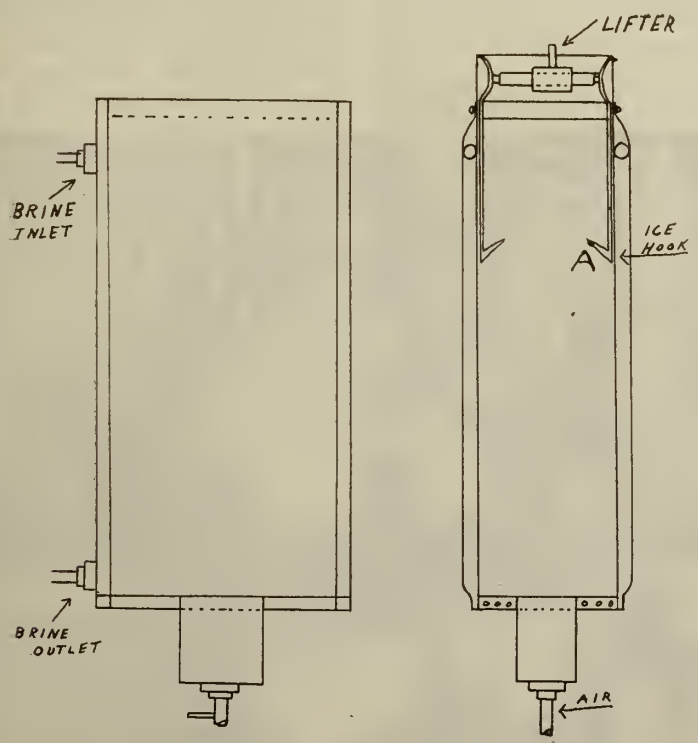


FIG. 5

have a waste of ice which has cost money. This is a serious matter, as in a plant of a hundred tons daily capacity, this loss might easily amount to several thousand dollars annually, as at least 5 per cent. of the product must be thrown away.

In Fig. 3 is shown what may be called a medium pressure system. The air tubes are suspended from the side of the can by a brass bracket and they extend diagonally down to a point near the bottom of the centre of the can. Both the bracket and air tubes are handled together, and when the can has been filled and lowered into place, the tube is easily hung on the side of the can.

The details of the tube and bracket are shown in Fig. 4. A permanent air pipe is placed between each two rows of cans, and supplies air to both sides. This pipe carries air at about 20 lbs. pressure, but as each nozzle contains a very small opening, just enough air escapes to properly agitate the water as there is a natural reduction in pressure. The moment, however, that ice forms around the end of the tube or there is any other obstruction, the pressure builds up until the air forces its way through and clears the passage.

The position of the tubes also serves to keep them surrounded with water at no more than 32 degs. Fahr. and therefore freezing of tubes does not occur.

When the can has been pulled, and it is necessary to remove the tube, the operator simply uses a thawing needle of very small diameter, which is pushed through the tube until it reaches the bottom, and by the time this is done, both tube and needle may be easily withdrawn.

The amount of steam used in this operation is very slight, and it can usually be completed in four or five seconds.

There are several systems on the market in which the agitation method is not used, one being shown in Fig. 5, a stationary double-walled can is used, cold brine circulating in the jacket space. A good brine circulation is insured by using from 5 to 10 lbs. pressure, and this gives a good heat exchange. The lower part of the tank is not in contact with the brine and therefore it is non-freezing. This lower part serves as a settlement place for the impurities which become concentrated as the freezing progresses. Hooks as shown at A, Fig. 5, are used in removing the ice cakes which have previously been thawed loose by a circulation of relatively warm brine in the jackets. This system is easily controlled, freezing is regular, but the ice is usually only semi-transparent, and not to be compared with that made by the agitation process.

The Installation of an Ammonia Compressor

The Following Article Describes a Recent Installation in Montreal in Which a Short Belt Drive Was Used With Good Results

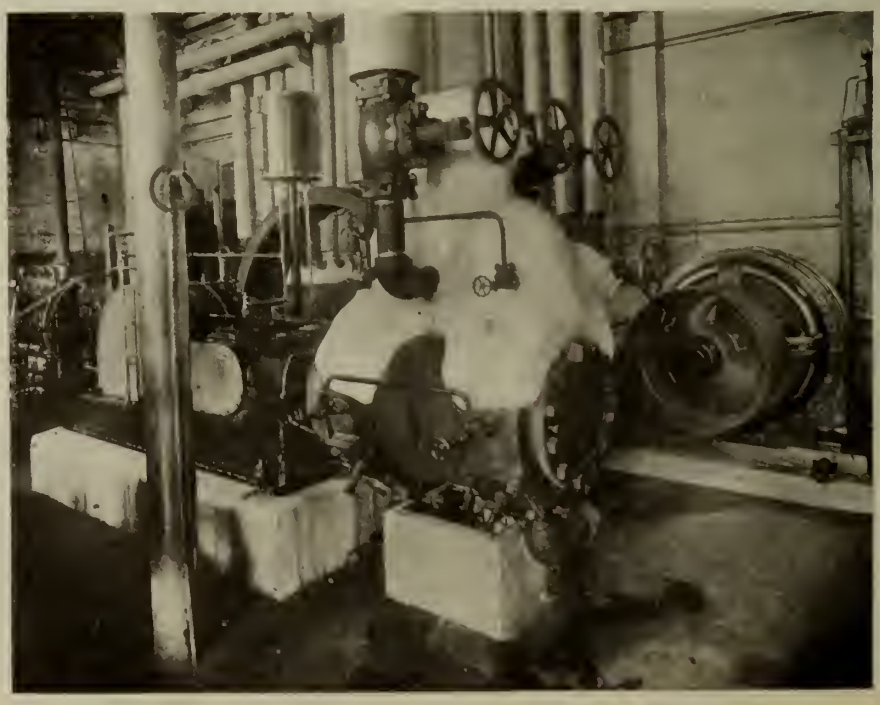
By J. H. RODGERS

HIGH speed ammonia compressors are by no means a new innovation to the artificial ice making or refrigerating industry, but their appearance in Canada is, virtually, of recent origin. The installation here illustrated is that installed last year at the plant of the Matthews-Blackwell Co., in Montreal. Lack of available floor space and the necessity of increased refrigeration were two of the main reasons for the decision to install one of these high speed machines. The unit here shown is a 50 ton De La Vergne high speed ammonia compressor, belt connected to a 200 h.p. Canadian General Electric motor. running at a speed of 600 r.p.m. The compressor operates at a speed of 149 r. p. m. The space occupied by this De La Vergne machine is less than the unit it displaced, and yet it has twice the capacity of the previous compressor. A feature of this installation is the comparatively short drive, the centre distance of the two shafts being only 9 feet; the respective diameters of the driving pulley and the compressor fly wheel being 31 inches and 8 feet. A skeleton sketch of the drive, together with the Lenix roller is here shown. With the exception of brief shutdowns, as a result of the power going off, this unit has been in continuous operation, night and day, for nearly twelve months.

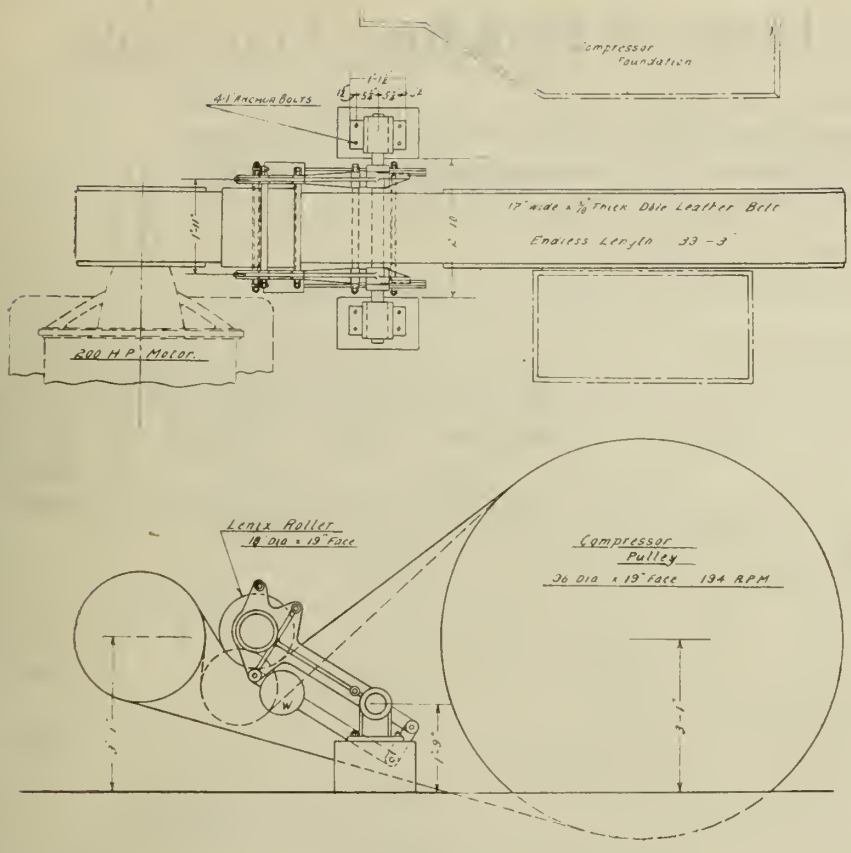
The following is a brief description of the machine: The frame of the compressor is of the tangye type and is designed for great stiffness, with large bearings for both crosshead and main bearings. Moving parts are enclosed in sheet metal guards, which may be easily removed and at the same time keep out dirt and saves the lubricating oil. There is an extension on the bottom of the frame, which rests on the foundation, giving added stiffness to the section under the main bearing. By grouting this extension firmly in the foundation, movement of the machine on the foundation is prevented. A large opening is left in the frame for ready access to the stuffing box. The stuffing box is an integral part of the front head, packed with a combination of special metallic and soft packing, containing a short lantern, which is connected to the suction line and into which the oil for lubricating the rod is pumped. The packing is held in place and adjusted by a screw gland.

The discharge ports and cylinder heads of the compressor are water-jacketed, but the suction ports and cylinder barrel are unjacketed because the water would heat instead of cool the incoming gas.

The main bearing is of the four part type. The cap is not babbitted, except at the end of the bearings, and then only to keep the oil from getting away, and to give a fixed point to which the shaft can be adjusted. The cap fits snugly between the jaws of the frame and is bolted down solidly on top of the jaws. Unlike all other bearing caps, it is not used in adjusting the bearing, as adjustment in a vertical position is made by a wedge under the bottom shell. In making up for wear, every adjustment brings the shaft back to the original position as fixed by the cap. Only one wedge is used for side adjustment, which construction was adopted because of the fact that the bottom shell follows the shaft in its motion. If adjustment in the other direction is necessary



DE LA VERGNE ICE COMPRESSOR WITH SHORT BELT DRIVE.



DETAILS OF BELT DRIVE.

shims can easily be placed back of the stationary quarter box. The adjustment in one direction only prevents the shaft from being moved out of line.

The connecting rods and cross head have few special features, except the method of lubricating the crosshead pin. A hole is drilled lengthwise through the centre of the connecting rod and connects with holes in crankpin and crosshead pin boxes. Special oil grooves are cut in the crankpin box, and the oil is forced by centrifugal force and inertia to the crosshead pin. This does away with one of the greatest difficulties to be overcome in the lubrication of a compressor. Other methods are unsatisfactory, due either to the necessity of catching drops of oil while in motion or to a multiplicity of small wearing parts which easily get out of order and cause shutdowns. On account of the large diameter of the crankpin and the shaft, it is deemed advisable to make the crank and crankpin in one piece, a steel casting, which includes also the necessary counterweight to balance the reciprocating parts.

Oil for lubricating all bearings and guides is collected in the base of the frame and is removed from there by a small geared pump, driven by a belt from the main shaft. The oil is then passed through a filter, mounted on the frame, and is returned free from grit, dirt and water, to the points of lubrication, namely, two on the main bearings, one on the crosshead guide, and one from which both the crosshead pins and crank are lubricated. The lubricator for the stuffing box is mounted on the same bracket with the oil pump, and is driven by a belt. These auxiliaries are belt driven so that in case of trouble the belts can be thrown off and the pump and lubricator repaired, replaced and put in operation again without necessitating a shutdown of the compressor. A hand-pump for cylinder lubrication is also provided, and the filter contains enough oil to last for at least one-half hour, thus giving plenty of time for repair. The only part of this machine which is made fast to the foundation is the frame; the cylinder is merely supported and is free to move, thus taking care of contraction and expansion, and the deflections due to pressure changes.

SUFFICIENT POWER FOR TWENTY CITIES

Southern British Columbia is Rich in Important Water Powers

In British Columbia there are many important water powers. The investigation of the water powers of British Columbia by the Commission of Conservation has disclosed the existence of two great water power centres, namely, Nelson, with 400,000 h. p. within a radius of 50 miles, and Vancouver, with 300,000 h. p. within the same distance. Based on experience at Toronto, these quantities would suffice for a population of 1,700,000 at Nelson, or for 10 manufacturing cities of 170,000 each. The power near Vancouver would suffice for one manufacturing city of 1,250,000 population, or for 10 cities of 125,000 each.

There are 12 power sites in British Columbia of 50,000 h.p. and upwards. With the exception of the South Fork Quesnel and Peace River, all these powers are less than 125 miles from the 49th parallel.

	h. p.
Kootenay River, Upper and Lower Bonnington Falls, possible development	125,000
Pend d'Oreille River, Waneta	73,000
Pend d'Oreille River, Salmon River	50,000
*Thompson River	100,000
*Fraser River, Hellgate	200,000
Bridge River, Tunnel	70,000
Stave River, lower site	52,000
Stave River, upper site	52,000
Coquitlam-Buntzen, north arm Burrard Inlet	84,000
Campbell River, possible	100,000
South fork Quesnel River	90,000
Peace River Canyon	100,000

There are 18 power sites of between 20,000 and 50,000 h. p. Eight of these sites are distant less than 100 miles from the 49th parallel.

Kootenay River, Cora Lynn to Granite Rapids	22,000
Kootenay River, rapids near mouth	20,000
Pend d'Oreille River, Nine-mile Falls	32,000
Pend d'Oreille River, Fifteen-mile Creek	34,000
Columbia River, Long Rapids	30,000
Adams River	30,000
Barriere River, ultimate development	20,000
Murtle River, Helmken Falls	20,000
Nahatlatch River, rapids below lakes	30,000
Jones Lake (Fraser River)	25,000
Jordan River (25,000 h. p. developed) ultimate	38,000
Cheakamus River, Bear Mount canyon	40,000
Powell River (24,000 h. p. developed) utimate 32.000	35,000
Nechako River, Grand canyon	30,000
Nechako River, Tetachuck Falls and Rapids	30,000
Bulkley River, Hagwilget canyon	20,000
Nass River,falls below Cranberry River	20,000
Nass River, falls below Cranberry low White River	20,000

There are 29 power sites of between 10,000 and 20,000 h.p. capacity and 585 of less than 10,000 h. p. The report of the Commission of Conservation on the water powers of British Columbia includes all vailable data respecting 644 water power sites.—James White.

*Development debarred owing to presence of railways.

German textile industries not only used paper as a substitute for wool and cotton but also made great use of hair, human and from dogs and other animals. Great hopes were based on a scheme for the breeding of rabbits of the white silken-haired variety, but nothing was done as presumably rabbits made good stew or pie. The scheme which may yet be carried out involved the breeding of several million rabbits. The hair may be spun into very fine and soft threads.

Heat Transfer Tests of Building Materials

The Following Article, Reprinted From the Journal of the Engineering Institute of Canada, December Number, Gives Some Interesting Results of Tests on the Transmission of Heat Through Various Types of Building Materials

By L. M. ARKLEY, M.E.I.C.
Assistant Professor of Mechanical Engineering, University of Toronto.

IN 1912 the following series of tests were started at the request of the Department of the Provincial Secretary of the Ontario Government, for the purpose of assisting in the selection of the proper materials to be used in buildings in course of erection at that time by the Department. The general method of making the tests was decided at a conference including Professor Angus, of the University of Toronto, Capt. R. J. Durly, M.E.I.C., consulting engineer to the Ontario Government; James Govan, architect of the department of the Provincial Government, and the writer.

In 1913 another set of tests was authorized to determine the effect of the transfer of heat through a 12 inch hollow tile wall of laying it up, first with the hollow spaces horizontal, and second with the hollow spaces vertical and directly over each other.

And in 1914 a third set of tests was required to investigate the heat insulating qualities of a number of materials which might be used in the walls of refrigerating rooms.

The apparatus shown in Figures 1 and 3 was installed in the Thermodynamic laboratory of the University of Toronto, in order to carry out these tests.

Object of Tests Made in 1912

To compare the insulating values of walls of approximately equal thickness, but built of different materials, viz.:

8 inch hollow concrete block.
9 inch brick wall.
7 3-4 inch hollow tile.

And further to determine the effect in insulating value of plastering the walls and of stopping air circulation in the hollow walls by filling the spaces with cheap materials, or by using paper on the inside of the walls.

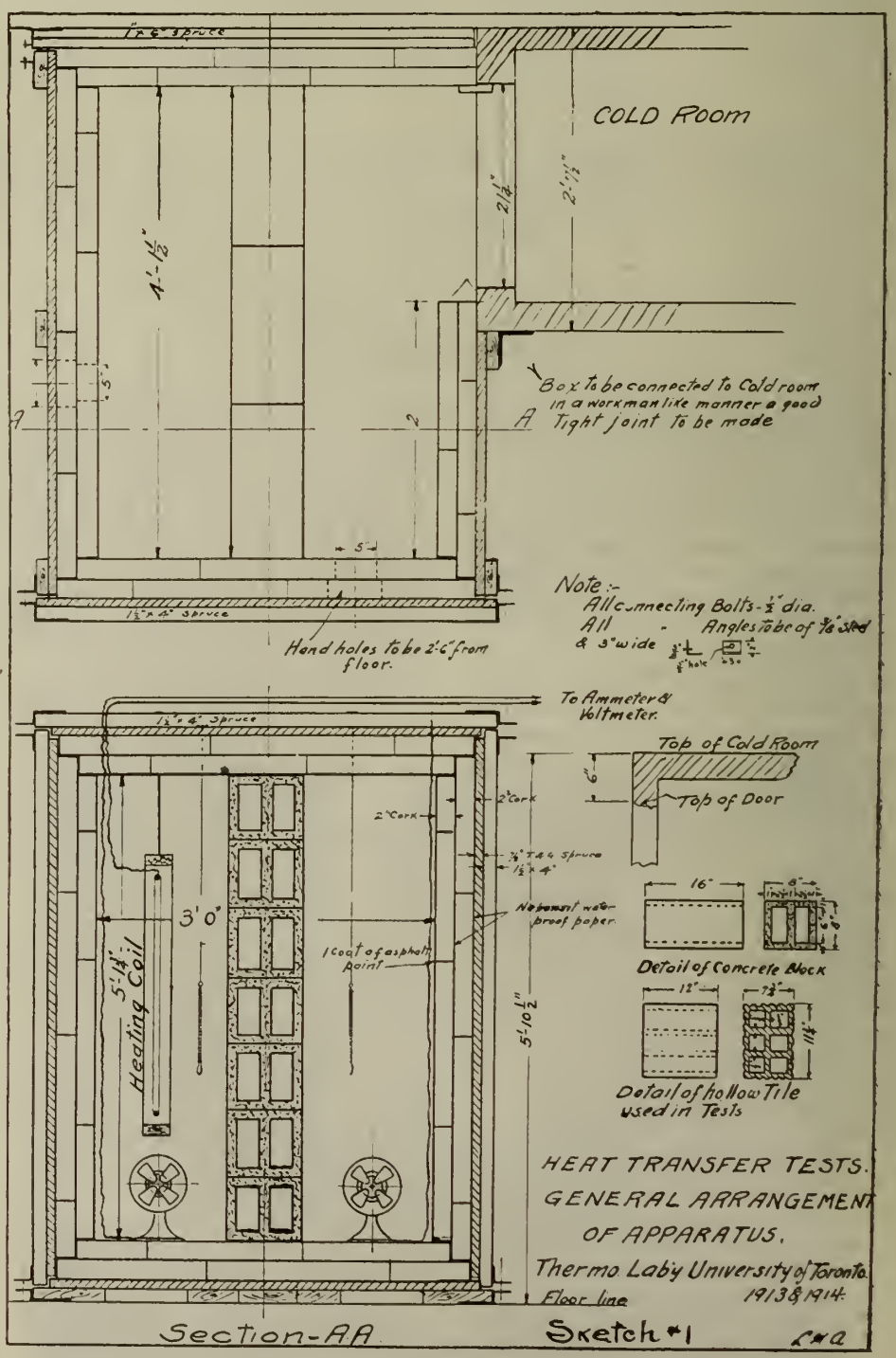
The most common methods that have been employed in making such tests are as follows:

(1) A box is made of the material to be tested; inside the box is placed a vessel containing a weighed quantity of hot water at a known temperature (the water must be agitated in order to get the true average) by taking the temperature after a certain time the b.t.u. loss may be approximately computed.

(2) The same arrangement is used as in method No. 1, but a weighed quantity of ice is used instead of the hot water, and the b. t. u's transmitted computed from the weight of ice melted in a certain time.

(3) An electric heater made of fine resistance wire, wound on an electrically insulated sheet is imbedded in the material to be tested and the b.t.u's computed from the electrical energy supplied to the heater in a given time.

A box is built of the material to be tested, and the heat is supplied to the inside of this box by means of an electric heater. This box is placed in a room which is kept at a low temperature by means of a refrigerating machine. By measuring


COLD Room
Box to be connected to Cold room in a workmanlike manner a good Tight joint to be made
Note:- All connecting Bolts-½" dia.
All - Angles to be of ¾ sted & 3" wide
Hand holes to be 2'-6" from floor.
To Ammeter & Voltmeter.
Top of Cold Room
Top of Door
2" Cork
Heating Coil
3'0"
1 Coat of asphalt Paint
Detail of Concrete Block
Detail of hollow Tile used in Tests
HEAT TRANSFER TESTS.
GENERAL ARRANGEMENT OF APPARATUS.
Thermo Lab'y University of Toronto.
1913 & 1914.
Floor line
Section-AA
Sketch #1

LOG OF RESULTS TESTS MADE IN 1912

Date	No. of test	CONDITIONS	Average Temperature			Total watts	No. of sq. ft. of wall surface	B.T.U's transferred per 1 degree diff. of temper. hr. per sq. ft.
			Room	High side	Low side			
			F	F	F			
1912 Dec. 23	1	Hollow concrete block wall. Not plastered. Air spaces empty	67.9	68.1	20°	174.63	19.65	0.630
Dec. 28	2	Hollow concrete block wall. Not plastered. Air space filled with sawdust	70.7	72	22	126.21	19.65	0.438
1913 Jan. 8	3	Hollow concrete block wall. Plastered both sides. Air space filled with sawdust	72.43	73.5	22.75	99.83	19.65	0.342
Jan. 9	4	Hollow concrete block wall. Plastered both sides. Air spaces empty	74.5	76	23.75	152.76	19.65	0.506
Jan. 13	5	Hollow concrete block wall. Plastered both sides. Air spaces filled with gravel.	71.75	71.15	21.90	109.52	19.65	0.385
Jan. 18	6	Hollow concrete block wall. Plastered both sides. Air spaces empty. One layer of flooring felt on high temperature side of wall	72.1	73.45	22.75	75.70	19.34	0.263
Jan. 21	7	Hollow concrete block wall. Plastered both sides. Air spaces empty. One layer of tarred bldg. paper on high temp. side of wall	74	74.75	22.82	75.92	19.34	0.258
Jan. 22	8	Hollow concrete block wall. Plastered both sides. Air spaces empty. One layer of asphalt paper on high temp. side	74	73	23	74.46	19.34	0.263
Feb. 4	9	Brick wall without plaster, 9"	73	72.45	22.5	118.92	20.56	0.392
Feb. 6	10	Brick wall without plaster, 9"	69	72.25	21.6	121.04	20.56	0.397
Feb. 17	11	Hollow tile without plaster. Air spaces empty	68.8	69.16	20.33	119.43	20.05	0.416
Feb. 19	12	Hollow tile without plaster. Air spaces filled with gravel	71.3	71.82	22.75	102.32	20.05	0.355

the current and temperature inside and outside the box the b.t.u. loss may be computed.

The main objection to the first three methods mentioned is that they do not represent conditions found in practice, and from the nature of methods No. 1 and No. 2 it is almost impossible to get accurate results.

In most cases in practice either in dealing with heating problems or problems in refrigeration the medium of transfer of heat is air, and air usually in motion, so that in choosing a method for making these tests a modification of method No. 4 was decided upon, but instead of using a box it was decided to use a wall whose area could be measured directly. See sketch No. 1.

Arrangement of Wall and Instruments in Making Tests

By referring to sketch No. 1 the arrangement of the testing apparatus will be seen. A box was made of ⅞ inch T. and G. sheeting supported by 2x4 in. scantling, and held together by steel angle braces and bolts. This box was lined with two 2 in. layers of pressed cork held together by wooden pegs, all joints were carefully broken and a sheet of waterproof paper was placed between the layers of cork. The inside of the box was finished with a coat of asphalt paint.

Into this box, which is a very good heat insulator, the wall or material to be tested was built in such a manner as to divide the box into two compartments. When the wall to be tested was in place the cover ends and sides of the box were firmly drawn together by means of bolts. One of these compartments communicated direct with the cold room of a 3-ton refrigerating machine, and in this way a temperature of 20 degrees F. or lower if desired, was easily maintained. On the opposite side of the wall heat was supplied by means of an electric heater made of resistance wire strung on a 3x3 ft. frame, a bank of lamps and a rheostat placed in the circuit supplying the heater allowed any desired quantity of heat to be supplied.

To get the average temperature on each side of the wall four thermometers were suspended from the roof of the box, two on the cold side and two on the hot. When readings were required these thermometers were partially withdrawn through small openings in the covers, but the bulb of the thermometer was never exposed to the room temperature. These thermometers indicated the necessity of circulating the air on each side of the wall in order to get a uniform temperature, and two small electric fans were placed, one on each side of the wall inside the box to give the required circulation. The electric current being supplied to the heater and fan was measured by

means of an accurately calibrated voltmeter and ammeter.

Method of Conducting Test

The refrigerating machine and fans were operated until the temperatures on each side of the wall remained constant. This indicated that all the heat being put into the high temperature side of the box was being transferred through the wall. After this state had been reached a run of about an hour's duration was made, while readings of temperature, amperes and volts were taken every ten minutes.

Method of Making Calculations

As an example we will work out the value found in test No. 1 on log. sheet page 7.

1 watt = .0009477 B.t.u's per sec.
1 watt = 3.41172 B.t.u's per hr.
Watts = Amperes × volts
" = .647 × 227.7 = 147.32 used by heater.
" = .240 × 113.8 = 27.31 used by fan.
Total watts used = 174.63

B.t.u's per sq. ft, per hr. =

$$\frac{174.63 \times 3.41172}{19.65 \times 48.1} = 0.63$$

per degree diff. of temperature.

Possible Errors in the Above Method

(1) Leakage of heat from the high temperature side of box to the surrounding air or vice versa.

From the dimensions of the box it will be seen that the surface exposed to such a loss is about 26 square feet.

A liberal value for the heat loss in B.t.u's per square foot per hour per degree difference of temperature for the box is .0875.

Assuming a difference of temperature between the room and high temperature side in box of 1½° the heat loss per hour would be:

$26 \times .0875 \times 1.5 =$ B.t.u. per hr. $= 3.4$

This value is so small as to be negligible for practical purposes.

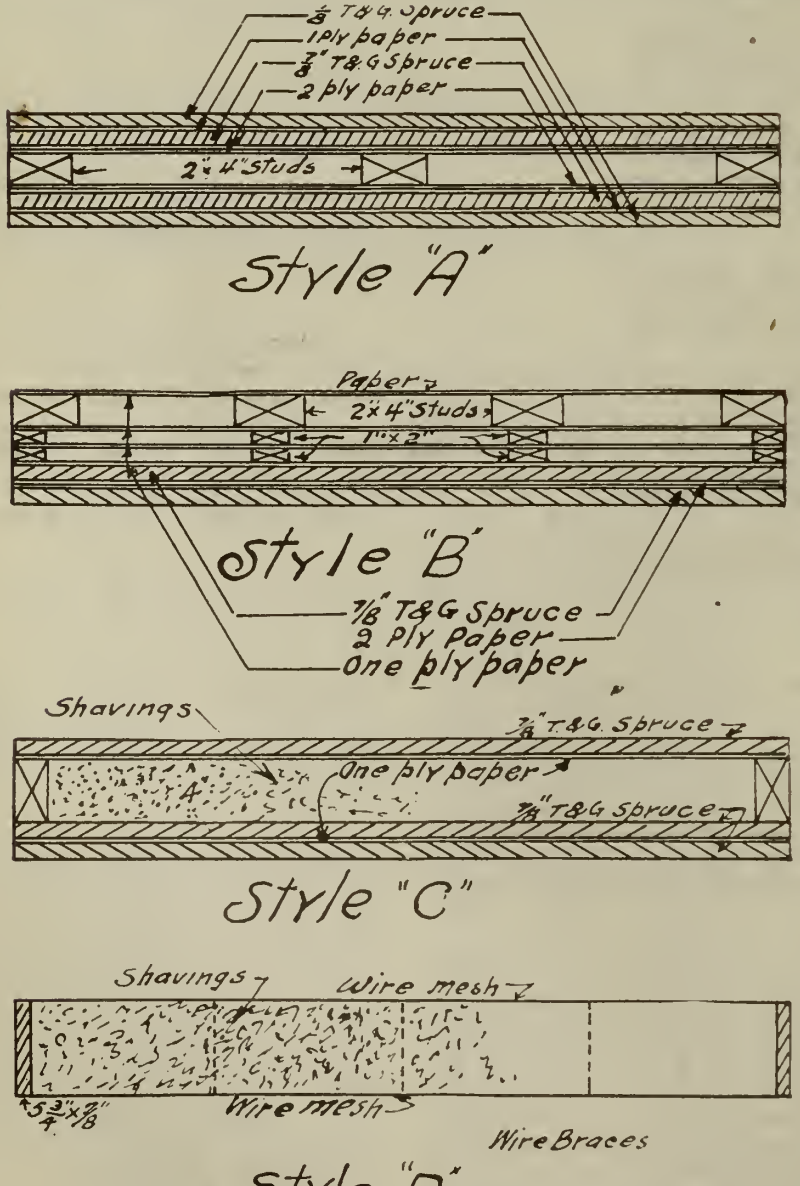
In order that there might be little loss from this source the temperature of the room was kept as near 70° Fahr. as possible. In most cases the difference between the room temperature and that inside the box on the high temperature side of wall was much less than 1½°. The range of temperature decided on for the tests was from 70° Fahr. on hot side to 20° Fahr. on cold side, giving a temperature of 50° Fahr.

(2) Possible error due to length of run.

The accuracy of the method employed in making these tests depends on the length of run being sufficient to allow the heat to permeate the wall and the heat gradient to be established. This is indicated by the temperature on both sides of the wall becoming constant; until this point is reached it would not be correct to assume that all heat being supplied was passing through the wall.

In testing the hollow walls with spaces vertical a good check on this point was obtained by inserting a thermometer through the box cover into the centre of the wall. When the thermometers on the high and low temperature sides of the wall showed a stationary condition the thermometer in the centre indicated very nearly the mean of the other two readings.

As stated in the beginning of this report, three series of tests were made, in 1912-13 and 1914 and the report is therefore divided into 3 parts: descriptions of the walls tested, specifications for plastering and log sheets of tests follow each part.



TYPES OF WALLS TESTED

Tests Made in 1912

Description of materials used in walls tested:

Concrete Blocks.—For dimensions see sketch No. 1.

Composition: One bag cement to four cubic feet of sand and one cubic foot of ¾ in. crushed stone, with ¼ in. and all below screened out.

Age: About two months. Weighs 38½ lbs. Weight of water absorbed per block after being submerged twenty-four hours, 3¾ lbs.

Tile.—For dimensions see Sketch No. 1.

Dry weight of tile 30¾ lbs. Weight of water absorbed per block after being submerged twenty-four hours, 3½ lbs.

Brick.—Hard burned common brick, dimensions 2½ in. x 4¼ in. x 8½ in.

Weight dry = 4.67 lbs. Weight of water absorbed per brick after being submerged twenty-four hours, 1.125 lbs.

Flooring felt used in test No. 6, actual weight per 100 square feet—11.5 lbs.

Tarred felt used in test No. 7, known as 16 oz. felt, actual weight per 100 square feet—25 lbs.

Asphalt felt used in test No. 8, known as Neponsit, Asphalt felt.

Specification of the construction and finish of walls to be built at Thermodynamics Building, University of Toronto, for thermal-conductivity tests by James Govan, architect.

Test No. 1—Tile Wall

Tiles to be used.—Wall to be built of 8 in x 8 in. x 16 in. concrete hollow wall tiles.

Mortar.—Mortar for building tile to

LOG SHEET OF RESULTS TESTS MADE IN 1913

Date	No. of test	CONDITIONS	Average Temperature			Total watts	Sq. ft. of wall surface	B.T.U's transfer per degree diff. of temper. hr. per sq. ft.
			Room	High side	Low side			
1913 Dec. 16	1	12″ tile wall laid with hollow spaces horizontal	70.7	71.75	20.9	91.78	20.91	295
Dec. 17	2	12″ tile wall as above but with 1 layer of paper on high temp. side of wall	70.6	69.55	19.	6.5	20.91	210
Dec. 18	3	12″ tile wall as above with paper removed and 1 coat of dehydratine painted on high temp. side of wall	70.	70.13	19.9	63.75	20.91	206
Dec. 25	4	12″ wall as above but plastered both sides, plaster ⅝″ thick	65	67	18.25	53.75	20.91	179
Feb. 27	5	New 12″ tile wall built with hollow spaces vertical and directly over each other	72	70	20.4	99.7	21.28	322
Mar. 2	6	12″ wall as above with one coat of dehydratine on high temp. side	69.5	69.25	20.45	76.4	21.28	250
Mar. 9	7	12″ wall as above but plastered both sides, plaster ⅝″ thick	73.3	70	20.8	69.97	21.28	228

be composed one part lime to three parts of good clean sharp sand.

Joints.—Joints to be ⅜ in. wide. Tiles to be wetted before laying to prevent absorption of water from mortar.

Furring strips.—Provide and build into side of wall away from refrigerator at every second joint, wood furring strips ⅜ in. x 1¼ in. for wood strapping.

Strapping.—Strap this side of wall with wood straps at 12 in. centres.

Metal lath.—Metal lath for plastering to be expanded metal No. 24 gauge.

Plastering. — Plastering on this side of wall to be three coat work composed as follows:

1st coat.—One part alca and lime mixture as supplied.
Three parts sand.
Fibering material or hair as required.
This coat to be thoroughly scratched.

2nd coat.—One part alca and lime mixture.
Four parts sand.
Fibering material as required.

Finishing coat.—One part alca and lime mixture.
One part fine white sand, trowelled to a smooth polished surface.

Stucco on side of wall next refrigerator.—Base coat shall be applied direct to the tile wall and shall consist of one part alca and plaster mixture to four parts sand. Surface of tile wall must be thoroughly wetted before this base coat is applied and the mortar scratched in preparation for the second coat.

Second coat to be composed of one part alca and plaster mixture, to four and one-half parts sand, trowelled smooth.

The second coat must be applied before the first coat is allowed to dry out.

Test No. 2—Brick Wall

Bricks.—Bricks to be good, common stock bricks, approved of by the architect.

Mortar.—Mortar for building bricks to be composed of 1 part lime to 3 parts clean, sharp sand.

Joints to be ⅜ in. thick and struck on both sides of wall. Bricks to be thoroughly wetted before laying.

No plastering inside or outside of wall.

Note: There will be no plastering on either inside or outside of brick wall for this test.

Conclusions

The most important conclusion to be drawn from the above results is that the commonly held assumption that a hollow block wall is more efficient from a heat loss standpoint than a solid brick wall of approximately equal commercial standard thickness is not founded on fact. This will be clearly seen by comparing tests Nos. 1, 9, 10 and 11. On the other hand tests Nos. 2, 3, 5 and 12 show that if the spaces in the hollow block wall are filled with some material which separates the air into small pockets and prevents circulation that the rate of transfer of heat is considerably diminished.

An interesting result is shown by comparing test No. 4 with No. 7. The conditions in these tests are exactly the same with the exception that one layer of tarred building paper was placed on the high temperature side of the wall in test No. 7, the effect of this layer of paper was to reduce the heat transfer by nearly 50 per cent.

Tests Nos. 9 and 10 serve as a check on the work, as many tests have been made on 9 in. brick walls and the commonly accepted value as the coefficient of conductivity is 0.4 B.t.u.

It may be mentioned that in having the brick wall built, the architect took special pains to see that the laying of the bricks was no better than the ordinary standard of bricklayers' practice. No attempt was made to have all points in the interior of the wall filled and the face jointing was struck with the trowel as the wall was laid up. If the bricklayer had been allowed to fill carefully every joint with mortar and to have the wall so well flushed as to reduce air circulation through the wall to a minimum, better results would no doubt have been obtained. On the other hand in building 7¾ in. hollow tile wall the practice adopted was decidedly better than would obtain in ordinary contract work.

Where hollow tiles are laid with webs vertical it is practically impossible to get the bricklayers to spread mortar on all webs of the tile. As a rule the two outside and the two end webs receive mortar, while the interior webs are left uncovered. In the wall tested every web was carefully covered and every precaution taken to keep the air spaces free.

When the wall was built the outside and inside face joints were carefully pointed up so as to reduce air circulation through the joints to a minimum. Under these conditions the results obtained are probably more favorable to the hollow tile wall than they would be in ordinary construction practice.

Note: Sawdust was not used as filling with the idea that it would be a suitable material for building construction but simply to show the effect of breaking

up the circulation of the air in a hollow block wall.

Tests Made in 1913

Object of Tests.—(a) To determine the rate of transfer of heat through a 12 in. hollow tile wall, first when the tile was laid with the hollow spaces horizontal; second when the tile was laid with the hollow spaces vertical and directly over each other.

(b) To determine the effect on the rate of transfer of heat of placing a layer of ordinary building paper on the high temperature side of wall.

(c) To determine the effect on the rate of transfer of heat of painting the high temperature side of the wall with one coat of "dehydratine."

Materials Used in Walls

Tile.—The hollow tile used was a shale tile made at the Ontario Government's clay plant at Mimico, Ont. For dimensions, see Sketch No. 1.

"Dehydratine." — Described by the manufacturers as a "Foundation compound for waterproofing substructures."

It has about the consistency of the ordinary ready-mixed paint, is black in color and is made up principally of asphalt

These tests were made in the same manner as those previously described in this report and the specifications for plastering are the same for both series of tests.

Conclusions

Comparing tests No. 1 and No. 2 the marked improvement in the insulating

LOG SHEET OF RESULTS TESTS MADE IN 1914

Date	No. of test	DESCRIPTION OF MATERIAL TESTED	Average Temperature			Total watts	No. of sq. ft. of wall surface	Transferred per sq. ft. per degree diff. of temp. per hr.
			Room	High side	Low side			
1914								
Nov. 6	1	1 ply oiled paper	70	71	31.5	320.25	20	1.38
Nov. 9	2	1 ply climasat water proof building paper.	68	68	26	297.6	20	1.21
Nov. 12	3	Wall shown on sketch No. 2 marked D	72	69	20	79.3	20	0.276
Nov. 13	4	Wall shown on sketch No. 2 marked A	70	70.25	20.8	41.49	21.335	0.134
Nov. 17	5	Wall shown on sketch No. 2 marked B	69.75	68.7	20.2	63.84	21.335	0.205
Nov. 19	6	Wall shown on sketch No. 2 marked Style C, filled with saw-dust	69	70	18.75	47.0	21.335	0.147
Nov. 20	7	1 layer of hair felt held together between two sheets of thin paper	72	69.5	26.9	144.17	20	0.578
Nov. 23	8	Style C, hollow space filled with granulated cork	68.0	70.0	18.1	46.94	21.335	0.144
	9	3" cork wall made up of 2 layers 1½" thick with 1 layer of paper between the 1½" layers of cork	72.5	70.3	19	41.47	21.11	0.130
	10	The preceding test repeated	72.0	69.8	18.33	42.0	21 11	0.131

For details of walls marked A, B, C, D, see sketch No. 2.

MISCELLANEOUS MATERIALS TESTED SINCE 1914

Date	No. of test	DESCRIPTION OF MATERIAL TESTED	Average Temperature			Total watts	No. of sq. ft. of wall surface	Transferred per sq. ft. per degree diff. of temp. per hr.
			Room	High side	Low side			
1917								
Nov. 22	1	Corrugated galvanized iron wall supported on 2 × 4 frame	67	69.6	19.7	368	21	1.2
Dec. 4	2	Wall made up of corrugated galvanized iron on one side of 2 × 4 frame and ⅞ T. & G. spruce sheathing on other side	69	68.4	18.1	168.8	21	0.55
1918								
Jan. 24	3	Beaver Board 3/16" thick	65	68.9	22.5	230	20.3	0.83
Feb. 18	4	Linabestos ball board 3/16" thick dark red in color made up of asbestos and concrete	67	71	20.6	389.5	20.3	1.305
Feb. 22	5	Asbestos lumber 3/16" thick	67	69.7	21	345.5	21.2	1.14
Feb. 28	6	Asbestos corrugated sheathing 2/16" thick	68	70.3	22.3	340.3	21.2	1.13
Mar. 11	7	Asbestos shingles laid on 1 layer paper and ⅞ T. & G. sheathing, laid 7" to the weather, size of shingles 16 × 16 × 3/16"	67	71.1	18.9	137.75	21·2	0.442

The composition of the asbestos products is approximately 15% asbestos and 85% portland cement.

qualities of a layer of paper is again demonstrated.

From test No. 3 it would appear that one coat of "dehydratine" accomplishes practically the same result as a layer of paper. This is what might be expected, as both the paper and "dehydratine" serve to close the pores in the wall.

Comparing test No. 1 with No. 6, we see that the wall is a better heat insulator when the hollow spaces in the tile run horizontally than when they are vertical. In the second case the circulation of air would be much more pronounced due to the chimney effect of the vertical hollow spaces.

Comparing tests Nos. 1 and 3 with Nos. 6 and 7, approximately the same saving is shown due to one coat of "dehydratine."

Comparison of the results obtained with walls plastered and without plaster show that plaster is not a good heat insulator.

Tests Made in 1914

Objects of Tests.—To determine the rate of transfer of heat through walls suitable for refrigerating rooms, including built-up walls (for details see Sketch No. 2), cork walls, and ordinary building papers.

Materials used.—Paper used in test No. 1—oiled paper—thickness 10/1000 of an inch, weight per square foot—5¼ pounds.

Paper used in test No. 2—trade name "Climax"—sat-building paper, advertised as acid, salt, alkali and waterproof, thickness 18/1000 of an inch, weight per 100 sq. feet = 10.4 pounds.

Test No. 3 was made to test a wall of planer shavings 6 in. thick. A frame 6 in. deep shown on sketch No. 3 as style D was made of ⅞ in. boards. A fire screen, 12 mesh to the inch, was fastened to each side of the frame and shavings packed between the screens, giving a wall of shavings 6 in. thick.

For details of walls used in tests No. 4, No. 5 and No. 6, see sketch No. 2.

Cork walls used in tests No. 8, No. 9 and No. 10 were made of slabs of pressed cork, 1½ in. thick x 12 in. wide x 3 ft. long.

We wish to acknowledge assistance given by Professor Angus, of the Mechanical Engineering Department, University of Toronto; James Govan, architect, Department of the Provincial Secretary of the Ontario Government, and the Asbestos Manufacturing Co., of Montreal, which furnished the asbestos products tested.

THE PROPER SIZE OF FUSES FOR INDUSTRIAL MOTORS

THE proper size of fuse for a motor is only too often obtained by the chief electrician or one of his repairmen by haphazard methods. The motor's normal operating current is given by the maker on the name-plate, but fuses are properly selected of a larger capacity to allow for starting and for momentary overloads. Hence it is rather more unual for the maintenance man to select his fuses "be guess and be gosh," with a view to their permanence in service rather than the safety of the motor they are supposed to protect.

In order to give a practical working idea of what sizes to use, the Westinghouse Electric & Mfg. Company has prepared the accompanying tables. These are based on the following assumptions as to size of fuse required to stand starting current without blowing:

Type	Time fuse load Current at starting
Polyphase wound rotor	1–¼
Squirrel cage (thrown on line)	3
Single-phase repulsion induction with rheostat	2
Single-phase repulsion induction without rheostat	4
Direct current	1–¼

Since the fuses for squirrel-cage and repulsion motors without rheostats are, respectively, rated at 3 and 4 times full-load current, they give practically no overload protection. Hence it is recommended that double-throw switches be installed connecting the motor through fuses of 1.25 times full-load rating (as under wound rotor sizes) for running and through the regular heavier fuses or direct to the line for starting.

DIRECT CURRENT MOTORS

H.P.	115	230	550
1	10	5	3
1–½	15	8	3
2	20	10	5
2–½	25	12	6
3	30	15	6
3–½	35	15	6
5	50	25	10
6–½	65	35	15
7–½	70	35	15
8–½	85	45	20
10	90	45	20
11	100	55	25
12–½	110	60	25
15	125	70	30
20	175	90	35
25	225	110	45
30	275	125	55
35	325	150	65
40	350	175	75
50	450	225	95
60	550	...	110
75	...	...	150
100	...	...	200

3-PHASE SQUIRREL CAGE MOTORS

H.P.	Fuse Rating (Amp.) When Voltage is 110	220	440	550
½	12	6	3	2
1	20	10	5	4
2	35	20	10	8
3	50	30	15	12
5	90	45	25	20

2-PHASE SQUIRREL CAGE MOTORS

H.P.	Fuse Rating (Amp.) When Voltage is 110	220	440	
½	10	6	3	..
1	20	10	5	..
2	35	15	10	..
3	45	25	15	..
5	80	40	20	..

TYPE "AR" SINGLE PHASE MOTORS

H.P.	Without Rheostat 100	220	With Rheostat 110	220
2	80	40	40	20
3	120	60	60	30
5	200	100	100	55
7–½	325	175	175	80
10	400	200	200	100
½	20	10	10	6
¾	30	15	15	8
1	40	20	20	10

3-PHASE WOUND ROTOR INDUCTION MOTORS

H.P.	Fuse Rating (Amp.) 220	440	When Voltage is 550
5	20	10	8
7 ½	30	15	12
10	40	20	15
15	50	25	20
20	70	35	30
25	85	40	35
30	100	50	40
35	125	60	50
40	150	70	60
50	175	80	65

2-PHASE WOUND ROTOR INDUCTION MOTORS

H.P.	Fuse Rating (Amp.) 220	440	When Voltage is
5	20	8	..
7–½	25	15	..
10	35	20	..
15	45	25	..
20	60	30	..
25	70	35	..
30	90	45	..
35	110	55	..
40	120	60	..
50	150	70	..

VOORHEES RUB-STEEL VALVE

Owing to the isolated nature of steamship operation during long journeys it is of the utmost importance that the engineering equipment be of first-class quality, assuring continuous operation under the most severe service. Valve maintenance is an essential detail of engineering efficiency. Leaky pump valves are frequently a source of great annoyance to the operator, and expense to the owner.

The Voorhees Rub-Steel Valve is made in four different grades. Standard, for service under moderate temperatures up

RUB-STEEL VALVE

to about 160 degrees. Superhot, for use on equipment adapted for hot oil, etc., where temperature exceeds 160 degrees. Special soft, for low pressure water service, slightly gritty fluids, etc. Red condenser, for service under specially severe conditions. These valve discs are made in a large variety of sizes and for any particular purpose. As the name implies the valve is made of a combination of rubber and steel; the rubber composition attached to the central steel disc by a special electrochemical process known as the Elchemco process. The steel plate adds great strength to the valve and prevents distortion under high pressure, while the rubber assures perfect contact with the seat. This construction increases the average life of the valve, eliminating the possibility of destruction by forcing through the grating or breaking up into pieces. Reliable service is an economic necessity in steamship operation.

MEDIUM SPEED HORIZONTAL AMMONIA COMPRESSORS

THE high cost of labor, machinery, fuel and in fact all other things that pertain to the building and operating of an ice or refrigerating plant, have led the manufacturers of such apparatus to secure the highest economy possible.

This article will be confined entirely to the medium speed horizontal machine as shown in Fig. 1, which is built in three types, one for belt drive, another for direct connecting to a synchronous motor which is mounted on the shaft beside the fly wheel and the other direct connected to a uni-flow poppet valve steam engine. This machine in any case is of the same construction with the exception of the crank shaft which is made to suit any particular installation. As the majority of people are familiar with motor installations, this article will treat only of the engine driven outfit.

The manufacturers of the machines illustrated, The Frick Company, Inc., Waynesboro, Pa., U.S.A., build both vertical and horizontal, slow and medium speed compression machines, ammonia absorption outfits and carbon-dioxide machinery. The ammonia compression and carbon-dioxide types are made in both the land type and the marine type, especially designed to meet the inspection of the various bureaus and registers of shipping.

The compressor frame is of the heavy duty, Tangye type and is of a one-piece casting. The cylinder end of the frame is bored and faced true with the cross head guides to receive the ammonia cylinder shell which is made of a special close grained iron. Between the outside of the ammonia cylinder and the inner shell of the main frame is an opening which is used for the water jacket, the water being delivered into the bottom and discharged at the top. The ammonia cylinder heads are made of a special Maypul steel and secured to the face of the cylinder by long steel bolts passing through the water space with a nut on the outside of each cylinder head.

The suction and discharge valves are arranged in the cylinder heads. Two horizontal suction valves are located at each end at the top and four discharge valves are placed radial in the lower half of these cylinder heads. The cages forming the valve seats and the valves are of a special forged steel having ample area to insure the ammonia cylinder of filling with gas at each stroke and also providing ample area for discharging the gas into the compression side of the system. Both the suction and discharge valves are designed so as to prevent them from getting into the ammonia cylinder by failure of a stem, and in case of an examination it is only necessary to remove the cover plate over the valve chamber. The valve and cage can then be drawn out.

The ammonia piston has spherical ends which are turned to a radius conforming to that of the heads. The design permits the clearance to be reduced to a minimum. The piston is provided with four spring packing rings placed in suitable grooves and fitted carefully to prevent leakage. The piston rod is of forged steel pressed into the piston head and followed and secured by a doweled lock which is finished off even with the piston head.

The ammonia stuffing box is made very long compared with the diameter of the piston rod and in the bottom of the packing box is a babbitted ring closely fitted to the piston rod. There are two sets of packing used, separated by an oil lantern which is at all times filled with oil surrounding the piston rod. With the construction used, it is not necessary to draw the packing down hard to prevent leaks. This, of course, means that unnecessary friction and wear on the piston and packing is eliminated.

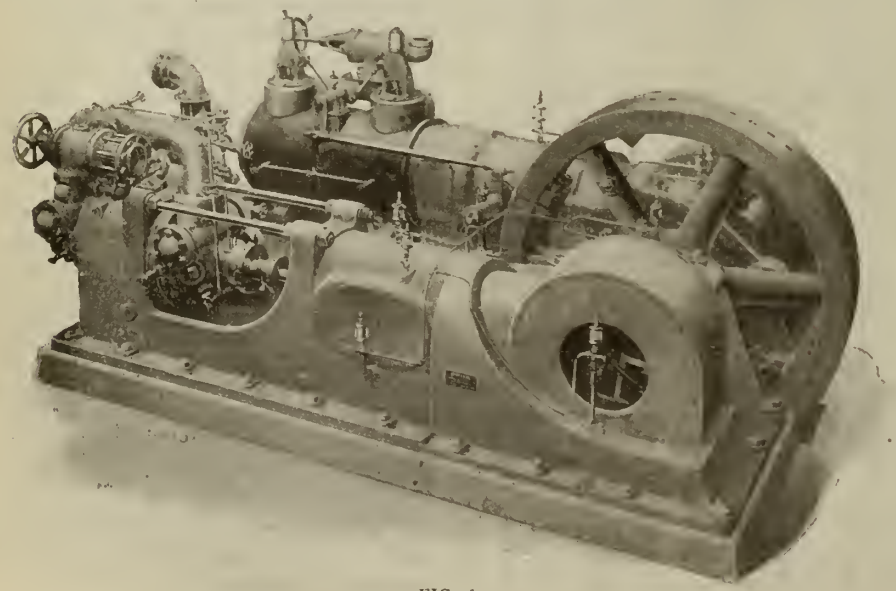


FIG. 1

The conduits or manifolds connecting the suction and discharge nozzles of the cylinder heads have long radius bends giving an easy flow of gas and are provided with purge and pump-out connections. A very fine mesh wire screen inserted in the suction trap near the nozzles of the suction manifold prevents all the foreign matter from entering the ammonia compressor valves and cylinder.

The cross head is of box form, designed for strength. The shoes have a large bearing surface of the best grade babbitt metal and are adjustable by means of wedges and screws.

The cross head pin is of special forged steel accurately ground to size and has taper fits in the cross head.

The connecting rod is of a rectangular section, forged from a solid steel billet. The stub ends are mortised at both crank and cross head ends to receive the bronze boxes which are lined with genuine babbitt metal. Adjustment at both ends is by means of steel wedges and large wedge bolts or lock screws. The wedges are so arranged that the length of the rod centres do not change when adjustment is made. The cross head and crank pin boxes are very large in proportion to the work they have to perform, thus reducing heating and wear to a minimum. The crank pin box is so designed that it may be removed without taking the connecting rod off the crank pin.

Crank shaft bearing is cast to the main frame and accurately machined and lined at right angles with the centre line of the cross head end and cylinder. The main bearing shells are extremely heavy and the side or cheek shells are adjustable for wear by wedges and special screws which lock them in position. The main bearing cap can be removed without disturbing the adjustment of the cheek shells. The bottom shell may be removed by raising the crank shaft a small distance. The bearings are generously proportioned and lined with genuine babbitt metal.

The steam engine is of the poppet valve, uni-flow type. The bed consists of a one-piece casting, comprising the main journal and the cross head guide. The general design of the engine bed conforms to that of the ammonia compressor and is of heavy duty Tangye type. The special feature is that all of the main bearing parts are identified with that of the compressor and are interchangeable. The cross head and the connecting rods are also the same as those of the ammonia compressor. In fact wherever possible without sacrificing design it is the aim to make the parts interchangeable.

The steam cylinder is of the uni-flow design with balanced double-seated poppet valves which are made of a hard, close grained metal, especially adapted for minimum wear after long service.

The valve chambers are located on the top of the steam cylinder near the ends and connected by special manifolds. The steam valve cages are fitted into these chambers, resting on ground joints. The valve cages contain the valve seats and

the valves which are carefully ground with the corresponding seats in the valve cages. The valves are actuated by cams lifting them vertically off the seats. The cam mechanism is properly designed and carefully machined to avoid all possible jar or shock to the valve and the seat when operating at medium speed. Special care in the design has been exercised so as to avoid sharp corners, restricted areas in the ports and warping of the valves and cages.

After cut off and expansion has taken place, the steam is exhausted through suitable ports arranged diametrically around the centre of the steam cylinder. These ports are uncovered by the steam piston at the end of the stroke, and the steam is exhausted into the exhaust chamber, thence it passes through the exhaust pipe to the condenser or atmosphere.

The steam cylinder is provided with an expansion chamber and valve at each end. If for some reason the vacuum in the condenser should fail, these valves are open and relieve the cylinder from an over amount of compression pressure. This valve also operates when running non-condenser.

The steam piston is of the single-piece, hollow design, made as light as possible consistent with strength. Six grooves are turned in the circumference, three near each end into which self-adjusting spring rings are fitted.

The governor is of the inertia type attached to the fly wheel and consisting of a pendulum which is pivoted to the arm of the wheel and carries the eccentric, a balancing weight, links and leaf spring. The balancing weights are made in a series of disks, so that they may be removed or the number increased as conditions may require. The spring has a wide range of adjustment and consequently can be adjusted for a wide range of speed.

All bearings, pins and cross head guides of both compressor and engine are lubricated by a gravity oiling system. Special provisions are made for collecting the oil and returning it through a filter to the gravity tank to be used over.

All parts such as valves, valve cages and steam piston receive heat treatment after they are rough turned, and then finished. The operating cams, rollers and valve gear pins and bushings are of steel, carefully case hardened and accurately ground to size.

When this unit is installed for marine service a heavy cast iron sub-base is furnished to which the compressor and engine is securely bolted with fitted bolts in reamed holes. This same sub-base can be furnished for land service if desired.

Figures 2 and 3 show illustrations of the vertical enclosed and vertical open type machines respectively.

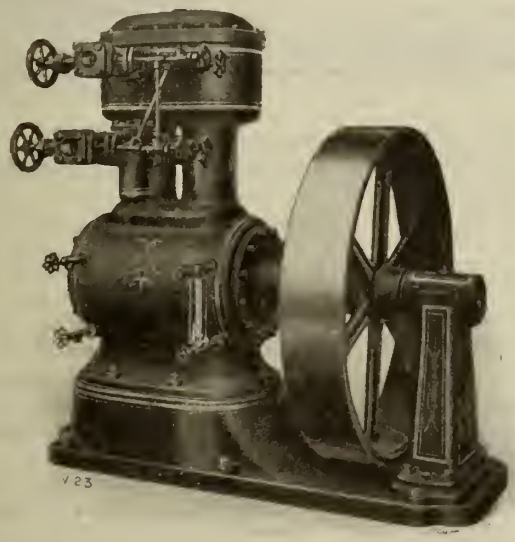


FIG. 2.

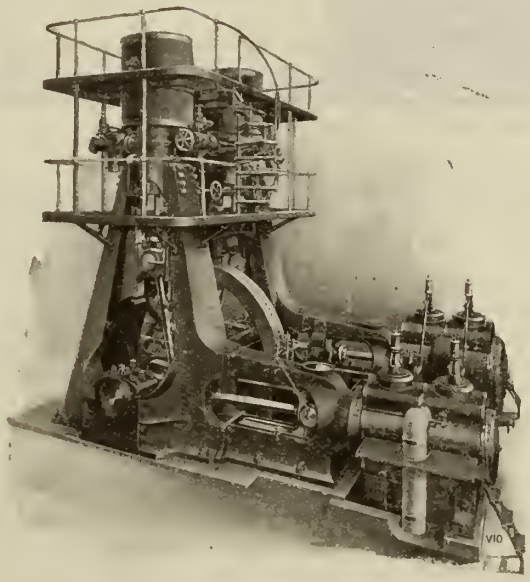
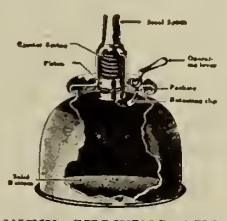


FIG. 3.

FORCE FEED OIL CAN

The accompanying illustrations show a new oil can developed by Gustave Lidseen, Desplaines street, Chicago. The mechanism controlling the feeding of oil is all in the spout and its arrangement is such that it will entirely empty the can. The oil can spout is self cleaning, and is easy to operate. The drawn steel body and heavy welded spout make the can leakproof. The spout is held on the can body by means of curved flanges with a packing ring held in the spout flange.

The can has a large opening and is therefore easy to fill and having a positive force feed is self cleansing and requires no spring bottom.



INTERIOR VIEW SHOWING SIMPLICITY IN CONSTRUCTION

SHOWING WIDE OPENING FOR FILLING ALSO CURVED FLANGES AND LOCKING MEMBERS WHICH MAKES IT LEAK AND WEAR PROOF AT THIS CONNECTION.

R. M. Wilson, M.E.I.C., chief engineer of the Montreal Light, Heat and Power Co., at a recent meeting of the local branch of the Engineering Institute of Canada, read a paper that dealt with the ice problems in connection with the operation of Hydro-Electric power plants. He described in detail the methods for dealing with ice troubles at the Cedars plant. With experience and improved design of hydraulic equipment, Mr. Wilson believes that machinery can now be designed that will be immune from ice troubles, excepting, perhaps, only those depending on canals running across country, where means cannot be taken to mitigate or eliminate the difficulties.

Winnipeg.—The last gap in the Shoal Lake to Winnipeg pipe line has been closed. Within the next few days Shoal Lake water will be pouring through the big pipe and into Winnipeg for purposes of cleaning and testing, and within two or three weeks the soft water will be flowing from all taps. The great undertaking, under way since 1914, has cost in the neighborhood of $16,000,000. The pipe is 97½ miles long, and makes seven river crossings.

EDITOR'S NOTE

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, advise us that the Yarway (formerly the Simplex) blow-off valve is of similar design to the blow-off valve suggested by K. Walsh on page 108 of POWER HOUSE for April 5, and embodies his valuable suggestion.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Questions Before The House

If a tube in your boiler developed a slight leak, as through a pitting that had gone through the tube, or a small sand hole, how would you stop the leak without dropping the pressure?

You have a compound engine, 11x19x 12 in. stroke, running at 260 revolutions per minute. Cut off in the high pressure cylinder is a ⅝ of the stroke. Cut off in low at 3-4 of the stroke. What is the horse power aproximately?

In the case of the above engine, what is the probable steam consumption per hour, and what size would you have to make a pump to supply the water consumed to the boiler?

10. Why is a horizontal engine, running over, provided with guides top and bottom? Which guide does the pressure act on, and why?

11. A cylinder 24 in. bore, carrying an initial pressure of 100 pounds per square inch. Allowing 5,000 pounds per sq. inch on the studs, how many would be required, and what pitch should they be set at?

12. The stays in a horizontal tubular boiler have an allowance of 6,000 pounds per sq. inch. If the segment is 24 in. high and the boiler 72 inches diameter, what is the number and diameter of stays required?

Questions Asked In Last Issue

1. A horizontal return tubular boiler, 72 in. dia. by 18 feet long, made in three courses, has sustained damage by the plate over the fire becoming overheated. The plate has come down in a blister of elliptical form, the axes being 14 in. in a longitudinal direction and 36 in. in a circumferential.

How would you put a single riveted patch on this boiler so as to preserve the full strength of the longitudinal seam? Would you put the patch inside or outside the plate?

2. In the case of a pump having a lift of over twenty-six feet, would the fitting of a foot valve be of any help in starting the pump. Generally speaking, where does the advantage of a foot valve in a suction line lie?

3. Can you state, clearly and definitely, why a longitudinal seam of a boiler requires stronger riveting than the circumferential? Show by figures the relation between the two.

4. The area of a safety valve on a boiler is proportionate to the grate area. What is this proportion, and in what way does the grate area affect the safety valve area?

5. What is the proportionate weight of air to weight of coal used to obtain combustion? Give any formula you know.

6. Can you give a clear description of what takes place when a boiler explodes through failure of a plate. What is the sequence of events?

Answers to Questions In Last Issue

1.—It looks as if it would be impossible to put a patch on this blister which would be of any great value and still retain the full strength of the seam. In order to put on a patch over the seam that would be effective, a portion of either the inside or outside lap would need to be removed, and, after the bulge or blister had been put back, the patch would be made to fit down snugly over the whole damaged part and riveted as required, the seam to fit down snugly to the patch. This, of course, would affect the strength of the seam. To put a patch over the seam straps would be more ineffective than the former course.

2.—A good close seating foot valve would, no doubt, be of great value in starting a pump with a high suction lift of 25 ft. With the foot valve on, it holds the water up to the pump all the time, and when the pump is started it just begins where it left off, without having to displace all the air in the 26-ft. of pipe to form a vacuum. (26 ft. is some lift to depend upon to supply a boiler. Why not use a deep well pump and be safer?)

3.—The force tending to rupture a boiler along the line of the longitudinal seam is proportional to the diameter divided by two, while the stress tending to pull it apart endways is only half that or proportional to the diameter divided by four. Although the pressure is exerted on both heads, only the area of one can be considered as the stresses are exerted against each other and the stress of each head, not of both, is exerted against the girth seams.

4.—Boilermakers allow ½ sq. in. area of safety valve opening to one sq. ft. of grate surface. It has been proven to the satisfaction of engineers that this proportionate area is required to relieve the boiler of the steam that one sq. ft. of grate surface can generate.

5.—Approximately 12 lbs. of air are required to burn one pound of coal, but this will vary according to the quality of coal.

6.—I have never had any personal experience with a boiler explosion, nor am I anxious to, but my idea is, that when the plate goes in a boiler, carrying the pressure boilers are subjected to, the velocity of the steam leaving the boiler so suddenly causes such a recoil (much on the principle of the reaction turbine, only a great many times more powerful) that the boiler is usually thrown from its arches, sometimes a considerable distance.—C. T. M., Chatham.

* * *

1.—It is sometimes possible to heat a blister and drive it back into place again. This, of course, is only possible when the blister is only down slightly, say, a couple of inches or so.

2.—The foot valve in the suction line of a pump is of use not only to retain the water in the line, but also prevents any material getting into the valves of the pump.

4.—The weight of air required to burn one pound of coal varies with the coal, but about 14 lbs. of air is required to give sufficient oxygen for combustion. —JOHN QUINLAN, Toronto.

* * *

6.—According to Rankin's experiments, a cubic foot of water, under pressure of steam at 50 lbs. by the gauge and at the same temperature, contains as much explosive energy as 1 lb. of gunpowder.

When a boiler bursts, especially if the rent be under the water level, the violent disturbance of the water is like putting a lighted match to the gunpowder.

This is why, when a boiler bursts, the water, instead of rushing out at the hole, explodes with such terrific force as to shatter the boiler in pieces and spreads death and devastation around.

1 lb. of gunpowder gives out an explosive force of 245.5 foot tons.—G. ALDRIDGE.

Association and Personal

Programme of C.A.S.E. Convention at Brantford

Canadian Association of Stationary Engineers' Convention and Exhibition of Power Plant Equipment and Supplies, Convention Hall, Brant Ave., Brantford, June 24, 25 and 26, 1919

THE following programme is that issued by the C.A.S.E. for their annual convention which will be held in Brantford, June 24, 25 and 26. It will be seen that the three days' convention offers features of great interest and value to every engineer who is able to be present.

Monday, June 23—(all day)—

Installing exhibits.

Tuesday, June 24

Tuesday morning:

10.00—Official opening.

Welcome to Brantford by Mayor Morrison McBride.

W. Welsh, president Brantford Lodge.

Response—W. W. Cook, Belleville.

President C.A.S.E.

C. N. Schrag, Toronto, president Exhibitors' Association.

Lieut. L. Archibald, Toronto.

Jack Armour, New York.

11.30—Meeting C.A.S.E. Executive for appointment of committees.

Tuesday afternoon:

2.00—Meeting C.A.S.E. Executive.

2.30—Ladies' trip through Brantford factories as guests of Brantford Lodge.

Tuesday evening:

8.00—Educational Session and Smoker (men only). All engineers are invited.

Lecture on Causes of Boiler Failures, by D. M. Medcalf.

Address—Fred. W. Raven, Secretary N.A.S.E., Chicago.

Lecture with lantern slides, by J. M. Brown, Hamilton, on Turbines; and C. J. Porter, Hamilton, on Generators.

Lectures on Power Plant Accessories, by S. Balmfirth.

Address—Jack Armour, New York.

Chalk Talk on Piston Valve Setting, by Secretary Drummond, of Alberta Lodge. (Pipes and tobacco will be furnished by the Brantford Lodge).

8.00—Theatre party for the ladies (Guests of the Brantford Lodge).

Wednesday, June 25

Wednesday Morning:

9.00—C.A.S.E. Executive session in Convention Hall.

Exhibition Hall open morning and evening (not afternoon).

2.30—The engineers and their friends will be the guests of the Exhibitors' Association at Mohawk Park. Special cars will be provided to take the party to the park. Ice cream and peanuts will be supplied. There will be an excellent programme of sport with valuable prizes supplied by the Exhibitors' Association.

5.45—Cars leave the park for the city.

Wednesday evening:

8.00—Meeting in Convention Hall, open to engineers and friends.

Presentation of prizes.

Prize-drawing contests.

Unique sale of curios in aid of a Brantford institution.

Music—Vocal and instrumental.

Speech by Jack Armour.

Address by C. Z. Wise, Education Secretary N.A.S.E., Madison.

Comic recitations, etc.

Thursday, June 26

Thursday morning:

9.00—C.A.S.E. Executive sessions.

Exhibition Hall open all day. (Not in evening).

10.30—Annual meeting Exhibitors' Association.

11.30—Exhibitors' Association entertains the Grand Lodge in Exhibition Hall, demonstrating exhibits and distributing souvenirs, etc.

Thursday afternoon:

2.00—Installation of C.A.S.E. officers in open meeting. Installation of officers of Ladies' Auxiliary.

Thursday evening:

8.00—Annual Engineers' Ball in the Masonic Hall, under the auspices of the Brantford Lodge. Tickets, $1.00. Ladies free. A caterer will serve refreshments which will be extra.

Visitors desiring to visit any of the Brantford factories are requested to report to Wm. Welsh or D. L. Webster. They will arrange parties and supply escorts.

For complete programme (ready about June 16), write G. C. Keith, 435 Grace St., Toronto.

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Should Develop Canada

AN interesting idea has come out of the West regarding the natural resources of Canada, and what might be called a national policy of development. Prof. R. D. McLaurin, of the University of Saskatchewan, was in Ottawa recently, trying to forward the idea with the Government, and the Western members, who have formed a Committee of Natural Resources, have the matter before them.

They urge the Government to undertake a constructive policy looking to the development of the natural resources of Canada, particularly oil, iron and coal. Prof. McLaurin makes a rather interesting suggestion for solving the tariff hostility of the two sections of the country and bringing the East and West together. He argues that by developing the mineral resources of the West, and thus supplying materials for creating industrial communities there, we should develop basic national industries which every Canadian, even the grain grower, should be willing to see protected if necessary. "It is a different proposition," says Prof. McLaurin, "to protect industries necessary to the peace and security of a nation, from protecting a manufacturer who imports his raw materials from foreign countries and sells merely the finished product. By the latter method, economic independence for Canada is impossible. We should produce our own raw materials for the educational and economic benefit of our people. A nominal political independence is of less value to Canadians, when we are dependent on the United States for basic materials."

Graded Certificate For Ontario

WITH the action of the Ontario Legislature in its recent session before Easter graded certificates have practically become a reality from coast to coast. Only two provinces, Prince Edward Island and New Brunswick, still adhere to the single certificate, and action in conformity with that of the Ontario Legislature may shortly be expected in New Brunswick.

The grading of certificates is the only logical method of regulating the operation of power plants, as by it alone ability and experience are given their true value, and the operation of the larger stations entrusted to those capable of their efficient management.

Graded certificates having become law, it is of importance to note their effect on the status of the stationary engineers in the Province.

One of the most interesting results anti one which will redound most to the benefit of the engineer will result from the interchangeability of Ontario certificates with those of similar classes in other provinces.

Regulations for the working out of the Act will be made from time to time by order-in-council as has been provided for in the Act itself, and while these regulations have not as yet been developed in their final form or completeness, we are able to forecast with some degree of certainty such of them as will be of importance in the bringing of the new Act into force in January, 1920. While these regulations are tentatively given in abstract elsewhere, it is well to emphasize the method by which engineers at present holding certificates will be graded under the new law. Present holders of certificates will be divided into two classes, second and third, the standing to be set by the Board, and the first class certificate being obtained only by means of examination.

It will not be necessary for engineers at present operating a plant to obtain the certificate necessary for its operation under the new law, so long as he continues to remain in his present position, but if he changes to a plant having a higher rating the Act will necessitate his having the proper certificate for its operation, time being given for his preparation for examination.

The four grades of certificates which will be issued will permit of the operation of plants having certain boiler horsepower ratings by the holders of corresponding certificates. The exact rating for each grade of certificate is one of the regulations which will have to be determined by order-in-council, and until this is done no definite information will be available. The rating will, however, be fixed in terms of boiler horsepower, as stated in the Act, and engine or turbine capacity will not be of any moment in the operation of the Act.

It should also be noted that the Act does not come into force until the first of January, 1920. This intervening time will afford stationary engineers ample time for acquainting themselves with its workings, and if he so wishes, for preparing himself to derive the fullest benefits from its operation.

Graded Certificates for Ontario Engineers

The Passing of an Act by the Ontario Legislature Brings Graded Certificates into Operation in Ontario Starting January, 1920. The Act, with Explanations of its Various Sections and a Forecast of Regulations Which will be Made for its Operation, are Given

ONE of the bills which was given its third reading by the Ontario Legislature, on Thursday, April 17, was "An Act to Consolidate and Amend the Acts Respecting Stationary and Hoisting Engineers." This Act brings into effect the grading of certificates for engineers in Ontario and brings this province into line with other Canadian provinces with the exception of New Brunswick and Prince Edward Island, and while the Act in itself does not define many regulations which will be necessary for the examining and grading of engineers it makes provision for their carrying out by means of order-in-council. It is expected that the rating of certificates and the examinations held under the Act will be of such a nature as to conform to those in other provinces, and in this manner make the certificates issued by the various provinces interchangeable.

As before, the Act will be administered by the Stationary Engineers' Board under Dr. Riddell, Superintendent of Trades and Labor. The Act, together with such explanatory matter as is necessary to its various clauses, follows. In this Act,

(a) B.H.P. shall mean boiler horsepower or the equivalent to the evaporation of 34 lbs. of water per hour from and at 212°—15 sq. ft. of heating surface for return tubular boilers—12 sq. ft. heating surface for locomotive type boilers —10 sq. ft. heating surface for water tube boilers;

This clause defines what is meant by boiler horse power in so far as the Act is concerned.

(b) "Board" shall mean the Board of Examiners appointed as hereinafter provided;;

See Section 4.

(c) "Hoisting plant" shall mean and include a steam boiler and steam engine and every part thereof, working at a pressure of twenty pounds or over irrespective of horsepower and used for hoisting in structural operations or excavating purposes;

This clause defines what is meant by a hoisting plant and includes practically all steam hoists with the exception of those in use at mines or quarries, which latter are exempted by Clause (3) below.

(d) "Minister" shall mean member of the Executive Council charged by the Lieutenant-Governor-in-Council with the administration of this Act;

(e) "Steam plant" shall mean and include a steam boiler, a boiler and a steam engine and every part thereof and thing connected therewith or used with reference to any such boiler or engine or under the care of an engineer. R.S.O. 1914, c. 170.

(3) Nothing in this Act shall apply to the operation of any steam plant having a capacity of less than 50 horsepower, nor to steam heating plants operating at a pressure of twenty pounds or under, nor to the operation of a locomotive engine or a steamboat or a steamship engine or a hoist at a mine or quarry, nor to boilers used for agricultural purposes. R.S.O. 1914, c. 170.

Clause (3) above defines the exemptions to which the Act does not apply and to which of course graded certificates are not applicable. Power plants having a capacity of less than 50 boiler horse power (determined as in subsection (a)) are exempt. Heating plants operating at twenty pounds or under are exempt. Locomotives and steamships are also exempted and boilers for agricultural purposes; threshing engines, etc., also do not come under the provisions of the Act. It should be noted, however, that only those hoists which are used at mines or quarries are exempted, all other hoists being subject to the operation of the Act. This clause is re-enacted from the former Act.

(4) The Lieutenant-Governor in Council may appoint a Board of Examiners consisting of three competent and independent engineers practically conversant with the construction of boilers and the operation of steam plants, who shall hold office during pleasure and who, subject to the regulations mentioned in the next following section shall prescribe the subjects in which candidates for certificates of qualification as stationery or hoisting engineers shall be examined and shall conduct or provide for and supervise the examination of candidates and report thereon to the Minister. R.S.O. 1914, c. 170.

Clause 4 above is the same as that in the former Act and provides for the setting up of the board by which the examinations are conducted. In itself it effects no changes but in the provisions for setting up regulations which follow important changes have been made which apply to the grading of engineers and to the carrying out of the law.

(5) The Lieutenant-Governor in Council upon the recommendation of the Minister may make regulations for:

(a) The examination of candidates, the granting of certificates, the classifying of these certificates into their respective grades, and the evidence to be furnished by candidates as to previous training or experience and sobriety and good character; and the recording of changes made in engineer's positions;

This section makes provision for the grading of certificates and also for the recording of changes which may be made from time to time in the positions held by engineers.

(b) Determining the time of duration of certificates and their renewal;

(c) Fixing the fees to be paid by candidates upon examination and for certificates and their renewal;

(d) Prescribing the causes for which a certificate may be revoked, cancelled or suspended and for

(e) Fixing the fees or other remuneration to be paid to the members and officers of the board. R.S.O. 1914, c. 170.

(f) Fixing the fees to be paid by plant owners for certificates of registration.

(6) No person shall be elegible for examination unless he is a British subject, or has resided in Canada for at least one year. R.S.O. 1914, c. 170.

7—(1) On the recommendation of the board and on payment of the prescribed fees, the Minister may issue certificates of qualifications to stationary or hoisting engineers, and certificates of registration to plant owners.

(2) Subject to the regulations a certificate may be revoked, cancelled or suspended by the Minister on the recommendation of the board at any time.

(3) Every stationary or hoisting engineer shall, during the continuance of his certificate, register with the board on or before the 1st day of February of each year on a form to be furnished by the board, and any stationary or hoisting engineer who fails to do so shall not continue in charge of a steam plant unless by special permission of the board. R.S.O. 1914, c. 170.

(4) It shall be the duty of all owners of steam plants to advise the board, on a printed form supplied by the board on application, of the B.H.P. and steam pressure of their plants, on receipt of which, together with the prescribed fee, the Minister will issue a registration certificate. Any change made in the plant subsequent to registration will necessitate a re-registration of same.

(5) It shall be the duty of all engineers and firemen who come under this Act to report annually to this board on a form which will be supplied, the B.H.P. and steam pressure of the plant which he is operating.

8. A person who is not the holder of a certificate shall not operate or have charge of any steam or hoisting plant

except in case of emergency, when he may be employed in operating any steam plant for a period not exceeding thirty days at any one time. R.S.O. 1914, c. 170.

9. The board at its discretion may grant a provisional certificate to be good for a period not to exceed one year to any person who holds a stationary or hoisting engineers' certificate from the board of examiners or other duly constituted authority of any other Province of Canada. R.S.O. 1914, c. 170.

10. The certificate shall at all times be exposed to view in the engine or boiler-room in which the holder thereof is employed. The registration certificate to be exposed to view in the engine or boiler-room also. Failure to keep such certificate exposed shall be *prima facie* evidence of the lack of qualification under this Act. R.S.O. 1914, c. 170.

11. This Act shall not apply to firemen, who have had less than six months' experience, or other workmen acting under the personal direction or supervision of any engineer holding a certificate under this Act, who is actually in charge of a steam plant, or to the employees of engine builders or steam plant contractors engaged in installing, setting up or testing a boiler or steam plant. This section shall not apply to hoisting engineers. R.S.O. 1914, c. 170.

12. Any person who deems himself aggrieved by the decision of the board may appeal therefrom to the Minister, upon giving such notice as the Minister may prescribe and the decision of the Minister shall be final. R.S.O. 1914, c. 170.

13. The board shall on or before the 15th day of November in every year make to the Minister a report in writing for the year ending on the 31st day of October of the previous year, showing:

(a) The number of certificates granted;
(2) The number of applications for certificates refused and the causes for refusal;
(c) The number of certificates revoked, cancelled or suspended, and the causes for the same;
(d) The amount of fees received from candidates or holders of certificates;
(e) The number of boilers registered during the year;
(f) The amount of fees received from plant owners for registration purposes;
(g) Such other matters as may be directed by the Minister or the Lieutenant-Governor in Council. R.S.O. 1914, c. 170.

14—(a) Any member of the board, or inspector, on presentation of authority in writing, signed by the Minister, may enter any premises wherein he has reason to believe there is a steam or hoisting plant and make such inspection as may be necessary to determine whether the provisions of the Act are being complied with.

(b) Any person who interferes with or obstructs a member of the board in the exercise of the powers conferred on him, shall incur a penalty not exceeding $100.

15. Every person who
(a) Except as provided in section 8, operates a steam or hoisting plant as the engineer in charge thereof without the certificate required by this Act, or employs or permits any person to operate a steam or hoisting plant as the engineer in charge without such certificate; or
(b) Is guilty of a contravention of subsection 4 of section 7, shall incur a penalty of not less than $10, nor more than $25. R.S.O. 1914, c. 170.

16. It shall be the duty of the inspectors of factories to assist in the enforcement of this Act, to report to the board any violation thereof, and to furnish to the board such information as they may have as to the conduct and capability of any person holding or applying for a certificate. R.S.O. 1914, c. 170.

17. The penalties provided by this Act shall be recoverable under *The Ontario Summary Convictions Act.*

18. *The Stationary and Hoisting Engineers' Act* being chapter 170 of the Revised Statutes of Ontario, 1914; the Act passed in the 4th year of His Majesty's reign, chaptered 28; and section 17 of *The Statute Law Amendment Act,* 1915, are repealed.

19. This Act shall come into force on the 1st day of January, 1920.

Explanatory

Subsection (d) above is to be read in connection with Clause 7, Section 4 below, and applies to the registration of power plants by their owners.

It will be seen that this Act sets up the machinery for the grading of certificates, the registering of plants which come under the Act and the making of regulations for the carrying out of the Act.

It is probable that four classes of certificates will be issued: first, second, third and fourth. The fourth class certificate will embrace all firemen having six months' experience, night watchmen and water tenders. The holders of this grade of certificate will be required to know how to operate a boiler in a safe manner.

The third class certificate will be the lowest engineer's certificate and will be required of those operating steam plants of 50 boiler horse power or over, up to the lower limit of the next higher class.

The second class certificate will be required of those having the operation of plants of greater capacity in their care.

The first class certificate will be the highest grade and will be obtained only by examination. This examination will necessarily be of a highly technical and practical nature.

Present Holders of Certificates

Engineers who hold certificates at present will be divided into two classes: third class and second class, the standing to be set by the Board. New applicants, those holding no certificate, and those wishing to obtain a higher standing will have to pass the examinations for the class of certificate wished. Application forms will be sent to all engineers holding the present certificate, on which they will set out their standing, and this standing will determine their grading into the two grades above mentioned, second and third.

A most important question which many engineers will probably be interested in is the effect that the new Act will have on their present positions. That is to say, an engineer who will be given a third class certificate may at present be in charge of a plant which under the new law will require a second or first class certificate. His position will not be affected in the least. So long as he remains in operation of the same plant he will not be interfered with in any particular so far as his grading is concerned, but if he changes his position and goes to another plant where a higher class of certificate is required then he will be required to pass the examination for the particular class in question. This might in some cases work hardship and so time will be given for him to prepare himself for the examination.

Examinations

The examination for the fourth class certificate will be entirely oral and the questions asked will be those which will give an indication as to the candidate's understanding of boiler operation, particularly safe operation. The examination for other grades will be written examinations.

Any one who desires to try any of these examinations on and after the first of January, 1920, may do so by making application to the Board for an application form, which will be furnished. The first week of each month will be set for examinations in the Board offices, commencing on the first Monday in the month. Examinations will also be held at local points as at present, such as London, Kingston, Ottawa, Port Arthur, and elsewhere. Examinations will be conducted by the Board of Examiners and such other assistants as they require.

Registration of Plants

In the furtherance of this legislation all power plants coming under the Act will be registered and the boiler horse power of all plants in the province will be obtained. Registration certificates will be issued and these certificates will be permanent unless alterations are made, in which case a re-registration will be necessary.

Change of Positions

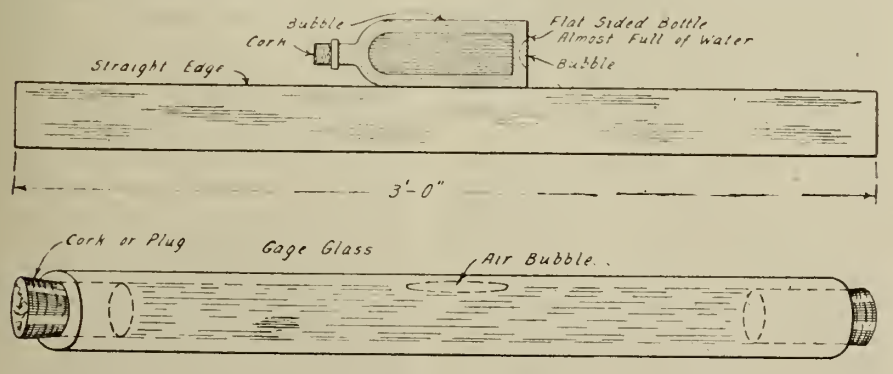
Any engineer making a change in position after 1919 will be required to notify the Board of such change.

The Operators' Point of View

LEVEL MADE FROM GAUGE GLASS

L. C. Bond

WHEN out on a job and a level is needed for lining up work, one can be improvised by filling bottle with water and laying it on a straight-edge. However, a bottle with parallel sides cannot always be obtained readily. A more satisfactory level can be made by following the suggestion of Fig. 2. The scheme of using a bottle for a level is shown in Fig. 1. To make the level of Fig. 2 a piece of water-gauge glass is used because these gauge glasses are usually true. Fill the gauge glass full of water and then insert a cork or a plug in the holes in each end. Of course, the gauge glass, when in use, is usually held on one face of a straight-edge. It is often desirable to attach the gauge-glass level permanently to a straight-edge with a couple of pieces of tin, one at each end, bent over it in the form of straps. It should be noted that the glass tubes in the levels which are regularly manufactured are curved somewhat so that when the straight-edge is level the bubble will lie in the centre of the tube. However, the gauge glass of the improvised level is not curved, but is straight. Therefore, when using one of these tubes it may be level when the bubble is just free from the plug in one end or other. It is not necessary that the bubble be in exactly the middle of the tube. It is a good plan, when using a level of this sort, to turn the gauge glass end for end to be sure that the bubble does not touch the plug in either position.



IMPROVISED LEVELS.

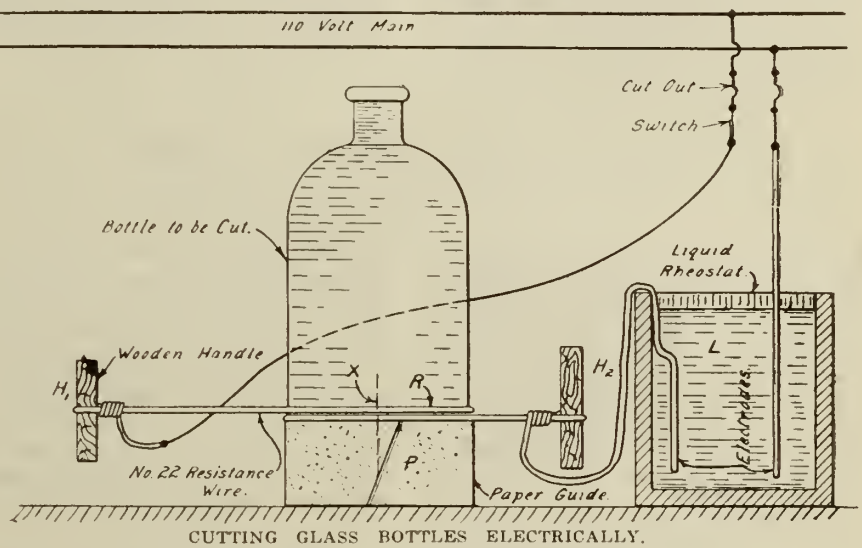
CUTTING GLASS ELECTRICALLY

H. M. Holt

(Copyright. All rights reserved.)

We have cut bottles with an electrically heated wire (Fig. 1) and have found this method more successful for cutting off bottles than any other one that we have tried. The first step where a bottle is to be cut, is to make a file mark at the location where the glass is to be cut off. The function of this file mark is to start the crack around the bottle in the right direction. Then a strip of paper, P, is wrapped around the bottle, just below the file mark. This strip acts as a guide by indicating just where the wire, which will be heated electrically, should be wrapped around the bottle. Then encircle the bottle with a length of high resistance wire, R. Small iron wire will do but probably No. 22, B. & S. gauge Nichrome wire will be found as satisfactory as any. Where the wires pass each other (at point marked X in the illustration) they may be prevented from contacting by the insertion of a piece of sheet asbestos or may be held apart simply by providing sufficient tension on the handles H1 and H2.

The source of voltage may be an ordinary 110-volt incandescent lighting circuit. To limit the current to the proper intensity, some sort of a rheostat should be provided in series with the arrangement. A simple liquid rheostat, L, is usually most convenient. Salt water can be used in the glass vessel, L, and the electrodes may be dipped into it to a sufficient distance that the current through the resistance wire, R, is of the right intensity to raise the wire to a red-heat temperature. About 10 or 12 amperes is usually required. The wire being red-hot, the operator pulls gently on the handles H and H. After the current has been flowing for about half a minute a cracking sound will usually be heard. This indicates that the bottle has cracked under the wire. In some instances it may be necessary to tap the bottle with a light tool after the heated wire has been applied in order to start the crack.



CUTTING GLASS BOTTLES ELECTRICALLY.

Circles and irregular shapes may be cut from sheets of glass, using the general methods described above, by holding the hot resistance wire on the glass plate in the contour to which it is desired to cut the sheet.

DIRECT OR ALTERNATING CURRENT MOTORS FOR CRANES

M. O. Huntington

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If both alternating and direct current are available in a plant it is probable

that direct-current motors are preferable to alternating current for crane service, particularly where time in handling must be minimized. Direct-current series motors are used for crane service. With these as the load decreases, the speed of the motor increases, so that with these motors light loads may be handled rapidly.

However, alternating-current motors will, from an operating standpoint, give entire satisfaction for crane work. At this time practically all of the alternating-current motors used on cranes are three-phase machines, but it is not improbable that in the future single-phase motors having approximately the same load speed characteristics as direct-current series motors will be used widely. The 3-phase alternating-current motor is best adapted for crane service applications where maximum speed of handling is not an important factor. In general, alternating-current motors will cost more than the equivalent direct-current motor for crane service.

To summarize the advantages of the direct-current motors for crane service are: (1) High no-load speed for return of crane hook because of series characteristics; (2) Simplicity of control apparatus and wiring; (3) Minimum amount of space required for motors and control apparatus. The advantages of the three-phase alternating-current motors for crane service are: (1) Expense of installation of a motor-generator set may be eliminated where only direct current is available; (2) More rugged and simpler construction which insures a minimum maintenance expense; (3) Satisfactory operation under adverse conditions, such as where motor is exposed to cement, dust, ashes, coal or an excess of any kind of dirt.

The last-mentioned advantage of alternating-current crane motors has dictated their installation in a number of applications in cement mill, steam plant and similar service.

YOUR FIRST JOB AS CHIEF

By J. M.

YOU have just been appointed to a job, the job you have been planning, scheming and studying for, for a considerable time past. It is not a big undertaking, just a plant that a third-class certificate will cover, but you are chief engineer, and instead of having to receive and execute orders you will now have to depend on your own ability and resources to keep your plant in running order.

On taking charge your mode of procedure will depend very much on circumstances, whether the plant is running, or whether it is shut down for overhaul or any other reason. In any case, whether running or shut, one of your first duties will be to notify the Government boiler inspector that you are now in full control of the boiler and engine of such and such a pant. The boiler certificate should also claim your attention and if it is still in force well and good, but if it has expired no time should be lost in informing the boiler inspector of the fact. Further, your employer should be told immediately that the inspection of the boiler is overdue, and that arrangements must be made for a visit of the boiler inspector at the earliest possible date.

On taking charge you find that the plant is running and there is no opportunity for you to examine either boiler or engine, other than giving a cursory glance as to the general lay-out. Fortunately, the night engineer has been on the job for some time and the first morning you arrive to start up, you find he has steam up and the engine warmed through ready for operation.

Five p.m. finds you tired, very tired, after a day of considerable moving around on your part, as many things have happened to cause you worry, and mostly all because you were strange to the job, and perhaps a trifle too anxious to make good. The fuel was very poor, consequently the steam pressure was kept very unsteady, and that fireman was certainly running with the water low in the glass at times, the injector or feed pump was not always to be depended on, you could feel the blow-down pipe distinctly warm, proving a leaky blow-down valve or cock or both, and there were quite a number of glands and joints fizzing away valuable steam all day long. That engine seemed to be running queer, not at all like the last one you were looking after, for apparently no reason a black streak would appear on the bright piston rod, a bearing would feel suspiciously warm, the slide valve started to chatter, but you got through the day without having a shut-down.

Tired as you felt there were so many little things you would like to do after shutting down, but the plant is running overtime, and you had to leave things as they were to the night engineer. You went home hoping for a better time the following day and the days to come, and you did have a much pleasanter time, petty things that previously worried you scarcely ruffle you now.

The persuasive arguments, rush orders, etc., of your employer have prevailed with the boiler inspector to allow you to run the boiler for another week or two or perhaps for a further month or two, and you want to have a look at that boiler badly. There surely must be lots of scale on the tubes, of this you are quite convinced. The other day during the noon hour when you had a look at the combustion chamber and tubes they looked dirty enough to require a good brushing out, and there were quite a number of air leaks around the brickwork, all helping to interfere with good combustion. But the dirty tubes and combustion chamber, and the air leaks did not seem to you to account for the poor steaming qualities of the boiler, even allowing for the inferior quality of the fuel, so you decide that scale is at the root of the trouble. To have that scale removed might mean the sacrifice of a Sunday's leisure, but rather than continue to operate with a hard steaming boiler you determine to have the job done, and the way that boiler steamed the following week repaid you for all your extra labor, and by the way, your reputation as an engineer who knows his job will have been considerably enhanced, not only in the opinion of your employer, but you will have raised the status of the engineer among your fellow workmen.

Supposing you take over the job when it is shut down.

Fortunately there will be plenty of time to overhaul both engine and boiler, and the boiler will claim your attention first.

After a thorough examination both internally and externally, you will get your men to work chipping, scraping and cleaning wherever necessary, repairing the furnace bridge wall and grate bars, and stopping up any cracks in the brickwork setting. Maybe a few of the tubes will be all the better for an application of the tube expander, and there are leaks in the boiler seams that require caulking, in fact the hundred and one jobs around a boiler that need your attention will be done. Having previously arranged for a visit of the boiler inspector you have made sure everything is in readiness for his arrival. Boiler clean inside and out, safety valve dismantled and the flange blanked off, provision made for filling the boiler in the quickest possible time, a connection ready for attaching the test pump, and don't forget to have a portable light ready. It may be a candle, electric or acetylene lamp, but have it ready, as all inspectors don't carry their own light. If you have had the time and the necessary test pump or natural water pressure you will likely have put a working pressure test on the boiler for your own satisfaction and lucky you did too, for a leak that had escaped your examination showed up pretty bad when the water pressure was applied. Inspectors vary in their methods as to inspecting and testing a boiler. Some of them want the water test applied first, while others prefer to examine the inside first and then apply the test. This making ready for an inspection has meant quite a lot of work to you, but you find the inspector a real nice fellow, he seems well pleased with your efforts to have everything in good order, and suggests several improvements here and there that you yourself had thought of, but being new to the job you did not care about speaking of them to the boss. However, armed with the authority of the Government inspector you suggest that these alterations be made, and they are made.

While your men have been busy cleaning the boiler you had found time to have a look at the engine, and tak-

ing it all together you found it in fairly good shape. The cylinder walls were smooth and true, the piston rings were a good fit, the slide valve was scored a little but nothing more than you could take down with a scraper. You found a good grade of packing in the piston rod and valve spindle glands and decided to leave it alone. The babbitt in the crank pin and crank shaft bearings you considered was of a good quality and a slight adjustment was all that was required.

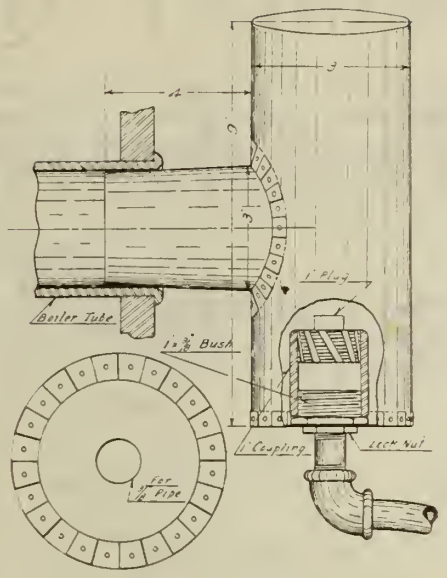
Thoroughly satisfied with your examination and overhauling you report to headquarters that you are ready to start up at any time.

Your success or failure in your new job will depend as much, if not a great deal more, on your personality as on your ability to fulfil the duties of an engineer-in-charge. Your predecessor may have been a man who by his ability and strength of character made the position of the engineer one to be respected and looked up to, and by following in his footsteps both morally and practically your success will be assured. On the other hand you may be taking the place of a so-called engineer, who by his lack of ability has brought into derision the position of the engineer, one who has lost the respect both of his employer and his fellow employees. His shortcomings as an engineer were not even compensated for by a stock of good manners. By his overbearing and swaggering behaviour he had antagonized everybody around the plant, and in this latter case your position may be somewhat difficult for some little time. However, by strict attention to your duty, courteous behaviour to all who come in contact with you, and firmness in maintaining your position when necessary, your job will in time be worth as much and more to you then you ever anticipated. "Be friendly and you will make friends." The consciousness of a duty faithfully performed will bring its own reward, and the experience gained from your first job as chief should be a stepping stone to one of the big jobs you have viewed from afar off.

A "CLEAN" TUBE CLEANER

By E. N. Howard

The accompanying sketch illustrates a simple device that is doing efficient service at the plant where the writer is employed. When blowing out tubes with steam or compressed air, the boiler room generally assumes an aspect of inky blackness, which eventually settles upon everything in sight. To overcome this trouble, and make the place more livable, it was found necessary to devise some means to eliminate this objectionable feature. The appliance here shown was originally made from 2-inch pipe fittings, but the sensation of holding this at the end of a pipe about 6 feet long proved tiring, to say the least. In looking round for something lighter the writer came upon some 3-inch conductor pipe which had been discarded when the roof was being fixed. When this was cut and put together as per sketch, it was found to be even more reliable than that previously used. The entire apparatus cost less than a dollar and the efficiency may be judged from the fact that in the past three years this has been used the tubes have only been cleaned with a rod about half a dozen times. This method has also an advantage over blowing the tubes inasmuch as there is no tendency to catch the soot on fire and blow back through the fire doors. It is also much cleaner as the soot goes up the stack instead of (as in a great many cases) into the boiler room.



A CLEAN TUBE CLEANER.

THE STATUS OF THE ENGINEER

Editor the POWER HOUSE:

Why is it that the pubic do not know that stationary engineers are among the most progressive people in the world so far as preventing waste in their own particular line is concerned, namely, fuel, oil, labor, machinery, etc. The answer is easy. They do not use the newspapers enough, they do not advertise. Practically every engineer who is a member of some engineering society, club, or association understands and knows what engineers are doing. Every engineer who is a reader of a power plant magazine knows the same thing, only more so, as any good journal will teach a faithful reader more about his work than he can learn at a meeting once or twice a month. However, both are good in their own place, but outside of the above class of folks there are very few who ever give the engineer a single thought. In the good old days when there were more fatal accidents around power plants, usually causing the death of the man called the engineer, the public did know that such folks did live or die. But in our day the engineer is usually so free from blame when an accident does occur that the name seldom shows in any important part of the report. This is very good. So far as the engineers are concerned, it shows they are a safe financial investment. The employers of engineers have probably noted these changed conditions and the money end of the deal is the only one interesting them. Why, it is not unknown, for some manufacturers to work "tooth and nail" to prevent the passing of a license law for engineers, the idea being that he would have to part with a few dollars more if such a law was in force. If engineers could collect a fund to be used for the paying for space in the newspapers, to educate the public to the important position in the world held by the stationary engineer, it would be money well spent. This world war has been a war of science and engineers—we have seen something like this over and over again in the newspapers. Has the stationary engineer been in the mind of the public at any time when reading the above sentence? Every other kind of an engineer, but not the stationary power plant man. No doubt there were thousands of cases where remaining at his post was necessary during bombardments of the power stations, and it is just as certain that he remained on duty until the plant was wrecked and himself killed, but the dear public never noticed anything about it in print. The stationary engineer, like other scientists who have become famous in spite of themselves, are as a rule very modest. So much of their time is used up studying how to reduce cost of operation, etc., that they are apt to neglect their own financial interest. To be one of the best is a fine thing and well worth a struggle, but if you have a little change to spare after looking after the welfare of the wife and kiddies there are good books to buy and experiments to make. Neither books nor experiments will materialize to any great extent, unless the employer loosens up somewhat more than usual in the great majority of plants. Therefore get the newspapers to tell the people who you are and what you are doing. When they begin to notice that there are such animals on the earth's surface, even if under sky-reaching piles of brick, stone and cement, and realize that practically the comfort, safety, and conveniences of a city largely depend on the careful work of the engineer, then and then only will the power plant engineer begin to come into his own. The better class of power plant journals are forever fighting for the interest of the engineers, well and good, but about the only readers such journals have are the engineers themselves and the advertiser and the advertisers' managers. In the two latter cases it is safe to predict that many of them study mighty little in the journal outside the selling section. What the engineers require to do is to get before the public eye, and in the public mind, as they really are in the plant. Here is a chance for original sane suggestions.

James E. Noble, Portsmouth, Ont.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$28 00	$.....
1¼ in.	32 00	.....
1½ in.	35 00	28 00
1¾ in.	35 00	28 00
2 in.	40 00	28 00
2¼ in.	43 00	30 00
2½ in.	45 00	35 00
3 in.	52 00	40 00
3¼ in.	.....	47 00
3½ in.	62 00	48 00
4 in.	70 00	60 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$5 50	$4 50
Tank plates, 3-16 in..	5 75	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74

Standard Lapweld

2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Meritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 75
Steel bars, base, Toronto ...	5 00
Steel bars, 2" to 4" base...	6 00
Iron bars, base, Montreal ..	4 55
Steel bars, base, Montreal..	5 03
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 25	$ 6 25
Sheets, Black, No. 10.	5 25	5 25
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"a Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 85
Premier, 10¾ oz. ...	....	8 50

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.....	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1....	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws.....	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less...	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly 0	35
Solder, guaranteed 0	40
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums 5	20
White lead, pure, cwt. 16	20
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D." per lb..... 0	03
Rosin "G." per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned, 14x60 in.. 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd..	$0 43
Sheets 24 oz. and heavier base 0	48
Brass tubing, seamless..... 0	55
Tubing, I.P.S., 1" base 0	55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add 40,	10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper ...	17 25	19 00
Tin	60 00	58 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 50
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided ...	$0 38
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.. 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

Fairbanks-Morse Pumps

PIPE
VALVES
FITTINGS
GASKETS
REDUCING VALVES
GOVERNORS
STRAINERS
BOLTS AND NUTS
BELTING
PULLEYS
SHAFTING
HANGERS
MOTORS
ENGINES
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"Canada's Departmental House for Mechanical Goods."

The Canadian Fairbanks-Morse Company, Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

BOOK REVIEWS

The Fundamental Equations of Dynamics, by Frederick Slate, University of California Press, Berkeley, Cal. Price, $2.00.

The established connections of dynamical reasoning with other fields in physics are of increasing number and closeness, and a need has arisen for a treatment of the subject which would coordinate the more fundamental concepts of dynamical theory without encroaching on the more specialized fields which would demand more than one volume for their comprehensive treatment. The present work deals with the principles which lay out and direct all the main lines of thought.

An introduction summary develops a general conception of dynamics and leads to the treatment of the six fundamental equations which follow in the second chapter. The third chapter deals with reference frames, transfer and invariant shift, while the fourth takes up the main co-ordinate systems. The fifth is devoted to explanatory notes on the preceding ones, and discusses various phases of the development of dynamical theory. For those possessing a sound knowledge of higher mathematics and to whom dynamics is a study of absorbing interest the work is commended.

Schweitzer & Conrad Inc., 4431 Ravenswood Ave., Chicago, have issued a new catalog descriptive of their voltage protective and switching equipment. This publication describes and illustrates the various types of fuses, liquid pattern, made by this firm, and also describes the various methods by means of which fuses are incorporated in the design of various types of apparatus, to the greater protection from the results of emergency conditions. In addition to the fuses the publication describes safety disconnecting switches, high voltage circuit breakers, ejector primary cutouts, etc.

Philadelphia.—The Electric Furnace Construction Company, Finance Building, Philadelphia, reports the successful starting up of a special "Greaves-Etchells" type of electric furnace for the manufacture of corundum at the works of the Wm. W. McGregor Co., Airdrie. The material used for the charge is the waste dust accumulated from the crushing of natural corundum. This was practically useless and was considered to be a waste product. A charge of 7 tons of this material was treated in approximately eight hours. The total energy consumption was 3,500 units and the usable corundum ingots weighed nearly four tons. Results of the tests made gave great satisfaction and promise a new field for the electric furnace. We understand that a fairly constant load was obtained throughout the whole of the operation.

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Persons desiring to tender are requested to communicate with **THE SECRETARY OF THE WAR PURCHASING COMMISSION, BOOTH BUILDING, OTTAWA,** stating the items in which they are interested, whether new or second-hand or both.

Arrangements will be made to have samples on exhibition at places throughout Canada; specifications, full details, and tender forms will be mailed when ready to those who have registered as suggested above.

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Dominion, Provincial and Municipal departments, hospitals, charitable, philanthropic, and similar institutions which are conducted for the benefit of the public and not for profit may purchase goods without tender at prices established by the War Purchasing Commission.

All communications should be addressed to the Secretary, War Purchasing Commission, Booth Building, Ottawa, who will be glad to supply lists and further details to those interested.

TRADE GOSSIP

Making Water Meters.—The Neptune Company of New York, the largest manufacturers of water meters in the world, have decided to locate a branch manufacturing plant in Canada. They will be incorporated under the name of The Neptune Meter Company, Limited, of Canada. They have obtained floor space on the corner of King and Dufferin streets, in the former munition factory of the Russell Motor Company, and will, just as soon as it is practicable, equip a factory for the manufacture of water meters for the Canadian trade. The parent company has done a very large business in Canada during the past ten years, and will now be in a position to render very prompt service in the way of supplying repair parts, etc.

Open Montreal Office.—The Canadian Link-Belt Co. have opened a branch at 1195 St. James St., Montreal. A liberal stock of popular types of Link-Belt will be carried in stock at Montreal in the future from which all orders in that section will be promptly filled. This will not only enable the Canadian Link-Belt Company to render its customers a more prompt service than has hitherto been possible, but will also effect for them a considerable saving in freight and express. For the present the Montreal branch will serve largely as a warehouse, all engineering assistance being ren-

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Cable Address "Willwills" Montreal, P.Q. Established 1891

Williams & Wilson's

"Lancaster" Patent Steam Trap

For all pressures from 2 lbs. to 300 lbs. Very compact. Float is made cylindrical and extends the full length of the box, enabling a float of greater capacity than the ball float to be fitted in much smaller space.

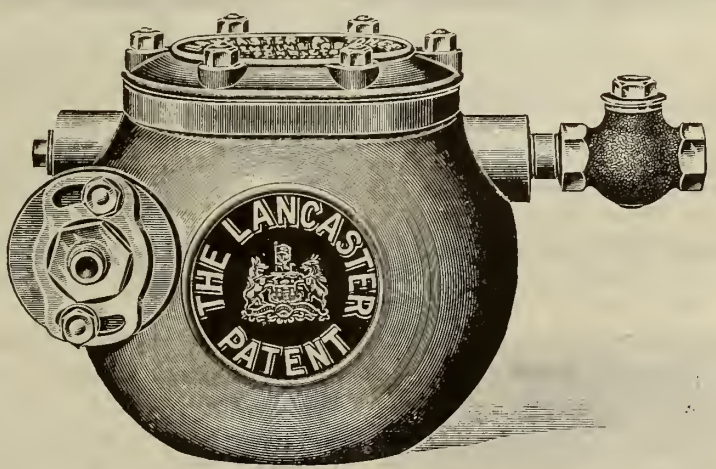
To show the compactness of the new trap, we may say that the ⅜ in. trap is 8⅜ in. high, 10½ in. long, 6½ in. wide over all. **The SPECIALTY OF "THE LANCASTER" STEAM TRAP** consists in the **Loose Disc Valve** at the orifice of the discharge pipe in connection with a **quick-threaded screw** motion, worked by the float. This valve is **frictionless** in action, and, being loose, **cannot stick** to its seat. It is very prompt in its movements for opening and closing the discharge pipe, and the working parts are **very simple and easily examined.** It also acts as a **Safety Valve,** as any excessive pressure exerted against the face of the loose disc valve would, by virtue of the Quickness of the Screw Thread, force it open.

THE "LANCASTER" STEAM TRAPS ARE RELIABLE, ECONOMICAL AND EFFICIENT.

The Lancaster Lifting and Marine Steam Traps

(R.T.M.)

These Traps are similar in construction and action to **"THE LANCASTER" STEAM TRAPS,** with the exception that being made with a much stronger box and fast lid, they will raise the discharged water **2 feet for each 1 lb. pressure of steam.** The condensed water and air pass away with the greatest ease.



These Traps Cannot Stick, and have **Never Yet Failed** under most **Severe Tests.** In ordering, please state Size and Steam Pressure.

Write for full information. First Trap sent entirely on approval.

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Agents for the DOMINION OF CANADA

dered by the Canadian Link-Belt Company at Toronto, where Link-Belt is manufactured for the Canadian market. Although shipments for the Montreal and Quebec territory will be shipped from the Montreal branch all correspondence should continue to be addressed to the Canadian Link-Belt Company, Toronto.

SAYS PART OF STEAM LINE OUGHT TO BE ELECTRIFIED IN THE EAST

W. G. Gordon, transportation engineer of the Canadian General Electric, read a paper on "Main Line Electrification in Canada," with special reference to the Moncton-Halifax line of the Canadian National Railways.

"The latest heavy trunk line electrification to contribute data illustrating successful operation is the Chicago, Milwaukee and St. Paul Railroad. This line has in electric operation 440 route miles, and has let contracts for the electrification of a further 220 route miles.

Saving in Ton Mileage

On a steam operated trunk line twelve per cent. (12%) of the entire ton mileage movement of freight and passengers carried is represented in the cars and tenders required to haul the coal supply for the steam locomotive. When such a line is electrically operated from water power stations it means that the total movement for railway coal and locomotive tenders is eliminated; and, even if partially or wholly operated from steam power stations, the movement for locomotive tenders is eliminated, and the movement for railway coal is greatly decreased. The benefit is self-evident of being able to apply this ton mileage in the movement of revenue tonnage.

"The cost of maintenance of the electric locomotive is very much less than that of a steam locomotive. The steam locomotive is a power plant which, owing to physical limitations, can attain only a certain capacity and efficiency. On the other hand, the electric locomotive, itself very efficient, can draw any amount of power desired from a system fed either by hydro-electric plants or highly efficient steam electric plants.

"With regard to the 187 miles of the present steam-operated line of the Canadian National Railways, between Moncton and the Halifax Ocean Terminals, it can be shown that the electrification of this line is economically justified on the basis of sound engineering principles. In Halifax the Ocean Terminals have been laid out with a capacity of several times the present traffic, and with ultimate provision for many times the present tonnage, whereas the present line is a single track railway, with heavy grades. To increase the tonnage capacity of this line several plans may be considered, including electrification, grade reduction on the present line, double tracking the present line with grade reduction, double-tracking the present line without grade reduction and construction of low grade single track on new locations.

"During winter conditions of extreme cold the steam engine is at its worst, owing to the dissipation of heat, while the traffic conditions are most severe. This condition, instead of being detrimental to the operation of the electric locomotive, increases its service capacity as the motors can more readily dissipate heat. Further, the tonnage traffic over the line can be largely increased, due to the electric locomotives being able to haul much heavier tonnage at higher scheduled speeds with almost an entire elimination of the failures and delays at present due to steam operation.

"It is human to err," and in our last advertisement the printer let us down. He made a simple error. Not being an Engineer, of course, he couldn't see the importance of the error.

He substituted the word "STEAM" for the word "FEED," which is quite a different thing. The ad. referred to the coal consumed in "feeding" boilers by two different methods—the "Direct" Steam Pump, and the "Direct" Return Steam Trap.

The coal piles above more nearly represent the comparative amounts required to "steam" boilers when using Cole Direct Return Traps, feeding hot condensation as feed water into boilers.

Approved by Boiler Inspector, Ontario

Cole Return Traps and Automatic Boiler Feeders

will certainly make a big cut in your fuel bills. Write for our Bulletins, on "Condensation" and on "Boiler Feeding." They show how fuel economies are effected.

Geo. W. Cole, Limited
2002-4 Dundas St. West
TORONTO

NEW CANADIAN INDUSTRY

The Canadian Corkboard Co., Ltd., 17 Adelaide St. East, Toronto, an entirely Canadian company dealing in cork insulation and other cork products, has recently made its first shipment of corkboard to Mohawk, Ont., and their plant is in a position to make immediate shipment of pure corkboard, impregnated corkboard, and granulated cork. This plant affords the Canadian plant owner the opportunity of purchasing Canadian-made cork products, where formerly he was forced to obtain them in the United States and Spain. The present company have taken over the plant formerly operated by the Robinson Brothers Cork Co., Ltd., at Port Colborne, Ont., and it is of interest to note that Mr. A. C. Robinson has for some time past seen service in Palestine. Mr. Frank White, who was ten years with the Robinson Company, is the sales manager, with headquarters in Toronto, and Mr. H. M. Edwards is the assistant sales manager, located also in Toronto. Mr. Edwards was formerly with the Armstrong Cork Co. for seven years, and five years with the Johns-Manville Co. The Canadian Corkboard Co. are prepared to sell materials and to furnish specifications, or to undertake the installation complete.

NEW POWER HOUSE

The Public Works Department proposes to construct a power house and laundry in connection with the Military Hospital building at Lake Edward, P.Q. It will consist of a basement and one storey, with concrete foundations. The basement will contain coal bunkers at the rear, engine, dynamo, pump rooms and workshop at the right hand side, the central portion being used for the laundry. The dynamo room is to be separated from the pump room by a 9 in. brick wall, and the laundry will be cut off from the other section by 14 in. brick walls. The first floor will contain another portion of the laundry, including the disinfection room, with stores and toilets. A high brick chimey is also to be erected, having a cast iron cap. The foundation walls and beams, including the chimney foundation, are to be

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Whose presence is known only when the climbing and ever-increasing operating cost has to be met. His real name is improper and neglected equipment. Start to-day and cut him down. With the following supplies in stock at attractive prices we can assist you.

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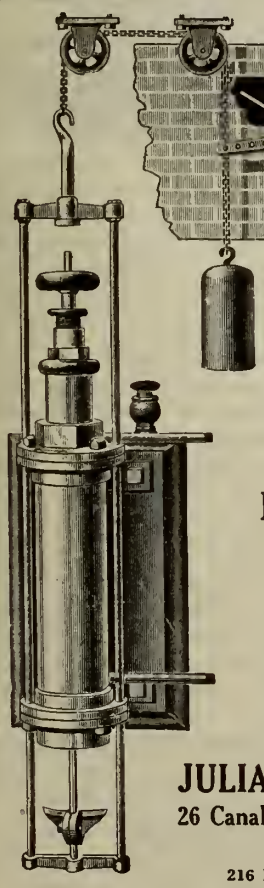

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Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

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Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1918 catalog showing the Curtis line of Engineering Supplies.

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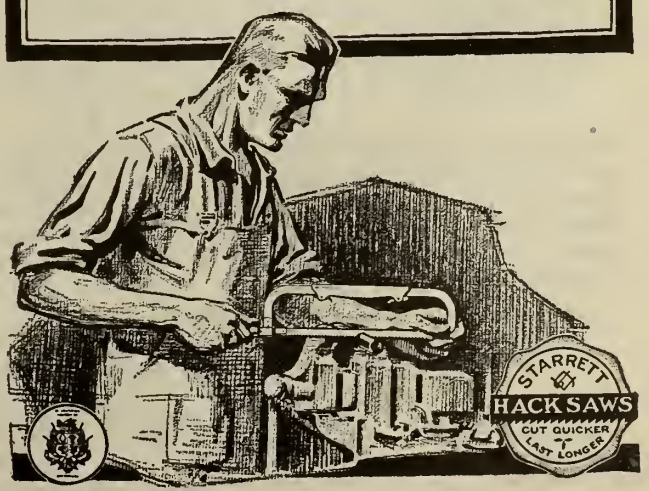
174 North Market Street, Chicago, Ill.

STARRETT HACK SAWS

Just one trial will prove that the Starretts will cut faster and last longer.

Write for our Catalog No. 21CD. It shows many styles and sizes of fine precision tools and hack saws.

The L. S. Starrett Company
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
Athol .·. Mass. 42-877



Requires Very Little Attention

Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admission of steam to the apparatus to which the trap is attached.

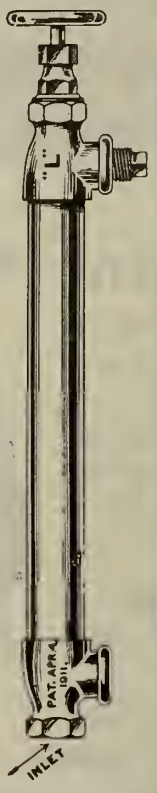
The trap is regulated to work against any pressure between 1 and 200 pounds.

Being open at starting, it cannot become air bound, this doing away with air cocks or vents—Does Not Freeze.

It is capable of draining from 900 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to



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84 Adam St.
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If your dealer does not sell it, write direct. No. 2

of concrete. The boilers are to be carried on girders supported by concrete piers.

The floors of the boiler room, bunker, engine and dynamo room, and pump house will be of 4 1-2 in. concrete, with a wearing surface 1 1-2 in. thick. The floor and laundry roof over the bunkers will be of reinforced concrete. The main floor is to be covered with asbestos shingles, and the roof of the other portion with tar and gravel.

The power plant will consist of a 20 k.w. 125 v.d.c. generator, multipolar type, direct connected to a steam engine. The panel board is to be of the double branch type. The system of wiring will be designed for the parallel two wire 110 v. d. c. interior conduit system.

ITALY UTILIZES VOLCANIC POWER

The present enormous price of coal in Italy, according to the Italian Bureau of Public Information, has resulted in the realization of an idea which at first thought seemed but a dream, but which instead has been developed in a marvellous manner and is assuming quite considerable importance; this is the industrial exploitation of one of the features of vulcanism and that is the natural heat emitted from the soil in those regions more or less volcanic in character.

The first experiments along this line were made some years before the war by Prince Ginori-Conti in Tuscany at Larderello, near the salt-mines of Volterra, a region extensively covered with volcanic formations, the most wonderful being the so-called "soffioni," which are certain volcanic vents emitting powerful jets of very hot steam containing boric salts and various gases used in the extraction of boracic acid. Instead of limiting the use of these steam-jets, as in the past, to extracting the salts contained in the exhalations of these natural vapor-vents, the ejection of the steam is stimulated by boring holes. In this way it is possible to obtain powerful jets at a pressure of two to three atmospheres, according to the locality, and in some exceptional instances as high as five atmospheres, the temperatures varying from 150 to 165 degrees centigrade. These jets maintain their force and temperature unchanged for many years, and they are not affected even when other openings, not too near each other, are bored in the ground, proving that they do not influence each other reciprocally, so great is the underlying thermic energy below. In 1905, Prince Ginori-Conti applied this natural steam to a 40 H.P. engine, using only a small section of the Nenella fissure, which is the most powerful "Soffione," the steam ejected having a pressure of five atmospheres.

The results obtained during several years of experimentation were satisfactory, so that he continued to make larger and deeper borings, measuring the force of the steam ejected; combined, this force could operate engines of many thousand horse-power.

In 1912 an experiment was made, very wisely on a more modest scale, but sufficient to obtain conclusive results, for which a 300 H.P. turbine-alternator was used.

Later, because of the enormous increase in the price of coal, the Prince decided to exploit the thermic energy of these soffioni on a much larger scale, but as other substances are emitted with the steam, among them sulphuric acid, which corrodes metals, particularly iron, and therefore the pipes in which the steam was to be collected, he attempted to use this steam only for heating. Three turbine-alternators of 3,000 kilowatts each were installed, fed by boilers at low pressure not heated by coal or other combustible fuel, but by the natural steam, superheated to 165° C., issuing from these soffioni and piped and carried to the boilers.

To-day the works at Larderello have a central plant of 16,000 H.P. operating without interruption and distributing current to Florence, Livorno and Grosseto; its capacity is soon to be increased.

STEAM TRAP

AVOID WASTE

The waste of steam means the squandering of money. Even if steam were cheap, it would be prodigal to waste it; but, now that steam is costly, there is no excuse for not installing SARCOS.

SARCO

saves steam at every essential point. SARCO performs this work as no other steam trap can. As efficient as the best, its small size and novel construction render SARCO capable of being placed at any needed point—and at a remarkably low cost. It never leaks and won't freeze. Several hundred thousand SARCOS in use tell the story.

Investigate our free trial offer and convince yourself.

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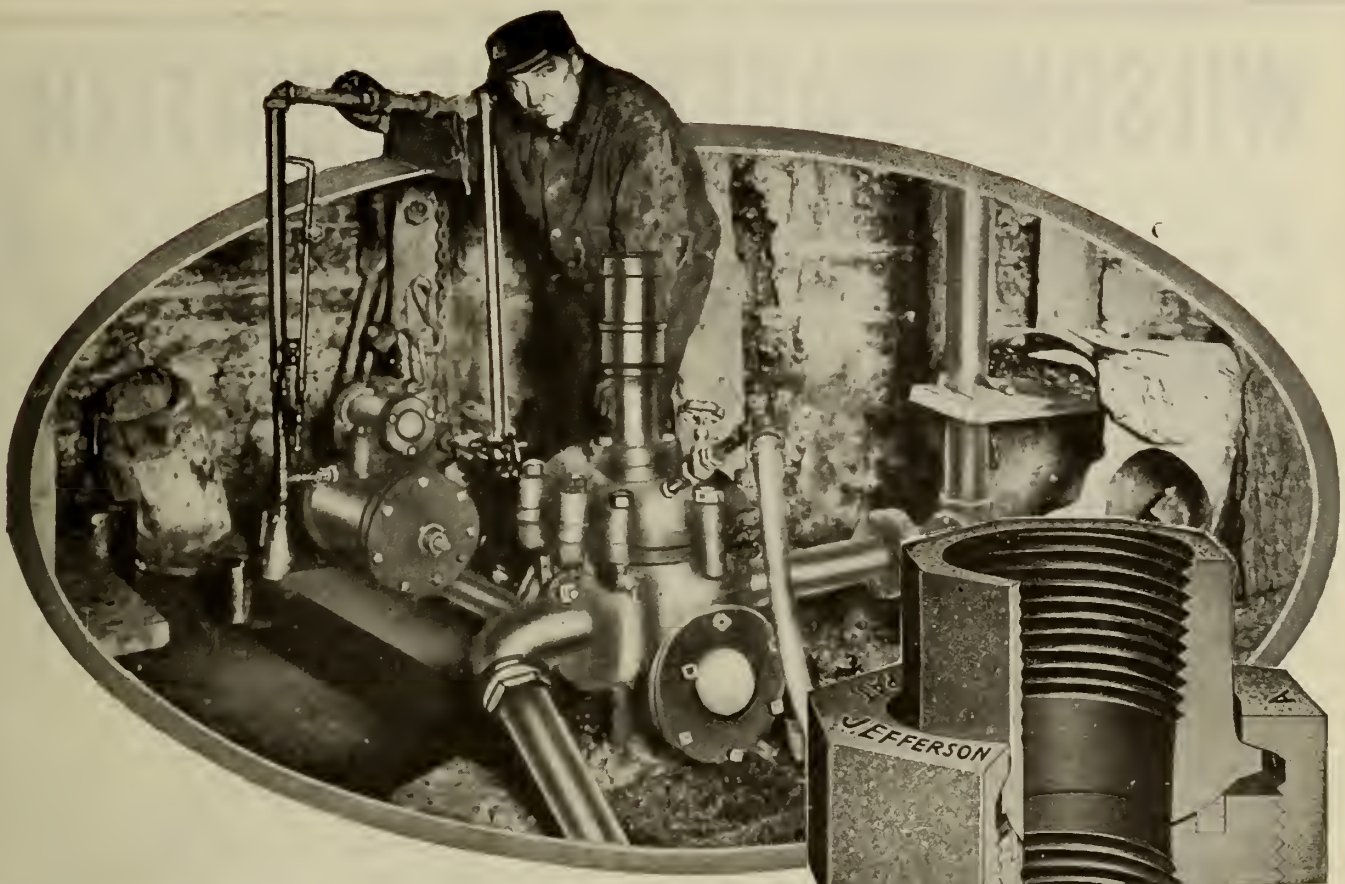
And representatives in all principal cities. *Canada:* Peacock Brothers, Montreal

ONE MOTOR GENERATOR SET—PRACTICally new. 100 k.w., 125 volt, continuous current, direct connected to 150 h.p., 3-phase, 25-cycle motor. One 100 k.w., 125-volt, 270 r.p.m. Generator direct connection to Robb-Armstrong 14" slide valve engine. Engine only run two years. One 150 h.p., 13 x 27 tandem compound wheelock engine. All above in first-class running condition. Change in voltage only reason for selling. The Sheet Metal Products Co. of Can., Ltd., Toronto, Ont.



For Severe Service

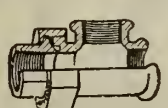
JEFFERSON UNIONS

Pumps—frequently hard to reach—must chug away hour after hour, day after day, without stopping and without attention. Leaky unions have no place in power plant service.

JEFFERSON UNIONS are particularly adapted to meet successfully the most severe tests of service. The Brass Seat Ring makes the brass-to-iron joint which will not corrode and is easily disconnected, no matter how hard or how long the union has been set up. The Spherical Ground Joint makes possible an absolutely tight joint, even though the line is not exactly straight on account of settlement or any other cause.

There are many other reasons why "JEFFERSONS" should be in your plant. They are not "just" unions and the name JEFFERSON stamped on the nut protects you from the doubtful variety. You'll find it mighty difficult to plug a leaky joint with a "just-as-good" promise.

Jefferson Swing Union. Allows widest variety of connections, ranging from a slight offset up to 90 degrees. For angle connections that cannot be made with simple elbow unions.



Jefferson Union Tee, with union on outlet. Has union end threaded either male or female. Should always be used where a union is desired near a tee.

All Male Union Saves two pipe joints between two female threaded parts.

Your Jobber will be glad to show you his stock of "JEFFERSONS." Your inspection will convince you of their merits. Write to-day for our Catalog "UNIONS" which shows the complete Jefferson Line.

Jefferson Union Company
Lexington, Mass.

Jefferson Union Co., Lexington, Mass.
Gentlemen: Mail me postpaid, and without any obligation to me, copy of your New Catalog.
Name .....
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WILSON FEARED THE BRITISH

THE American President crossed the Atlantic in the first place with the idea in his mind that his ideals would be thoroughly in accord with those of the French statesmen; but he was rather afraid of a conflict with the British delegates. He found in reality that his plan for peace terms was as far removed from the French plan as the two poles. Then he crossed to London and was surprised to find that the ideas of the two Anglo-Saxon powers were identical.

This situation, according to J. W. Dafoe in the May issue of MACLEAN'S MAGAZINE, explains much that has developed at Versailles. Further, it contains the promise of a close *rapprochement* between the two great English-speaking democracies for all time to come.

Mr. Dafoe has contributed a remarkably interesting article to this number of MACLEAN'S, lifting the curtain on many of the puzzling situations that have arisen overseas. As the editor of the Manitoba *Free Press*, he is the dean of Canadian newspapermen; as the representative of the department of Public Information on the Canadian Mission to the Peace Conference, he was in a special position to learn what was transpiring. He tells of the really big part that Canada has played in the Proceedings and points out that Canada's status as a nation was firmly established in the eyes of the world when she was allowed separate representation.

A Dozen Other Features---Nationally Important

This May issue is full of articles of unusual significance for Canadian readers.

"SOLVING THE PROBLEM OF THE ARCTIC"
—By Vilhjalmur Stefansson

The second instalment of his remarkable story of the four years of exploration that he undertook for the Canadian Government in the region of the "Pole of Inaccessibility"—a harder place to reach than the North Pole.

"ORGANIZING FOR PEACE"
—By George Pearson

An article of the Great War Veterans' Association by a well-known author-soldier.

"THE CANADIANS IN SIBERIA"
—By Capt. W. E. Dunham

A graphic story of what our forces did in combatting the Bolsheviki, by an officer who has just returned.

"SAFE IN THE SADDLE"
—By J. K. Munro

A review of affairs at Ottawa in which the opinion is expressed that Union Government for the time being is safely entrenched.

The National Idea

The articles in this issue of MACLEAN'S reflect the national idea—Canada's part in the Peace Conference, the political situation at Ottawa, the exclusive report of Stefansson's national explorations, the national organization of our returned men, the work of our forces in Siberia. The reader of MACLEAN'S gets a broad idea of what Canada as a whole is doing The value of this issue— and of all issues —is very great, therefore, from an educational standpoint.
MACLEAN'S is the one magazine that should be selected for young Canadians to read.

Four capital stories by famous authors—W. A. Fraser, Lloyd Osborne, Frederic S. Isham and C. W. Stephens.

The Review of Reviews

An unusually fine array of articles is given in this department. selected from the best in magazines and periodicals the world over. Some of the titles are:

Planned to Destroy British Fleet.
How Mackensen Was Caught.
Events of War Foretold by Stars.
What is Life Like Beyond the Grave?
A High-born Bolshevik.
The New Life in Dry America.
Germans Were Ready to Capitulate.
Japan's New Foreign Policy.
The Many Kings of Jerusalem.
Is British Foreign Office Against League?
Ambassador Tells Story of Peace Ship.
Hindenburg—After the Armistice.

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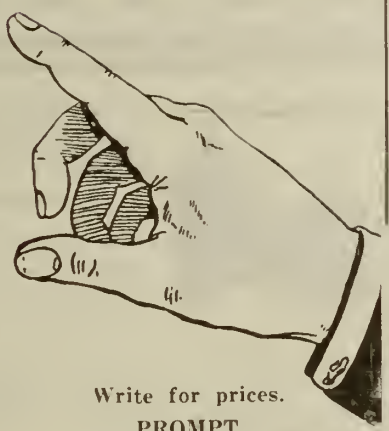

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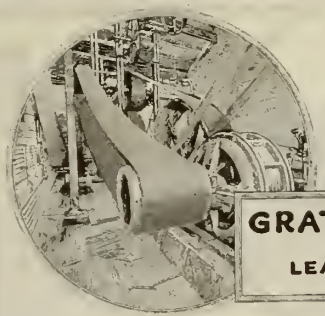

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Power--and the Right Material

Leather is the right material for belting. It is firm. It is strong. It has permanent power of expansion and contraction. It is tough, but it yields in the right degree, at the right time. It is easily and repeatedly spliced or repaired. It stands mauling by shifters. Side-slipping won't fray it. Even after long use it can be cut into narrower belts and goes on with its good work.

Graton & Knight Standardized Series Leather Belts are made to give the longest possible service at the smallest possible cost. Those who use them say that they do.

Write for new book about Standardized Leather Belting.

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Oak Leather Tanners and Belt Makers.
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YES, we have over 300 DIFFERENT ELECTROS

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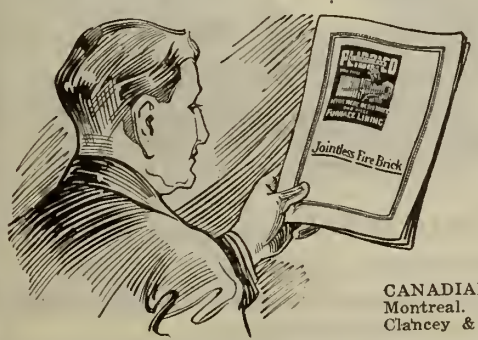

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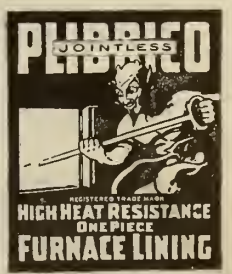

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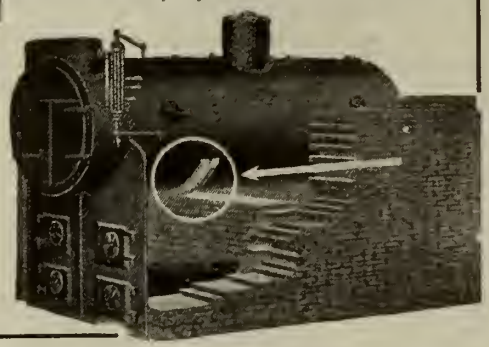

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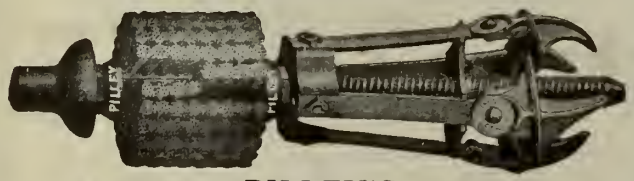

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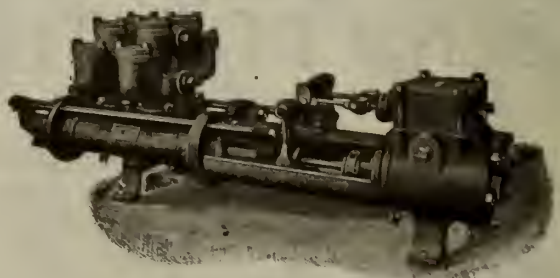

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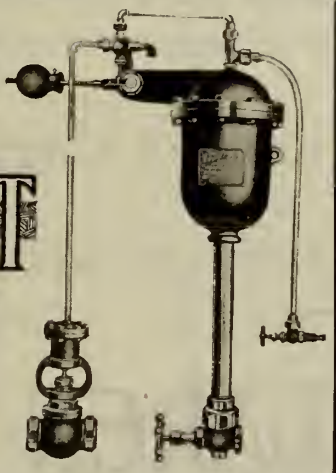

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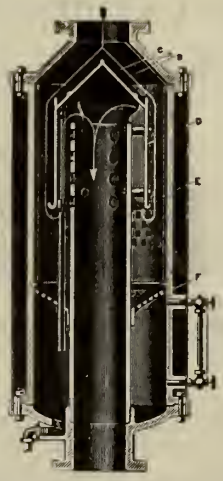

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Waterous Engine Works Co., Brantford.

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COPPER TUBE
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Can. H. W. Johns-Manville Co., Toronto, Ont.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
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Dart Union Co., Ltd., Toronto, Ont.

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Babcock & Wilcox, Ltd. Montreal.
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Sanford Riley Stoker Co., Worcester, Mass.

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Jeffrey Mfg. Co., Montreal, Canada.

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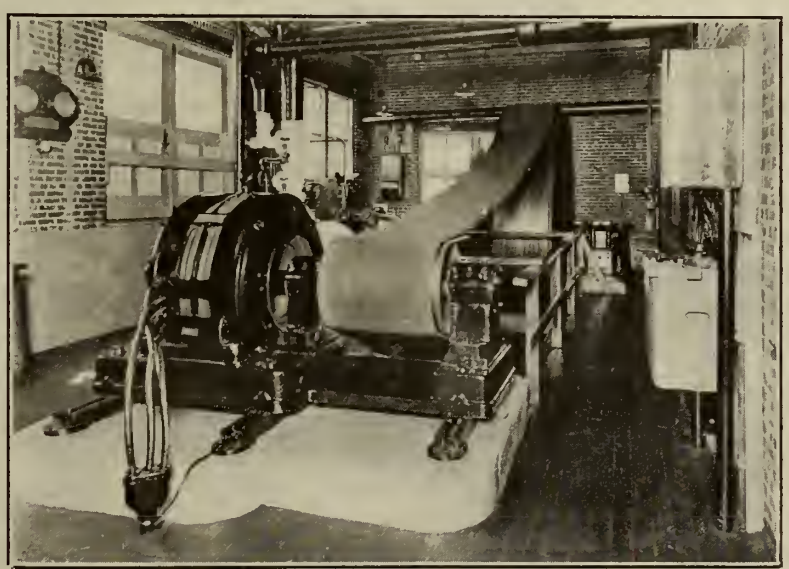

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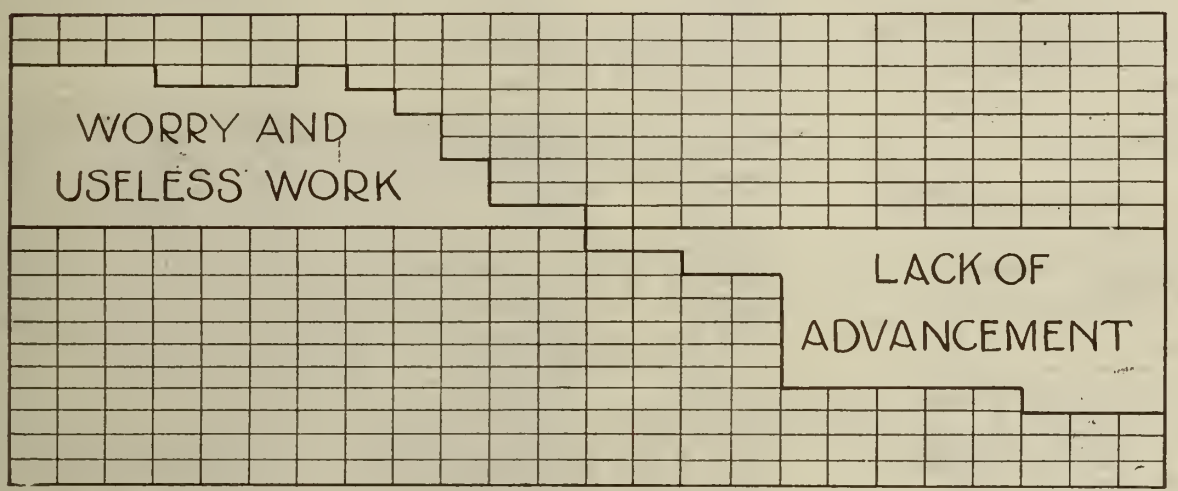

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KILNS

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Bowser & Co., Inc., S. F., Toronto, Ont.

KEROSENE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.

LUBRICANTS
Albany Lubricating Co., New York City.
Canadian Economic Lubricant Co., Montreal.

LUBRICATING OIL FILTERING AND CIRCUULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
Bowser & Co., Inc., S. F., Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Can. Economic Lubricant Co., Montreal, Que.
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Thomson-Gordon, Ltd., Hamilton, Ont.
Vorhees Rubber Co., Ltd., Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING, LEATHER
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Bolco Supply, Ltd., Toronto, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE, CAST IRON
Wood & Co., R. D., Philadelphia, Pa.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydranlic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd.
St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

15 Tons of Coal FREE

Mr. Engineer, does a saving of 15 tons of coal in every 100 tons interest you? This is an immediate and permanent result that comes from the installation of the

JONES UNDERFEED STOKER

It also effects a big saving of labor, automatically maintains a unform pressure, and responds instantly to load fluctuations. Everything that should be burned to generate steam is consumed — this means no fuel waste.
And there are many other advantages in using the Jones Automatic Stoker.

Serves day in and day out with very little attention.

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Why Permit Leaks in Your Air Lines?

Those cumulative leaks past your present globe and gate valve amount to a total of many cubic feet per minute and represent a dead loss in power.

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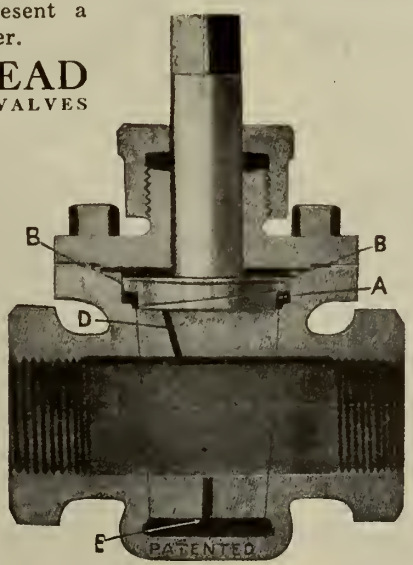
QUARTER-TURN-VALVES

are tight and will stay tight under any specified pressure up to 5,000 lbs.
Homestead Quarter Turn Valves not only give assurance against leaks, they save time too. They can be fully opened or closed by just one-quarter turn of the handle.
You can use them on all air, steam, water, oil, gas, acid and other lines. Made in straight-way, 3-way, 4-way and angle patterns; in brass, semi-steel and special acid resisting bronze; either screwed or flanged pattern.



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from Babcock, Stirling and other Water-tube Boilers and Evaporators also for Lancashire Boiler Scaling and Rust Removing—there is no tool made to equal my

'SKATOSKALO'
Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

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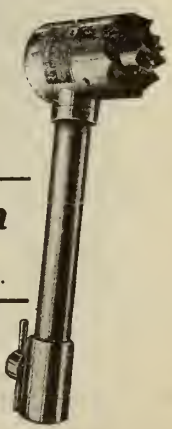

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Boving Hydraulic & Eng. Co., Ltd., Lindaay, Ont.
Hamilton Co., Wm., Peterboro, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng, Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindaay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairhanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamh, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Elliott Co., Pittshurgh, Pa.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelpbia.

PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Liberty Mfg. Co., Pittshurgh, Pa.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal
Hamilton Co., Wm., Peterboro, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairhanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.

PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamh, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PYROMETERS
Green's Economiser, Ltd., Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

RECLAIMING SYSTEMS FOR OIL
Bowser & Co., Inc., S. F., Toronto, Ont.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

REGISTERING MEASURES
Bowser & Co., Inc., S. F., Toronto, Ont.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

RUBBER CEMENT TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Canadian Griscom-Russell Co., Ltd., Montreal.
Laurie & Lamh, Montreal.

REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Chanlin-Fulton Mfg. Co., Pittshurgh, Pa.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

ROPE PRESERVATIVE
Cling Surface Co., Buffalo.

ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.

ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg, Pa.
Thomson-Gordon, Ltd., Hamilton, Ont.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.

SELF-MEASURING PUMPS (OIL AND GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.

SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd. Montreal.
Babcock & Wilcox, Ltd., Montreal.
Galt Foundry Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.

SMELTER LININGS
Beveridge Paper Co., Montreal, Que.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Atbol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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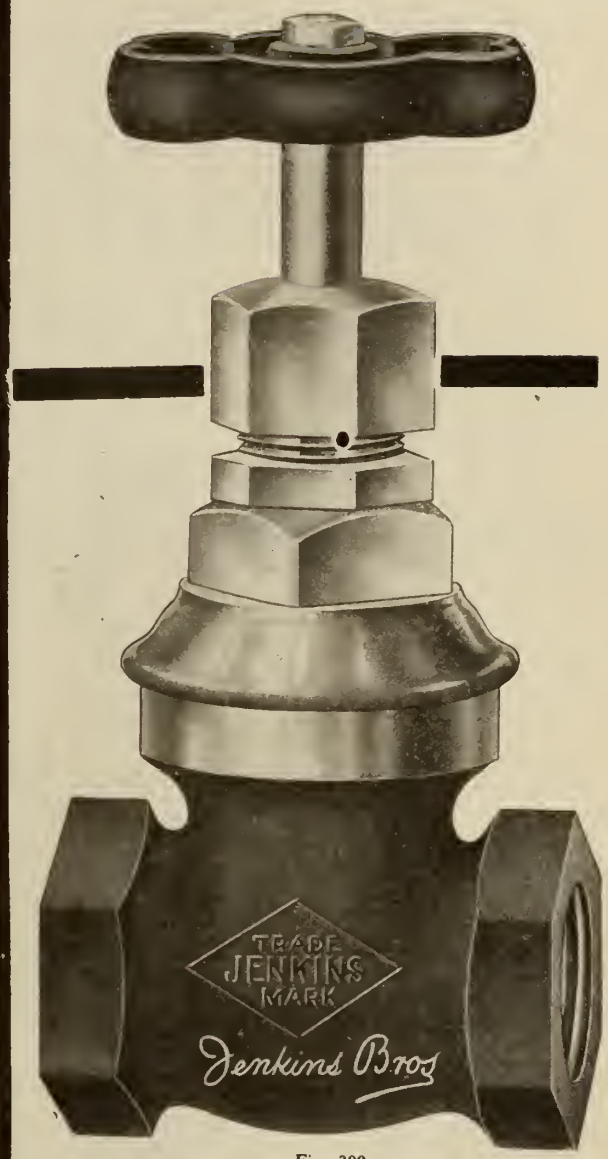

Fig. 300

Type "K" Brass Gate Valve Screwed

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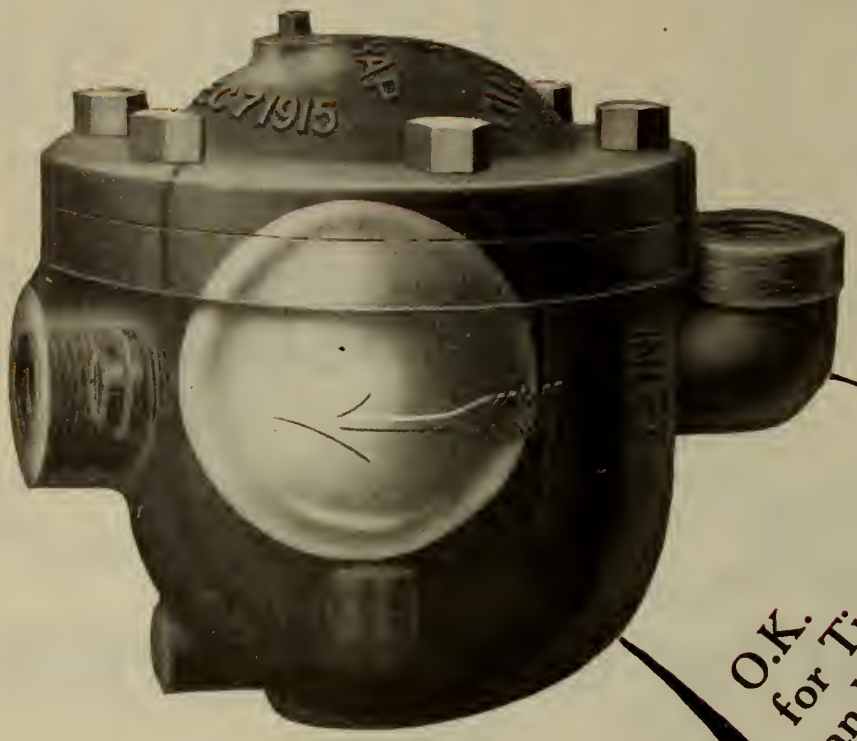

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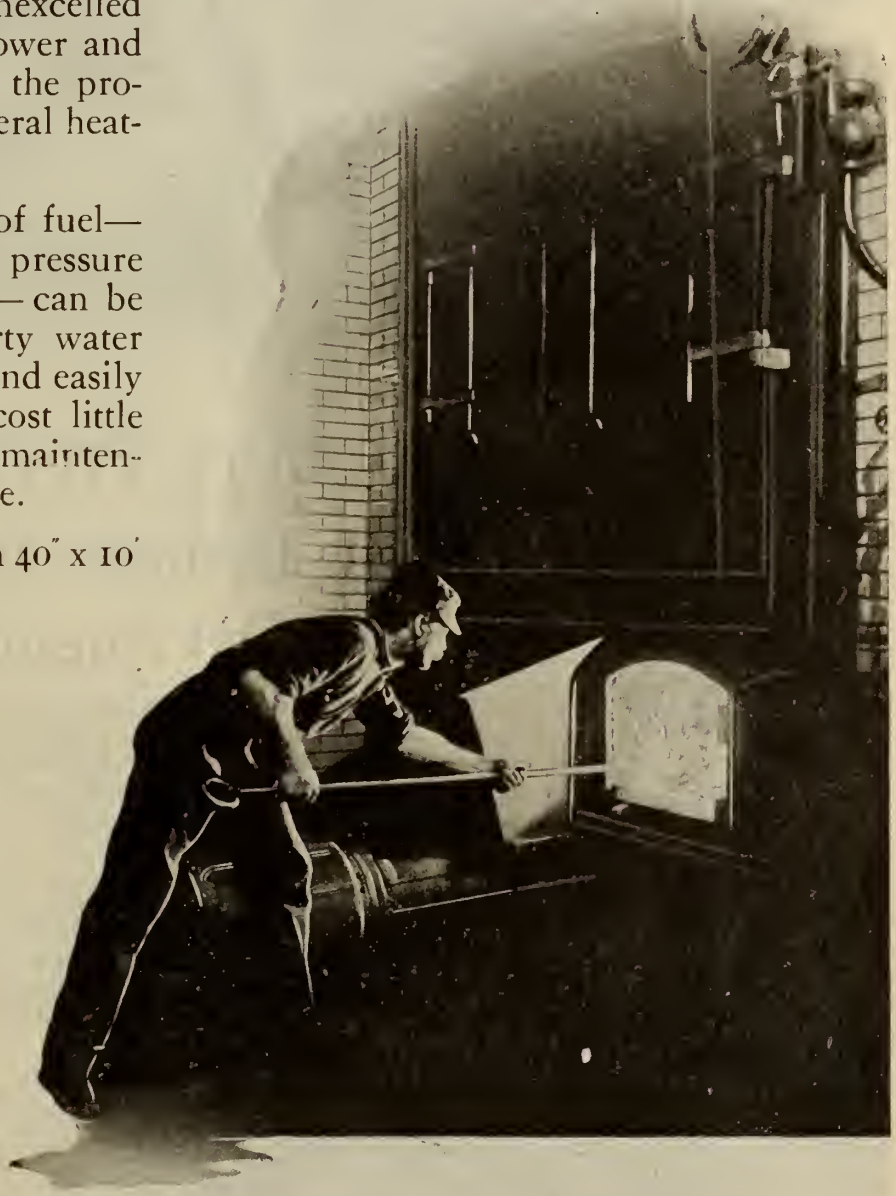

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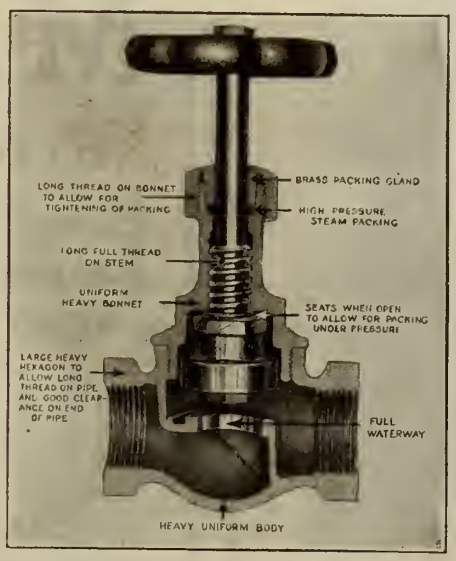
Ontario .....No. 1755


LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
BRASS PACKING GLAND
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREAD ON PIPE AND GOOD CLEARANCE ON END OF PIPE
FULL WATERWAY
HEAVY UNIFORM BODY

EMPIRE MANUFACTURING CO., LIMITED

LONDON and TORONTO, CANADA

TALBOT

Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)

SAVE ONE-SEVENTH THE SPACE OF THE ORDINARY BOILER.

NO BRICKWORK IS NECESSARY.

COST OF OPERATION LOWER THAN ANY KNOWN POWER PRODUCER.

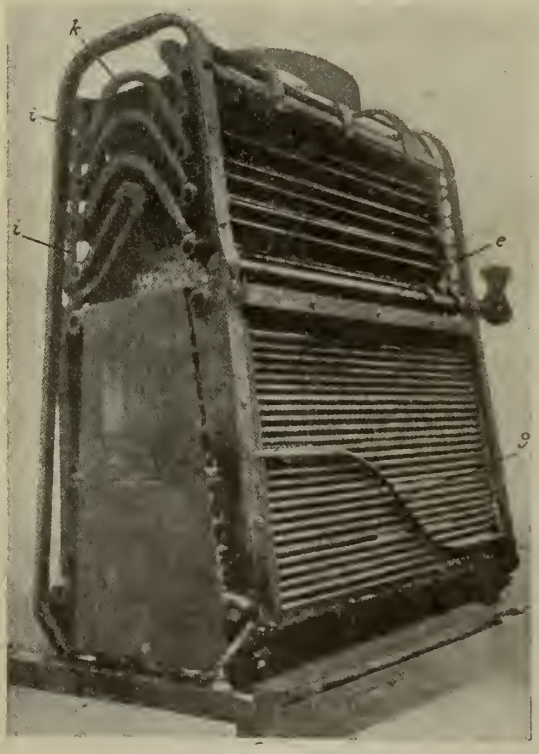
Water enters near the stack and leaves in the form of steam near the furnace.

No water drum. Circulation is through water tubes and is forced at a high velocity by means of a pump.

No Steam Drum.

By preventing gravity circulation the steam is drawn directly from the lower tubes.

The boiler is internally fired, and hence self-contained. Feed water and fuel burners are automatically controlled to adjust the boiler to widely varying demands for steam.



Head of Boiler Casing Removed

Tubes easily replaced under reduced steam pressure. Write for Catalogue B.

Canadian Manufacturers and Sales Office:

Montreal General Tool Co., Ltd.

675 Notre Dame, Maisonneuve

MONTREAL, P.Q.

Canadian Agents:
Engrg. Specialties Co.
Toronto, Ont.

Jenkins Bros.
300 W. Lake Street
Chicago, Ill.

93-33

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

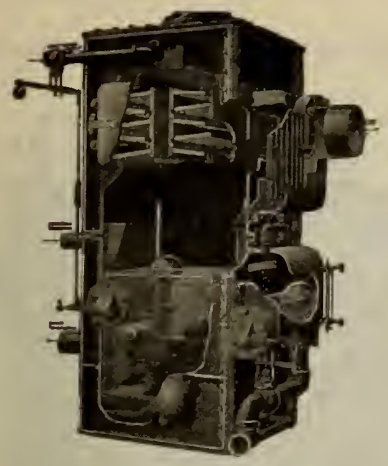
If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company

BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.



Cochrane Heater and Receiver for use with exhaust heating and drying systems.

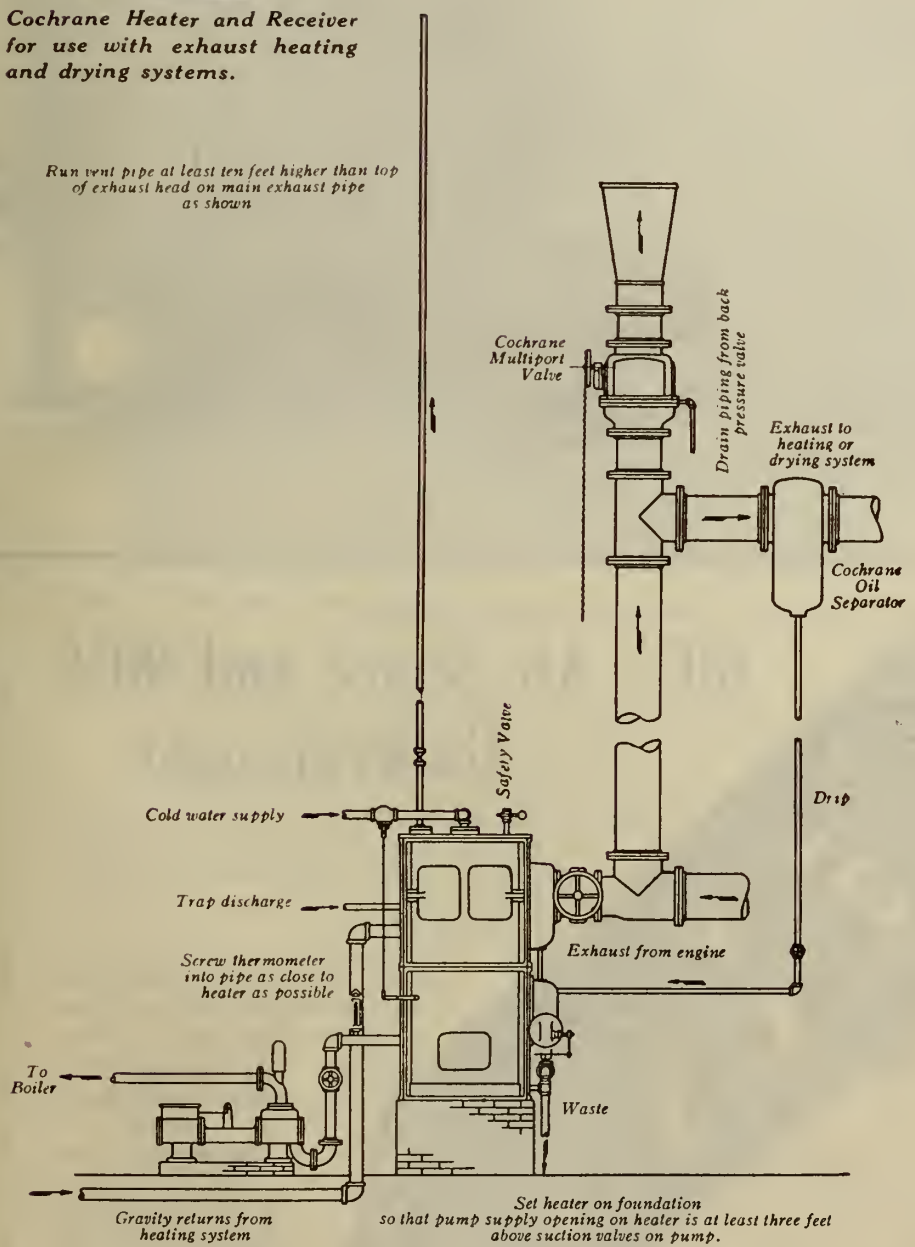
Value of a Cochrane Feed Water Heater

Heating boiler feed water by means of exhaust steam effects a very considerable saving in fuel. The heat imparted to the water in the feed-water heater takes the place of an equivalent amount of heat from fuel on the grates. If the water is heated from 60° to 210° F., the fuel saving amounts to, approximately, 14%, or 1% of fuel is saved for each 11° F. rise in the temperature of the water.

The importance of having the right kind of feed-water heater is shown by the fact that a difference of 1, 2 or 3% of the yearly fuel bill will, in most cases, cover the entire cost of a heater of any type. For example, a 500 H.P. plant running 10 hours, 310 days per year, will use about 3,100 tons of coal per year, worth, at $3 per ton, $9,300. One per cent. of this is $93, and if we assume the interest charge on the heater to be 5%, and depreciation, maintenance, etc., to be 10%, making altogether 15%, the $93 or more with a Cochrane Heater will save over a closed heater for instance will justify the investment of $93÷.15, or $620, that is, $93 is the annual charge on $620 at the rate of 15%. If 2% is saved by the Cochrane Heater over the saving by the closed heater, the excess value of the Cochrane Heater over the closed heater will be doubled, that is, it will be $1,240.

No saving of fuel is realized where the water is heated by an injector or by a live-steam purifier, since both devices first draw from the boiler the heat which is to be imparted to the water, whereas in the exhaust-steam heater a waste product is utilized.

The use of exhaust steam for heating the boiler feed water adds to the boiler steaming capacity; since, as part of the heat is supplied to the water in the heater, the boiler is able to make more steam with a given amount of heat supplied by the fuel. Roughly, six boilers and a Cochrane Heater will make as much steam, with less fuel and labor, as seven boilers without a heater.


Run vent pipe at least ten feet higher than top of exhaust head on main exhaust pipe as shown
Cochrane Multiport Valve
Drain piping from back pressure valve
Exhaust to heating or drying system
Cochrane Oil Separator
Safety Valve
Drip
Cold water supply
Trap discharge
Screw thermometer into pipe as close to heater as possible
Exhaust from engine
To Boiler
Waste
Gravity returns from heating system
Set heater on foundation so that pump supply opening on heater is at least three feet above suction valves on pump.

COCHRANE 5000 SERIES---FEED WATER HEATER

Method of making Exhaust Connections to Heater. Independent Cochrane Oil Separator in Horizontal Line Leading to Heating System.

CANADIAN ALLIS-CHALMERS, Limited

Head Office: TORONTO

Branch Offices: Montreal, Quebec, Halifax, Sydney, St. John, Ottawa, Hamilton, London, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Nelson, Vancouver and Victoria

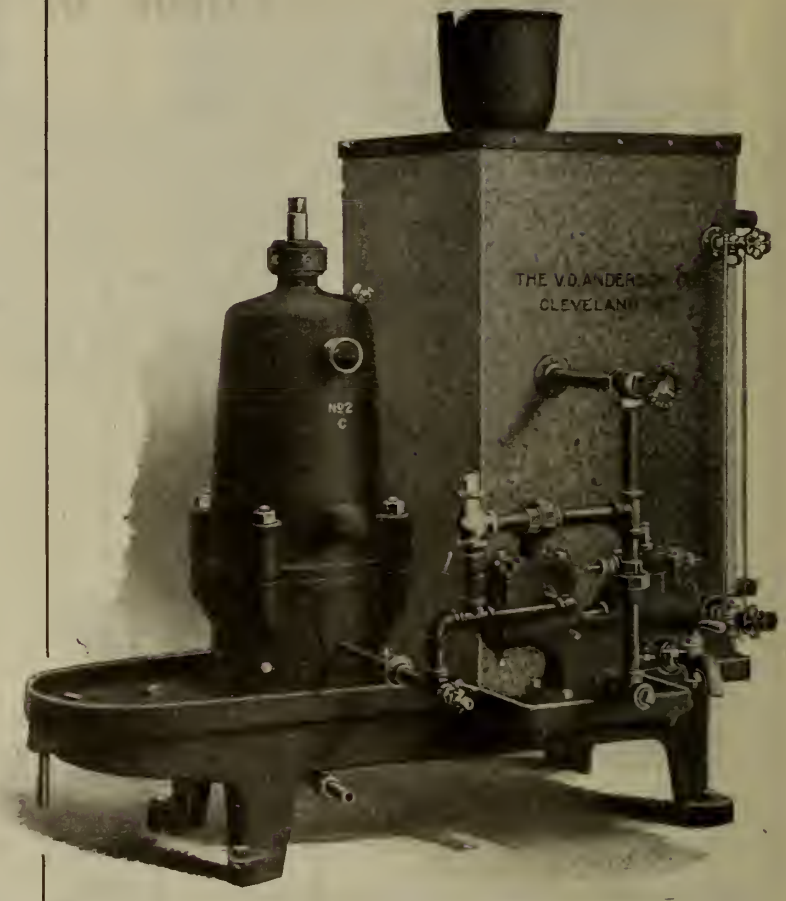
ANDERSON OIL FILTER

Cuts Oil Expenses in Half

How much oil is going to waste in your plant?—lost on the floors, soaked up in rags and waste? Stop this dead loss! Cut your oil expenses in half! It is easily done. Place drip pans beneath engines and machinery. Then pass this oil through the **Anderson Filter** and you will have oil just as **clean** and as **pure** as the new oil you purchase.

You can use oil over and over again with the **Anderson** on the job. No other filter will do the work like it.

Pay you to install the **Anderson** without delay. Let us hear from you and we will give you the full details.



The V. D. Anderson Co.
West 96th St., CLEVELAND, Ohio

Cyclone Grates

60% Air Space and 90% Underdraught

Insure combustion that is perfect. For this reason soft coal, the highest grade hard coal or cheap screenings can be burned on **Cyclone Grates** with absolutely no clinker formation and positively no loss of fuel energy.

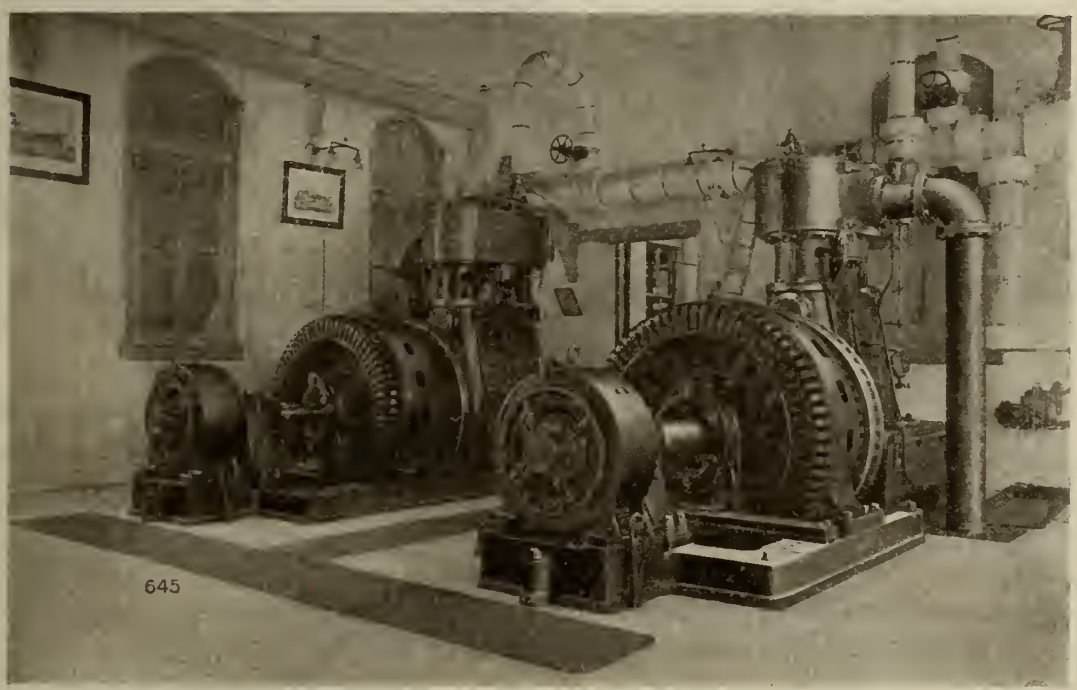
Your engineer can install Cyclone Grates without delay or trouble, and **the 30-day trial offer period is long enough to prove their worth to you.**

The Canadian Steam Boiler Equipment Co. Limited
Sole Makers for Canada
20 McGee St., Toronto, Ont.

AGENTS: St. John, N.B.: F. W. Blizzard, 329 Charlotte St.; Montreal, Mason Regulator Co., Ltd., St. James St.: Hamilton, Robt. Fitzsimmons, 8 Grove St.; Winnipeg, Vulcan Iron Works; Ottawa, J. W. Anderson, Room 7, Bank St. Chambers.

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss Engines at Verdun, P.Q., Waterworks

Steam and Exhaust Turbines
Diesel Engines, Air Compressors
Condensing Plants, Steam Engines

Heanan Refuse Destructors
Air and Water Coolers
Dynamometers

Paterson Water Softening Plants

Centrifugal Pumps

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

GARLOCK PACKINGS

"SPARE THE ROD"

Dust and grit are as injurious to piston rods as inferior and poorly lubricated packing. All styles of Garlock Ring Packing are enclosed in press-board tubes and are packed in cartons that are practically dust-proof, which not only prevents accumulation of dirt and grit on the packing but likewise prevents drying out of the lubrication.

On the blank lines of the label attached to the end of each box of Garlock Packing are entered the name of the rod for which the packing is intended and the order numbers, section number and style number of packing, which enable a customer to reorder a box of packing without remeasuring the rod and without likelihood of making mistakes in specifications.

Our packings are billed at net weights; the weights of boxes and tubes are not included.

The Garlock Packing Company

HAMILTON, CANADA

BRANCHES:

Montreal, Quebec - - 409 Shaughnessy Building
Toronto, Ontario - 404 Continental Life Building
Winnipeg, Manitoba - - - - - Galt Building
Calgary, Alberta - - - 211 Eight Avenue West

Municipal engineers demand efficiency—and insist on economy of operation. Power plant equipment, to secure the approval of public engineers, must measure up to the highest standards.

This 22" COPPUS Turbo Blower in the City Hall at Montreal, Canada, has been burning bird's-eye with economy, and holding steady steam pressure without difficulty for many months. Here, as in thousands of plants the world over, COPPUS Blowers burn cheap coal, save time, labor and money, and greatly increase plant efficiency.

That COPPUS Blowers are recognized as leaders in their line is evidenced in the fact that three-fourths of all the blowers made in America bear our trade-mark. Ask our engineers to show you how "COPPUS Equipment can save you money." Write for Blower Catalog H6.

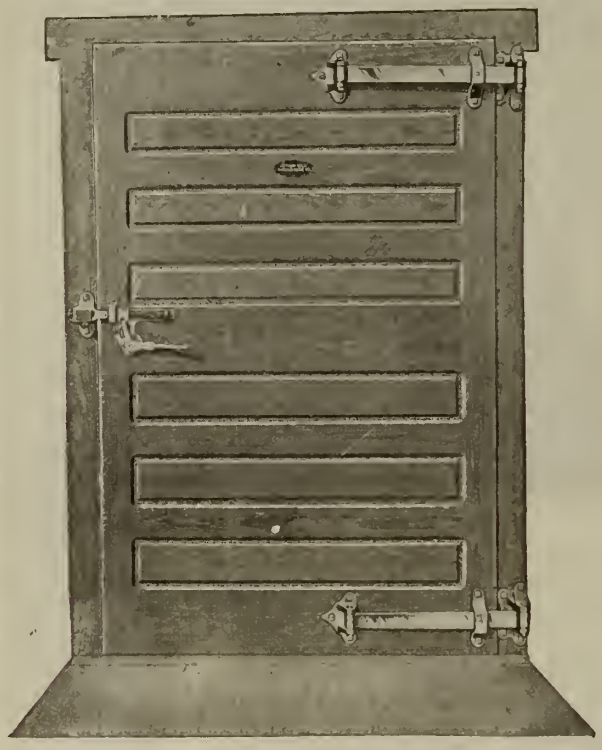
THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

Manufacturers of COPPUS Turbo Pumps and COPPUS Power Turbines

341 PARK AVENUE WORCESTER, MASS.

Agents for Montreal: Mason Regulator & Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Building.

COPPUS TURBO BLOWER



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

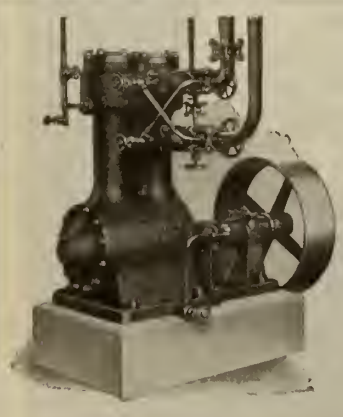
THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. HAGERSTOWN, M.D., U.S.A.



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

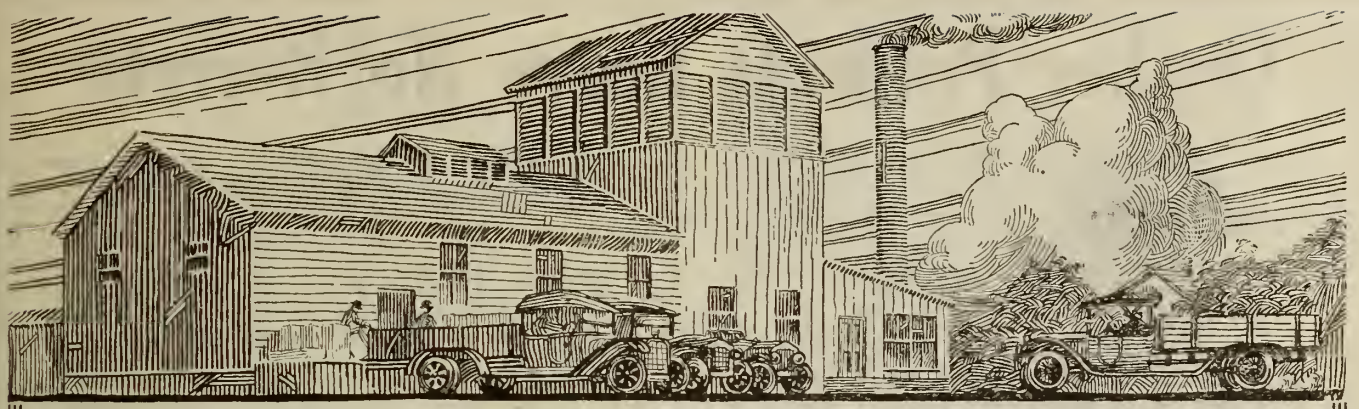
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



ICE PLANTS equipped with

FRICK Ice-Making Machinery will go a long way in supplying this season's enormous demand for Ice.

Durable and Efficient under heavy loads FRICK Machines maintain their superiority established 37 years ago.

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of "Ice and Frost."

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

1,000% on the Investment

Suppose you have a 3-inch brine line in your plant, 120 feet long, carrying brine at 15° F. If it were insulated with the proper thickness of

Nonpareil Cork Covering
For Cold Pipes and Tanks

at least $216.00 worth of refrigeration would be saved per year, figuring the cost of refrigeration at 75 cents per ton.

Now it is not at all uncommon for Nonpareil Cork Covering to give continuous, satisfactory service for at least ten years, if properly installed and cared for. Therefore, during its lifetime the covering would save $2,160.00—which at present prices for Nonpareil Cork would represent a return of over 1000 per cent. on the original investment.

Nonpareil Cork Covering installed in 1903 in the Sinton Hotel, Cincinnati, Ohio. This photograph was taken 11 years later and shows the Nonpareil Cork to be in perfect condition.

This shows clearly the advantage of insulating your cold pipes with a material that is not only efficient at the start, but which will retain its efficiency and will withstand hard service for long periods. Each year that covering keeps the heat out and the refrigeration in, means just that much money in your pocket.

In the 64 page book, "Nonpareil Cork Covering for Cold Pipes," there are complete tables which make it easy for you to figure out how much refrigeration Nonpareil Cork will save in your plant. A copy of the book will be sent free of charge on request.

ARMSTRONG CORK & INSULATION COMPANY
504 McGill Building, Montreal, Que., Canada
Also Manufacturers of Nonpareil Corkboard for Cold Storage Rooms.

Quality Products Leave No Regrets

York Ice-making and Refrigerating Machinery is not made to fit the price. We have a standard of quality and service which has been maintained ever since the York Organization was started.

It is betraying no secret to say that many owners of ice-making and refrigerating plants have expressed to us, by word and letter, their keen regret at having turned down a York contract because the price seemed too high.

Price is a poor gage to use in buying such important equipment as Ice-Making and Refrigerating Machinery. Confidence is a better one. You know from your own experience that business born of confidence begets new business.

No customer can truthfully say that the York Organization ever tried to take advantage of him. It is on this basis that we have been selling our products, and it is for this reason that we have been successful.

An inquiry from you will be appreciated. You are not obligated to buy York equipment until you are satisfied as to its quality and our good intentions.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 304 Craig St. West | CALGARY 605 Second St.

Pure Corkboard

Made in Canada

A New and Important Source of Supply

All buyers know that the sources of supply of pure Compressed Corkboard and Granulated Cork are few—too few—and the output entirely inadequate at times—an unhealthy situation for the buyers.

Therefore, you have special interest in this *new* and *important source of supply,* large in volume, fine in quality and right in price.

It offers you added *security* both as to *cost* and *deliveries.*

Pure Corkboard is now a necessity to the refrigerating industries, which use many millions of square feet yearly in the insulation of more than eighty per cent, of new construction and repair work.

We are prepared to handle your complete requirements, either for material only or installed in your building. Write us to-day and we will gladly give you full information and quotations.

Canadian Corkboard Company Limited

Head Office: 17 Adelaide St. East, TORONTO

Works at Port Colborne, Ont.

Get The Most Out Of It

"In every business club you will usually find two classes of members, those who get nothing out of their membership and those who find it the best investment they ever made." (Class).

But the man who gets nothing out usually puts nothing in but his application and fee.

Are you getting all you can out of your investment in POWER HOUSE?

Here's an engineer who is: **"I consider POWER HOUSE the best paper in Canada, as it touches on local power plant equipment and problems as no other paper does for the engineers."**

Another engineer writes that by studying the editorial pages he gets great help and by reading the advertising pages he learns all about the latest equipment. He says: "The circulars about new equipment usually are kept in the offices, but POWER HOUSE reaches the engineer straight."

Get the most out of Power House by reading it from cover to cover.

The All-round Boiler Room Instrument---*The Fireman's Guide*

THE IMPROVED

BLONCK

Boiler Efficiency Meter

Let us demonstrate this meter to you at your plant, or at our office. We have a model boiler and an actual meter, and can demonstrate all conditions that take place in the furnace. Let us show you how the BLONCK will save money, worry and trouble.

Keep perfect tab on steam generated or steam sold by installing a

REPUBLIC FLOW METER

Republic Flow Meters for measuring air, gas and water will prove an economical and profitable investment.

Republic Flow Meters appeal to engineers because of their accuracy and easy reading.

For full particulars, write—

Sole Ontario Representatives:

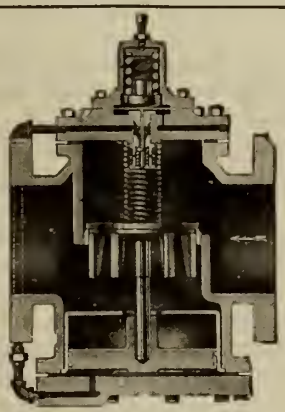
E. J. PHILIP & SONS

103 Hamilton Trust Bldg. Toronto, Ont.

Republic Flow Meters

For Steam, Water, Air or Gas

Stokers, Turbo-Blowers, Power Plant Appliances



Kieley & Mueller Specialties

Regulating Valves
Back Pressure Valves
Pump Governors
Separators
Traps

FOR EVERY SERVICE

SALES ENGINEERS

THE ARTHUR S. LEITCH CO.

TORONTO

Firing that is Different

WITH the RILEY STOKER the coal is fed—the fire cleaned—the ash discharged, *continuously* and *automatically*. All done without waste or effort, efficiently and economically.

It is not only the things the RILEY STOKER does but the way it does them. For instance, when steam is wanted quickly and time is precious, you can get this steam instantly and economically by increasing the motion of the grates.

With the first turn of the cranks the grates start moving—the whole fuel bed is thrown into action. There is no watching or waiting—poking nor slicing—the stoker responds instantly and in two or three minutes the boiler will be operating at 200 or 250% of rating.

It is this kind of flexibility that saves not only for the central station but for the industrial plant.

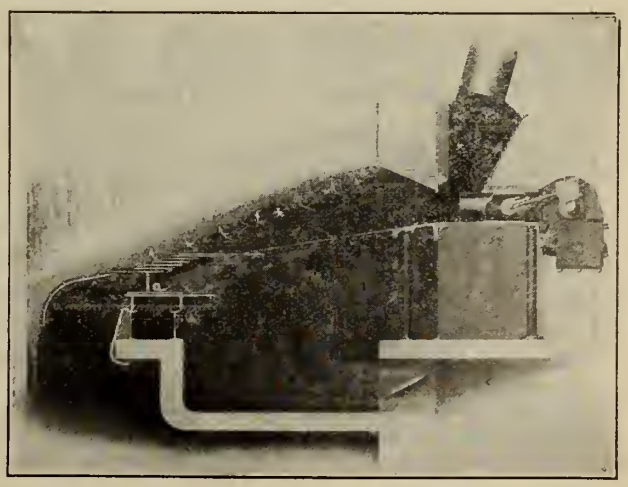
Riley Stoker Catalog HR-5 sent on request

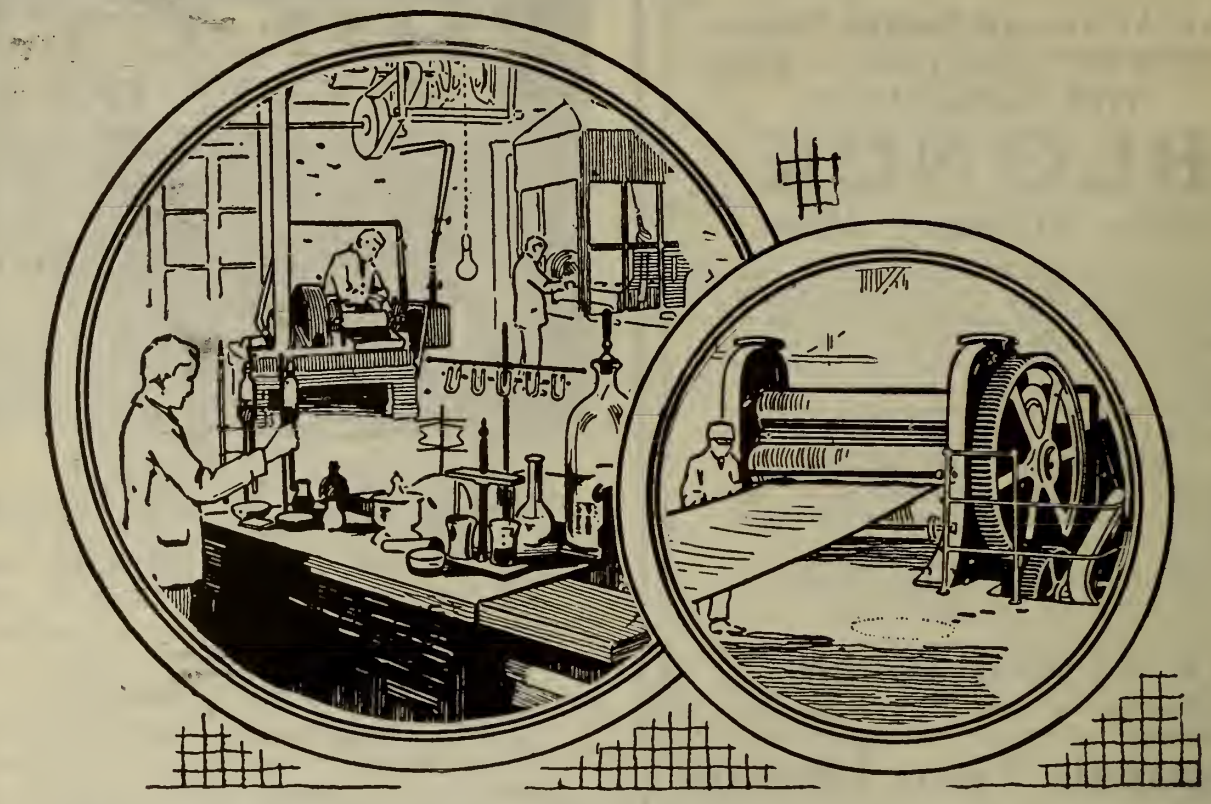
For information on Murphy Automatic Furnaces for small boilers, see April 25th advertisement or send for Murphy Furnace Catalog H M-5.

Sanford Riley Stoker Co.

WORCESTER, MASS.

British Licensees: Erith's Engineering Co., Ltd., London. French Licensees: Erith Leroy & Cie., Paris, France.





The Quality Standard That Produces "Plus Service" Belting

The only sure way to get satisfactory service is to buy products of known worth.

In Dominion Rubber System Belting, the worth is known because every ounce of material—each individual operation and each finished belt must test up to the highest quality standard ever made for belting.

From the time the materials come into our factory until the belt is running on your pulleys, there is no chance of your getting anything but "plus service" belting.

This is the result of over fifty years of belt making experience and research by the oldest, largest and most completely equipped rubber organization in Canada.

The rubber that goes into Dominion Friction Surfacing Belting is not a mere waterproofing substance—our chemists have given it a far greater value by making it into a friction compound that prevents practically all power wastage on the pulleys.

"Plus service" includes the free technical advice of our belting engineers who are ready to help you with your transmission and conveying problems without placing you under obligation to us.

A phone call, wire or letter to our nearest branch places all of our facilities at your disposal.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Service Branches:

Halifax,	Toronto,	Fort William,	Edmonton,
St. John,	Hamilton,	Winnipeg,	Calgary,
Quebec,	London,	Brandon,	Lethbridge,
Montreal,	Kitchener,	Regina,	Vancouver,
Ottawa,	North Bay,	Saskatoon,	Victoria.

The Publisher's Page

TORONTO MAY 5, 1919

"The Only Way"

Efficiency—that's the word. But it must become a reality in equipment and service, otherwise it is meaningless. We find that the engineers are definitely interested in everything that will contribute to their personal efficiency in knowledge and mechanical achievement. Every man wants to be and do his best. The day for the man who "don't care" is gone.

Our investigations have resulted in the conclusion that the editorial and advertising pages of POWER HOUSE have definitely contributed to the development of the engineer. We *know* of many instances where the advancement of men was the result very largely of their studying the editorial and advertising pages of POWER HOUSE. They have said so.

A well-known engineer in Hamilton, Ontario, wrote us on April 10, as follows:—

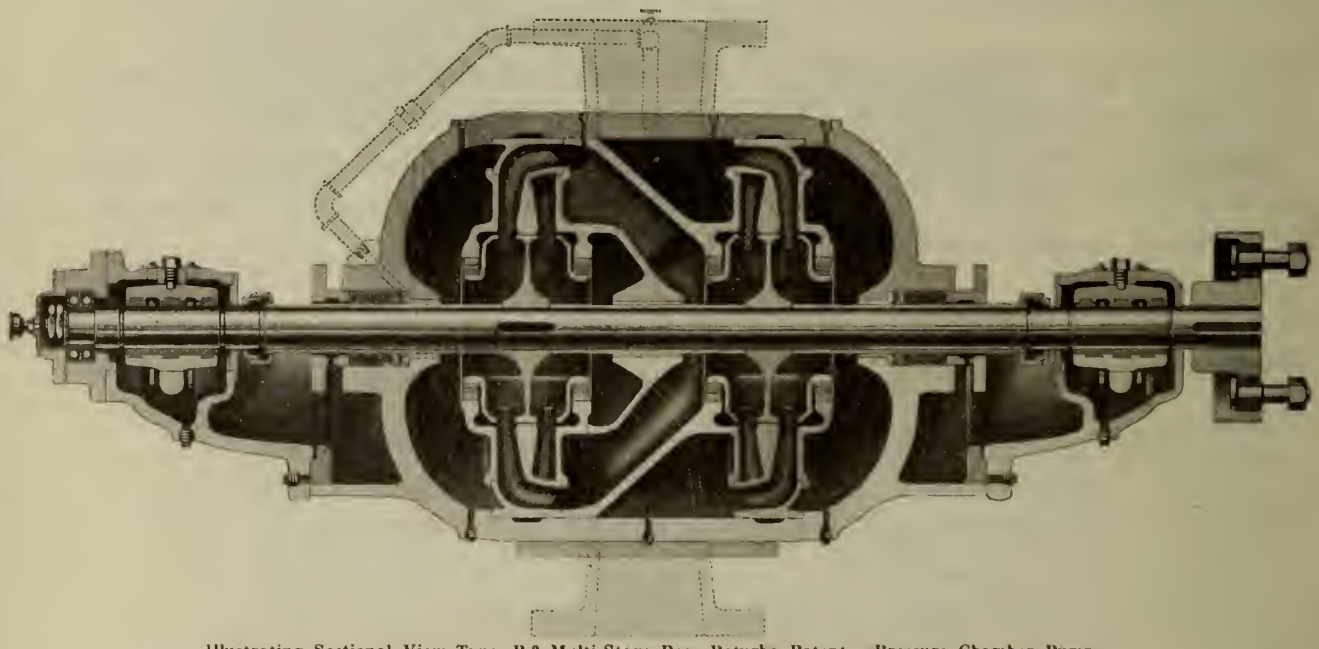
> *"I think the advertisements are good and I read them all the time. If it were not for the advertisements an engineer would not be able to keep up-to-date on new equipment. It is about the only way that we learn about anything new. Circulars are mostly kept in the offices."*

The latter part of this letter is significant—and shows the value of advertisers using their space for the purpose of presenting the merits of their products—the story really reaching the men who ought to be acquainted with the name and line. The engineer's influence on the buying of equipment must be appreciated. Their opinion is largely the basis of decision on the selection of equipment. The other day we saw two engineers in the office of a leading manufacturer of boiler room equipment, and *they* were making the decision regarding the merits of the article, and were recommending the purchase to the general manager of their plant. They were both readers of POWER HOUSE and the article was an advertised product. POWER HOUSE is the reader's one sure avenue of reliable information regarding efficiency in equipment and service.

REES RoTURBo

Pumping Machinery

Is in use all over the World in Waterworks, Mines, Power Stations, Irrigation Works, Pulp and Paper Mills, Salt, Chemical and General Industrial Plants where highest efficiency, reliability and the best class of Engineering are demanded.



Illustrating Sectional View Type, B.2 Multi-Stage Rees Roturbo Patent Pressure Chamber Pump.

REES RoTURBo Pumps provide a high and sustained efficiency over a wide range of duties. This means a very noticeable saving in power costs.

The Self-Regulating feature of RoTURBo design is responsible for this saving, and this same feature protects your Prime Mover from overloads on a decreased pressure head, eliminating expensive delays and costly repairs.

Our RoTURBo Pump and Condenser Catalogues, full of valuable information, are yours for the asking.

Sole Canadian Manufacturers

The Goldie & McCulloch Co., Ltd.

Head Office and Works, GALT, ONTARIO, CANADA

Toronto Office	Western Branch :	Quebec Agents :	British Columbia Agents :
Suite 1101-2,	248 McDermott Ave.,	Ross & Greig,	Robt. Hamilton & Co.
Bank of Hamilton Bld'g	Winnipeg, Man.	400 St. James St.,	Vancouver, B.C.
		Montreal, Que.	

POWER HOUSE

Established 1907

Published Semi-monthly

The Plant of the Western Canada Power Company

A Hydro-Electric Plant in British Columbia Operating at 125 ft. Head, Supplies Vancouver With Power for Industrial Purposes—Provision for Extension Has Been Made

By F. C. PERKINS

THE accompanying illustrations show the hydro electric plant of the Stave Falls water power development in the Province of British Columbia and the hydraulic turbines and electric generators in service. It may be stated that the Western Canada Power Company, Limited, was formed for the purpose of supplying power for industrial purposes in Vancouver and the vicinity, so as to encourage the establishment of factories, and in sufficient quantity to meet any demand that the growth of Vancouver may develop. Several years ago the company took over the property and franchises of the Stave Lake Power Company, Ltd., which had secured a charter from the Government of the Province of British Columbia, giving it the right to develop power on the Stave River, and to distribute power over the whole of the district surrounding Vancouver, and had also secured franchises for the sale of power for industrial purposes in Vancouver and New Westminster.

The Stave Lake Power Company had in the course of several years done a considerable amount of preliminary work at the Stave River, including the establishment of a gauging station, the building of roads and camps, and the partial construction of a log sluice dam. The Western Canada Power Company, Ltd., commenced the construction of a 50,000 h.p. power plant, and the first section of this house, comprising two units of 9,000 K.W. capacity each, was completed and power was delivered in Vancouver on January 1st, 1912.

POWER HOUSE, STAVE LAKE.

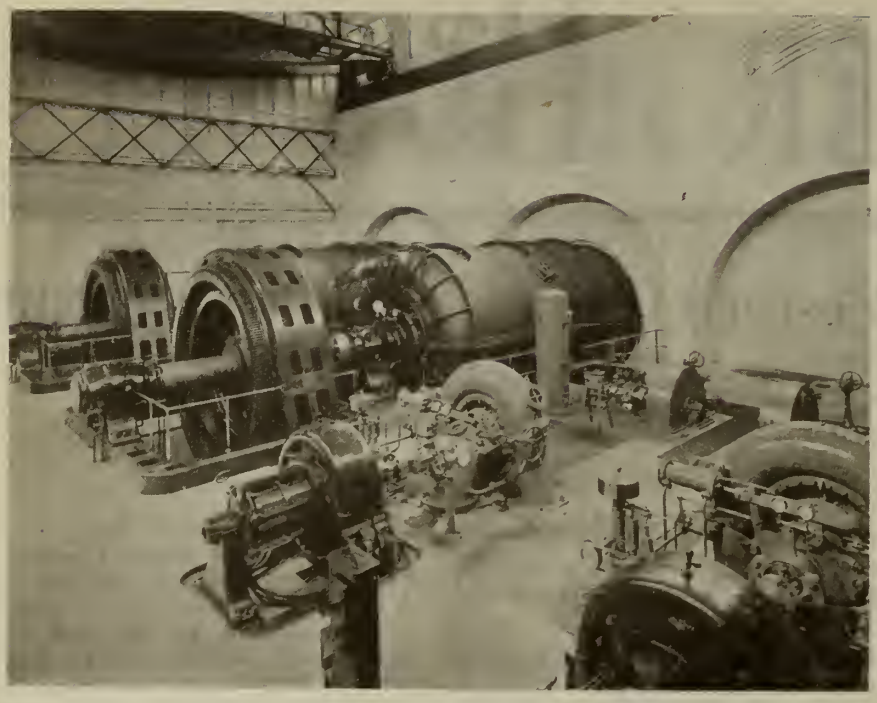
The site of the power development is at Stave Falls, about six miles north from the junction of the Stave and Fraser Rivers at Ruskin, B.C., and thirty-five miles east of the City of Vancouver. The mountains forming the watershed are granite; they rise high above the timber line, and are covered with snow and small glaciers. The upper river is a large glacier-fed stream, and several smaller streams empty into the lake, some coming direct from the glaciers on the high mountains on the west side of the lake.

It is of interest to note that the lake is nine miles long and about a mile or more wide. The east and west shores are precipitous, but at the head and foot there are large areas of low lying land, which are flooded during high water. From the foot of the lake to the Stave Falls the river is seven miles long, about two miles of this having been rapids, with a total fall of 11 feet, the rest being navigable at all stages of the river and having practically no fall. At the falls and the rapids, in the immediate vicinity of Stave Falls, the river drops 80 feet, and then continues on its course over a series of rapids for a distance of four miles, finally debouching through a narrow granite gorge into a tidewater basin, where it joins the Fraser River.

The total fall from the original low water level of the lake to tidewater was 225 feet, and when the dam which has now been constructed, has been increased to its full height, the water will be raised 35 feet above the low water level. The dam forms a lake extending from Stave Falls to the upper end of Stave Lake, a distance of 18 miles. The area of the lake at the present height of the dam is about 13 miles, and when the dam is completed to its full height the area will be 24 square acre feet, which is large enough to store the flood water so that the total mean flow of the river will be made available for the generation of power. Daily gauge records of the flow have been kept for over six years; during the past three years a careful series of hydraulic observations have been made, and the mean flow has been found to be 3,500 cubic feet per second that can be utilized for the purpose of generating power.

The total fall from lake to tidewater will eventually be made use of in two power houses; the upper plant, which is now in operation, utilizing 125 feet maximum and 105 feet minimum head, and the lower plant utilizing the balance. The site of the first development was chosen in the vicinity of Stave Falls; at this point the river is divided into two branches by a rocky island half a mile long, admirably adapted for the construction of forebay and intake works, while an old channel, known as the Blind Slough, with a rocky bed some 600 feet wide at a higher level than the bed of the existing river, presents a most excellent site for a dam to provide for the flood discharge.

The second development will consist of a dam 160 feet higher at the highest point, built in a narrow gauge between to form a reservoir about three miles long, backing the water up to the tail-



STAVE FALLS DEVELOPMENT, GENERATOR ROOM, STAVE FALLS POWER HOUSE.

race of the upper plant. The power house will be located to the east of the dam, with its tailrace on tidewater, within sight of the main line of the Canadian Pacific Railway, and the penstocks for the turbines will be laid in tunnels about 1,600 feet long.

This remarkable power plant, as it now stands, consists of a sluice dam 40 feet high, provided with five sluice ways 22 feet wide to take care of the flood discharge; a solid concrete intake dam, two 14 feet 6 inches steel penstocks, with provision for two more, a power house, with two 10,000 K.W. units and provision for extension of two more, and a tailrace channel 1,500 feet long, excavated in the old bed of the river.

The sluice dam, which was partially built by the Lake Stave Power Company, consists of four concrete piers 8 feet wide, with two abutment piers, the spaces between the piers being filled with 24-inch stop logs, 24 feet long, which can be removed by means of water. The intake work consists of a solid concrete dam about 70 feet high at its lowest point, imbedded in which are the four steel penstocks, which are belled out to 19 feet diameter at their entrance, and taper down to 14 feet 6 inches in diameter where they leave the dam. The entrance to these penstocks are closed by steel radial gates, closing an opening approximately 20 feet square, and designed to operate under a maximum head of 45 feet. These gates are operated by electric winches set on the top of the dam. There are also two 42-inch exciter penstocks, which are closed by radial gates.

In front of the radial gates are set screens of very large area. No special precautions are taken to protect the screens from ice, as it is a peculiar condition of the Stave River that no ice ever forms, even at times when zero weather obtains for as much as a week. The reason of the non-formation of ice is that there is a large overflow from the forests during the winter months which raises the temperature of the water. These dams are at present built to such a height as to store the water about 7 feet above the original low water level of the lake. They are being raised this year, 1914, an additional 10 feet and next year they will be extended another 25 feet in height. The sluice dam, which is being carried to its full height, will be made into a solid dam, and will no longer be used for flood discharges.

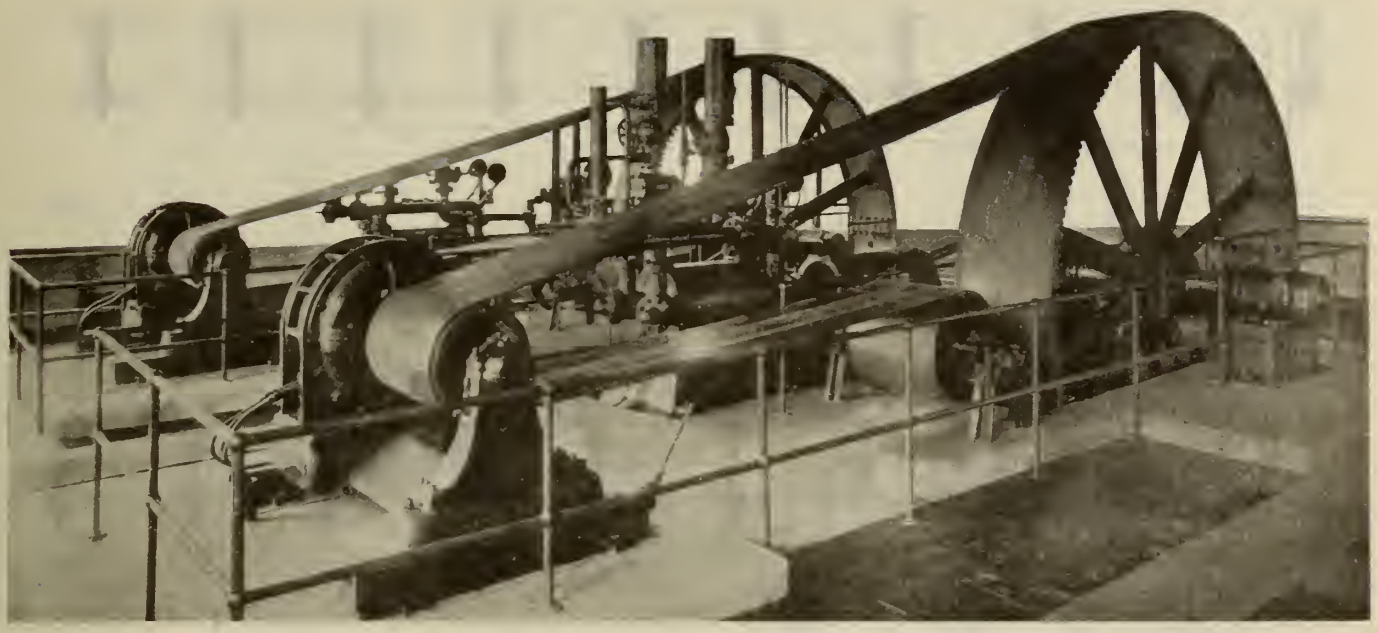
In the new construction the dam which is to be built across the Blind Slough will consist of concrete piers 30 feet high, making 14 sluice ways, each closed by stop logs, which can be removed by an electric winch. Provision will be made in the design of these sluice-ways, so that a stoney roller gate can be placed in any of them if it should be advisable, but the operation of the stop logs has proved so economical and successful for handling floods, that it is not likely that more than one of the sluice-ways will be closed by a stoney gate. The Blind Slough dam will provide for a maximum discharge of 100,000 cubic feet per second. The foundations for the power house were excavated in solid rock. The total quantity of rock excavation for the penstocks, power house and tailrace amounted to 75,000 cubic yards.

A tailrace canal, 70 feet wide, has been designed to run 10 feet deep when all four units in the power house are in operation. In addition to the rock excavation for the tailrace, some 75,000 cubic yards of sand, clay and boulders were excavated by steam shovel. Just below the power house a small V shaped weir was built to hold the water to a proper height to seal the draft tubes. At present the flow of the river is rapid from below the foot of the tailrace, but when the lower plant is built, the water will be backed up to this weir.

The foundations for the power house are of solid concrete construction, and the superstructure is a combined formation of steel and reinforced concrete. The building is 100 feet wide by 90 feet long. The turbine and generator room is 75 feet by 90 feet, and a two storey lean to 28 feet wide houses all the high tension and low tension switches. The control switchboard is on a gallery in a lean-to at the end of the building. The power house is now being extended 70 feet more for the installation of two new units. In the power house are installed at present two 10,000 K.V.A. 3-phase, 60-cycle, 4,400 volt generators, built by the Canadian General Electric Co., driven by two 13,000 h.p. Francis type turbines built by the Escher Wyss Company, of Zurich, Switzerland. Excitation is provided by two 250 K.W. 125 volt generators, each driven by its own turbine, and each capable of exciting four machines.

The writer is indebted to J. T. Johnson, hydraulic engineer of the Dominion Water Power Branch, for the accompanying photographs, and to Engineer G. R. Conway for the detailed information of this Canadian water power device.

STAVE LAKE



Effective Transmission Most Essential to Economy

Treatment of Shafting, Pulleys and Belting is All-Important—Various Details of Designs and Installations, as Well as Operating Features—Care of Belting and Proper Application of Dressing

By J. H. RODGERS

AMONG the many features involved in the problem of production few are more important than that of effective transmission of power from the primary unit to the machine that is performing the work. Very frequently, output is restricted owing to the failure of some part of the power installation, or the neglect in correcting some fault after the same has become evident. Too much attention cannot be given to this essential feature of plant operation. The treatment accorded to shafting, pulleys and belting, should be considered one of the fundamental details upon which the efficiency of the shop is based. No plant can expect to maintain a high average of production unless the transmission is constantly kept in the best condition. To accomplish this it is very advisable—and in large factories almost essential—to place the maintenance of this branch of the work under the supervision of one experienced party, a man that can give his entire time to the work, and with assistants if necessary. Where every machine operator is permitted to repair his own belts, tighten or adjust pulleys, effective operation is a doubtful factor. While it may be true that some men are thoroughly familiar with the peculiar and ofttimes apparently insignificant features relative to belt repair and upkeep, it is nevertheless good practice to have the transmission maintenance in charge of a man or gang especially selected for the purpose. We say selected in preference to appointed, as it is particularly advisable that the men doing the work of installation or repair, should know why they are doing it as well as how they are doing it. The various conditions under which a belt man has to perform his duties enables him from experience to evolve ways and means to maintain the maximum efficiency from the belts and pulleys under his charge.

The compilation of the following article is the result of observation and experience in the use and abuse of transmission equipment, and is here set forth as an aid to those who have, or may have, to do with the installation and subsequent repair and maintenance of shafting, pulleys, belts and accessories. In the unit system of machine operation, where each tool is driven by its own individual motor, the installation of overhead shafting is seldom required, but where the group system is adopted it is invariably a necessity to have a line of shafting to distribute the power to the different machines located about the shop. In general practice of to-day the group drive is so proportioned that the use of long lengths of shafting is vir-

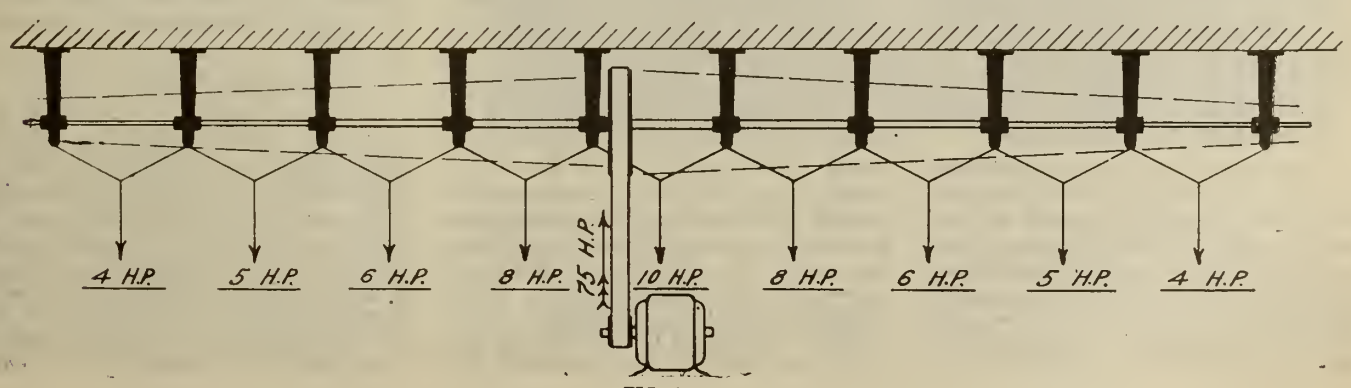
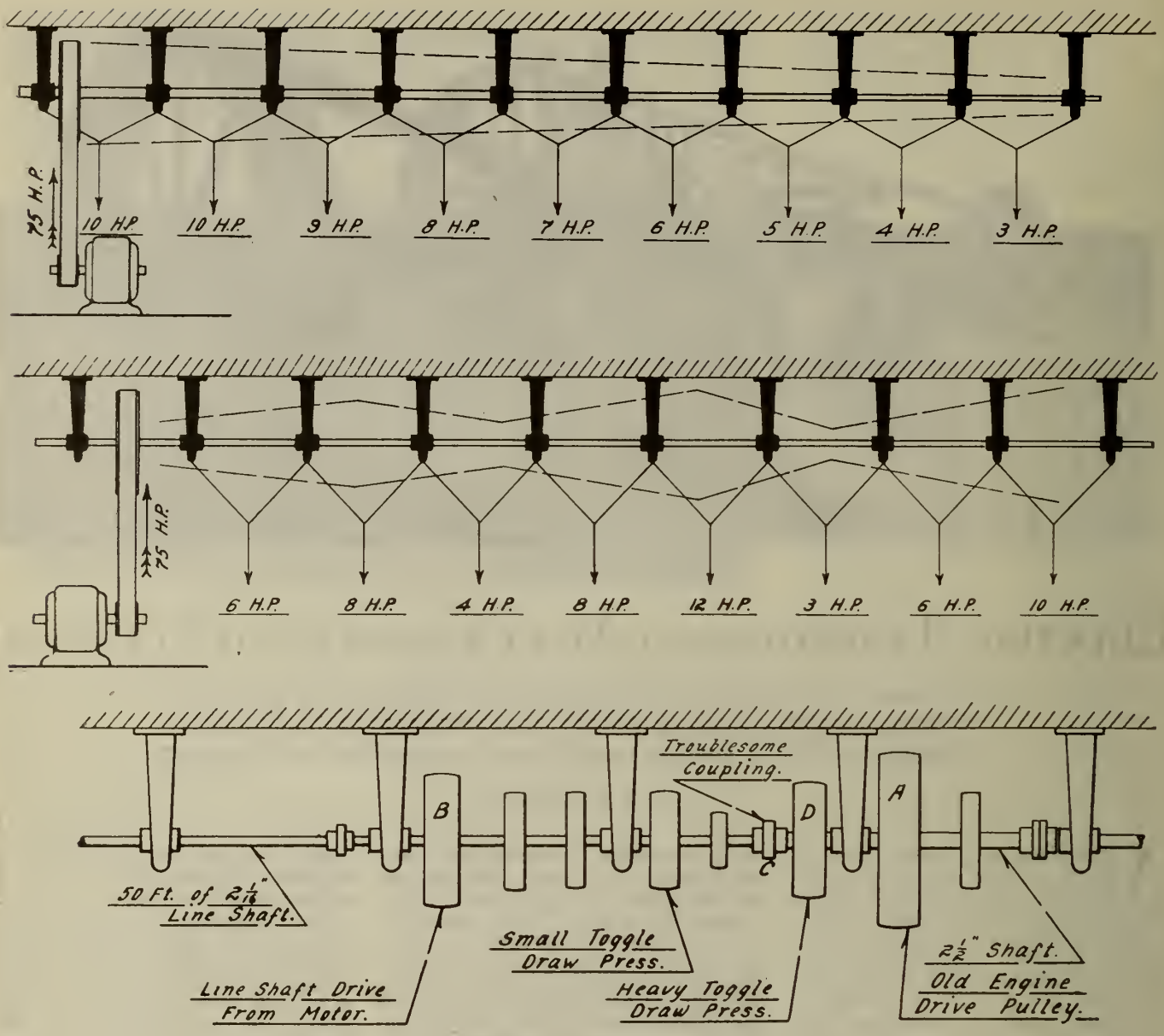


FIG. 1



FIGURES 2, 3 AND 4

tually eliminated, and where main shafts of excessive length are used it is considered an economic feature to arrange the power distribution in such a way as to minimize the torque throughout the shaft. This twisting action may often be so great as to develop a grave source of annoyance and may eventually necessitate the rearrangement of the drive to overcome the trouble. Very frequently, an installation of machinery may be made in a plant, or additional units located in available space, with but little thought of the source or distribution of the power required to operate the different machine tools.

Minimizing the Shaft Torque.

In determining the position of the machines in a group, or when adding a tool to the existing equipment, the volume of power required to operate, and the special purpose of the machine, are two factors that should be given careful consideration. If this is not done the efficiency of the machine may fall below expectations, and be prematurely condemned. Wherever possible—and it is advisable in all cases—the heavier machines that require a proportionately high percentage of power for their operation, and particularly in cases where the consumption of power is spasmodically varied from light to heavy load, should be located as near the source of line shaft power as conditions will permit. While no fixed rule can be applied for installations of this character, owing to the fact that no two plants are identical in their layout or production requirements, a general recognition of stabilized distribution would meet the end desired in practically every instance.

It is seldom that the entire power developed by the engine or motor is consumed in the operation of the equipment, so that in initial installations allowance is always made for subsequent units to be operated from the primary line shaft. The character of the motor support is very important, but is dependable upon local conditions. Good results are obtained by locating the motor on the ceiling or on a specially constructed concrete base. The former practice provides more available floor space, but the latter assures a more stable foundation and more accessible for repairs. Where a support of this kind is not permissible, a substantial timber framework may be constructed to carry the motor, which may be located on the floor, wall or ceiling. The fundamental requirement, however, it to have the support rigid enough to eliminate all vibration, a condition that is invariably the progenitor of many motor troubles.

Location of Motor Drive

It is good practice to locate the driving motor about midway of the line shaft length, as illustrated in Fig. 1. When delivering to, or taking power from a line shaft, it is advisable to place the pulley as close to the hanger as possible, and this rule applies in particular to heavy drives or those where the absorption of power is intermittent, such as the operation of machines requiring a flywheel for stability, as in power

presses, punching and shearing machines, and like equipment. In placing machinery in a shop it should be the practice to locate the heavy tools close to the main drive so that the twisting moment

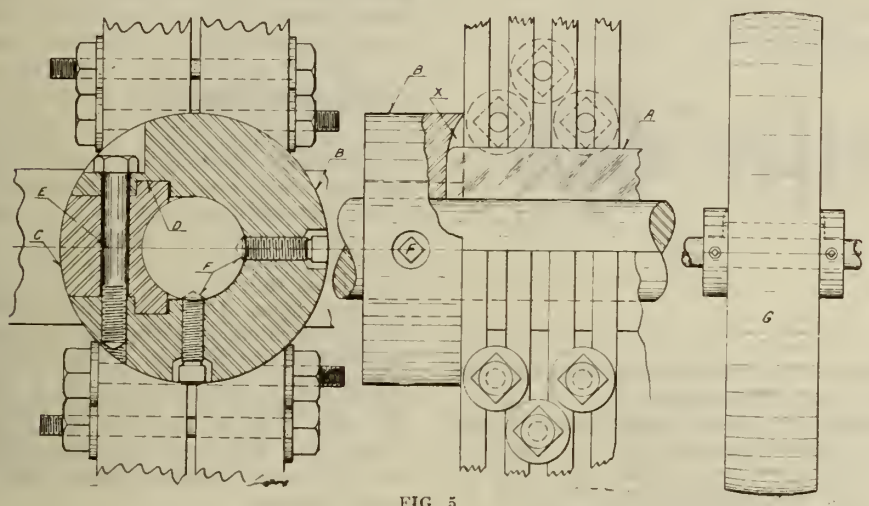


FIG. 5

in the shaft will be kept at the minimum, the lightest tools being situated farthest from the motor. Fig. 1 will serve as a good example of the central drive method; this shows the reducing value of the power delivered when nearing the extreme ends. This, however, is an ideal condition and can only be taken as a guide for an actual installation, theory only serving as an assist to practical adaptability.

When the drive is located at one end of the shaft, as shown in Fig. 2, it is imperative that the heavy machines be placed at the motor end of the shop. The farther such tools are situated from the motor the greater the twisting moment of the shaft and the increased possibility of line shaft. When main shafts are of extreme length it would be well to adopt a reducing size of shaft to aid in overcoming the shaft torque. An example of a line shaft drive that should be avoided is shown in Fig. 3. Here the drive is on the end, the diameter of the shaft uniform throughout its entire length, and the power delivered very irregular, factors that would provide excellent opportunities for inefficient operation. The skeleton lines show the varied fluctuations in the power delivered, and the great possibility of troublesome torque is quite obvious.

Inefficient Installation.

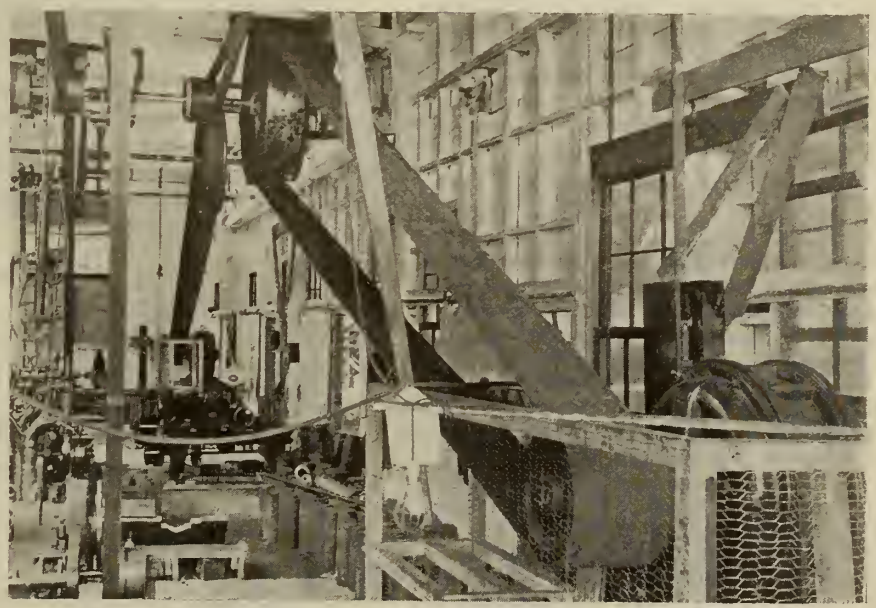
A special instance of ineffective line shaft drive is diagramatically illustrated in Fig. 4. In prehistoric days this shaft was driven by a steam unit belted to the large 6 foot cast iron pulley A, keyed to the length of 2½ inch shaft. The advent of the motor placed the engine in the discard and the new source of power was at the pulley B, the size of the entire line shaft, apart from the length above mentioned, being 2 1-16 inches in diameter. To the left of the drive, pulley B was approximately 50 feet of shafting carrying pulleys for operating various presses and other small tools. To the right were a couple of punch presses and a small draw press. Adjoining the reduction coupling C, and on the larger shaft, was the four foot pulley drive for the heavy drawing press. When the latter was in operation, more especially when on heavy drawn work, the coupling C was a source of constant annoyance, giving out a continual squeak when the full load came upon the press. This particular trouble was laid to the fact that the pulley A was out of balance and had an apparent oscillating motion, due to its poor alignment. Its removal was contemplated on different occasions, but no determined effort was made to do so. It is the writer's opinion, however, that the primary cause of the shaft trouble was the inefficient method of the drive itself, and the location of the heavy draw press in relation to the motor drive.

Cure for Slipping Pulley

In addition to the trouble arising in the coupling C, the pulley D, that operated the large draw press, could not be kept tight on the shaft and would persist in slipping when the extreme load came upon the press; this slip was invariably accompanied by the usual squeak. This pulley was of the wood split type but persistent tightening of the clamping bolts was of no avail. Sand paper and emery cloth was tried between the bushings but only provided a temporary relief. Holes one-quarter inch in diameter were then drilled in the shaft at either side of the pulley and in line, and a 3/16 inch strip of steel placed between the two halves of the pulley, this being the available space after the clamp bolts were tightened. On either end of this strip was a short tit about ⅜ inch long, that entered the holes drilled in the shaft. The clamp bolts were used as a backing to support the steel strip. This served the purpose for a short time but eventually the end tits were sheared off. The final and effective repair is shown in Fig. 5. Two collars B were provided, open on the side for placing over the shaft, and the gaps filled with the piece C, fitted with the tee slots D; the two parts secured by the bolt E. The steel strip A, located as in the previous case, entered a slot X milled in each collar. When in position the collars were secured to the shaft by the set screws F. A general view of the repair is shown at G.

Belts Require Proper Care

Few details in connection with manufacturing receive less considerate attention than that of the belting that transfers the power from the line shaft to the various machines. Many men think that all that is required is a tight belt and all their troubles are over. If the belt is slack, take a piece out and replace the belt. Very good, if this is done with a knowledge of the necessary requirements. Few men will deny the advantages accruing from a well spliced endless belt, but how many of such belts will one see in the average shop, apart



MAIN DRIVE WELL PROTECTED BY GUARD

from those used on the main drives. The general practice on the larger volume of belts used is to cut the belts to the desired length and join by means of lacing or other fasteners. Many types of fast-

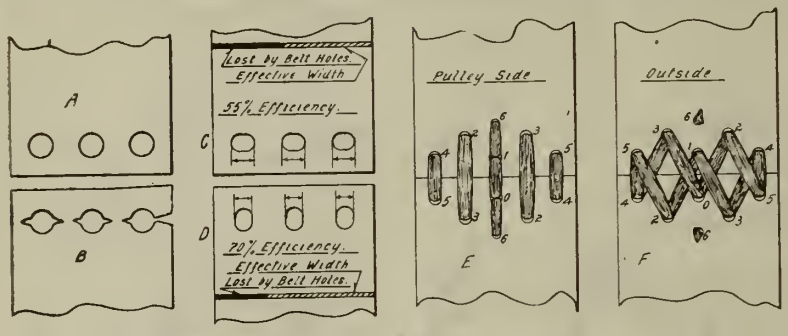


FIG. 6

eners are now in use and are giving very satisfactory results, but few will retain the all-round efficiency of the ordinary leather lace when the joint is well made. One great disadvantage of metal fasteners, particularly where shifting of the belt is to be made by hand, is the dan-

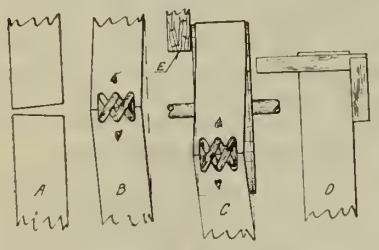


FIG. 7

ger to the operator contingent to the loose end of wire or metal portion. However, where careful attention is paid to such joints they are very effective for continuous drives. Leather lacing, nevertheless, will doubtless continue to be the general practice for belt repairs, owing to its accepted simplicity and general convenience.

Use Small Lace Holes

It must not be taken for granted, however, that all one has to do is to cut off a piece, punch a few holes and secure again with a lace, to obtain an effective drive. The fundamental details of a properly made joint may often seem of little import, but the subsequent operation of the belt may depend, very largely, on the consideration given to these apparently insignificant matters. When making a repair to a belt the beginner will usually make the lace holes of large size as indicated at A, Fig. 6. The inevitable consequence of such practice will be that shown below at B. With very few exceptions a belt will tear across the lace holes and seldom will fail in a direction parallel to the belt length. For this reason it is imperative that the amount of the leather cut out be kept as low as possible, consistent with the size of the belt and the thickness and width of the lace. Where it is necessary to enlarge the holes it should be done as shown at D and not as at C. This is obvious when comparing the resultant efficiency of the belt in each case. The heavy black line indicates the portion of the width cut away by the holes and the shaded line the effective section of the belt. With the same opening for the lace the efficiency of the lower method is 15 per cent. over that of the upper.

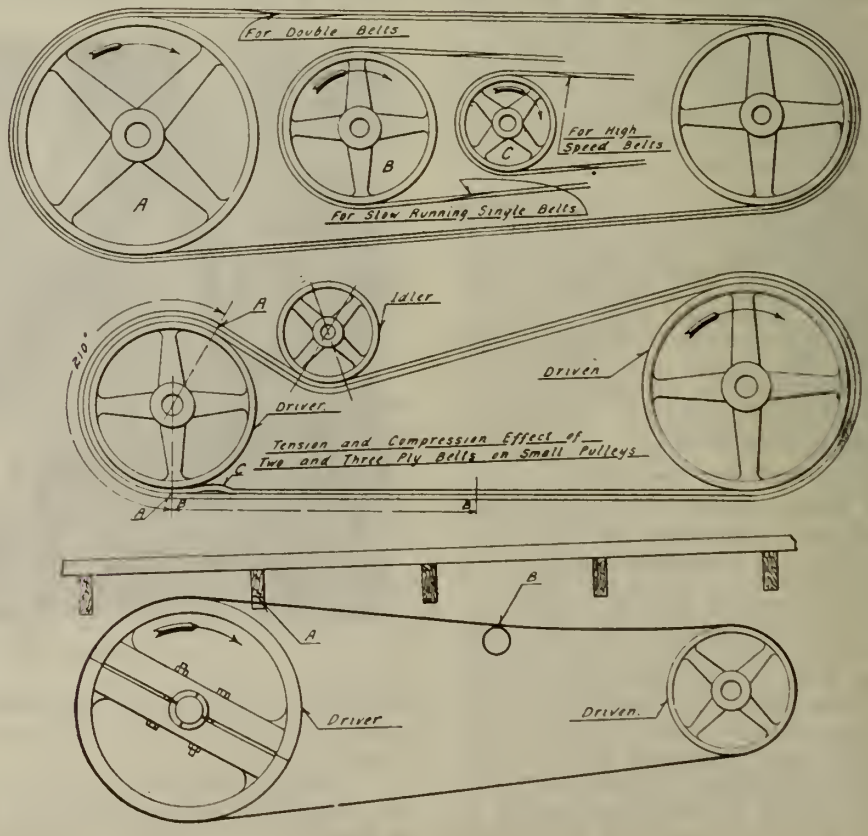
The best side of the belt to run upon the pulley appears to be a debatable question, as many favor the hair or smooth side, while others prefer the reverse. However, as the efficiency of a belt drive relies on the frictional contact between the surfaces it would seem practical that the smooth side would have the preference. Another factor in its favor is that of the recognized fact that the portion of the belt best suited for tensile strength is near the flesh or rough side, and the hardest side best adapted for the compression action; these features being quite evident when belts are operating on small pulleys.

Making a Laced Joint

In making a joint it is advisable to use a thin lace in preference to a thick one. This coincides with what has been said on belt contact, as it is clear that the thicker a lace is the less will the contact be when the joint is passing around the pulley, and in addition the jar will be all the more pronounced. When making a joint the straight lacing should be made on the pulley side. Owing to the different widths of belts no fixed rule can be applied for lacing, but in general the method may be the same for every case. Holes should not be closer to the edge or end than one-half inch, with centre holes spaced accordingly. The best practice is to commence at the centre and work out and back on each side. As a guide the illustration at E and F is given. Starting at 0 and 1 the order is as follows: 2, 3, 4, 5, 4, 3, 2, 1 or 0, both sides of the centre being identical; the locking is performed by passing the free end through a small hole 6, and cutting a short slit to form a hook that will prevent the lace from coming out. This lock should be on the outside of the belt. After the joint is made it may be lightly hammered down with a wooden mallet.

Preparing Belt for Lacing

One of the essential factors of a belt joint is that the ends should be perfectly square with the run of the belt, to assure its smooth running. When cutting a belt the use of a try square, as shown at D, Fig. 7, is always advisable. Without such a tool the tendency is to make an angular cut as at A, so that when the joint is made it has the appearance as illustrated at B. When passing over a pulley the belt develops a tendency to oscillate, and such a condition is very much aggravated when the belt is running a little loose. To prevent it jumping off, a stick



FIGS. 8, 9 AND 10

is frequently secured to some rigid support and extended down at the side of the pulley, as at E. This, however, provides only a temporary remedy for a previous fault, as the weakest portion of the belt—the laced joint—is continually brought into violent contact with this "guide," and eventually the value

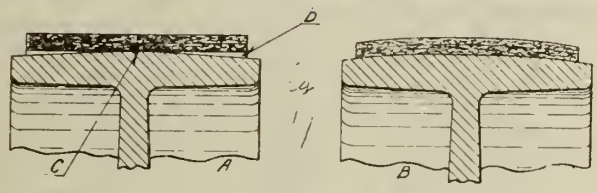


FIG. 11

of the joint is destroyed. Where guides are considered necessary—and they are only required to correct faulty installation or repair—they should take the form of rollers and not as rigid members; this would minimize but not entirely eliminate the source of trouble.

Direction of Travel

Another point that comes under discussion in connection with leather belts is that of the spliced joints, and their relation to the direction of travel. It is quite evident that the thin edge of the lap may show signs of parting after a period of service. For this reason some men contend that the belt should be run with the splice as shown at B, Fig. 8. On this principle the action of the pulley will aid in keeping the thin edge down to its place. On the other hand, some belt men say that the action of the air on the belt surface when in motion tends to lift the edge from its place. As this air action is greatest when the joint is passing around the pulley it would appear that the subject is open to discussion. However, as slow running belts are not subjected to excessive air action it might be said that the method shown at B would be best, and that at C best suited for high speed belts. Irrespective of the advantages claimed for either method, the entire question seems to be one of careful attention in the matter of re-

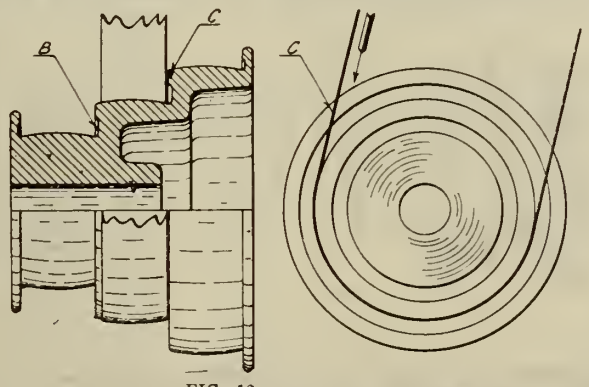


FIG. 12

pairs and maintenance so that faults may be remedied as soon as they are observed.

Avoid Small Pulleys

In double or three ply belts these splices can be run to meet both conditions as shown at A. In the use of double or triple belts for heavy power drives, care should be taken to use pulleys as large as possible, consistent with speed requirements, as effective heavy drivers are not to impossible on pulleys of small diameter. This is quite clear when we consider the lack of flexibility of the heavier belts. Another argument against the use of small pulleys is the imperceptible cheeping action of the belt in making the round of the small pulley. It will be obvious to all that two opposite forces are at work when the belt is on the pulley—that of compression on the inner side and tension on the outside. These forces are neutralized between the curves, but immediately come into action again when the pulley is reached. For instance, suppose the length B-B, Fig. 9, to represent the length of the pulley circumference in contact with the belt. The length of both sides of the belt between B-B will be the same, but not so when this same portion is wrapped about the pulley, as at A-A. If the contraction of the inner side equals the expansion on the outside, the centre length will remain unchanged, but such is seldom the case, so that the tendency is usually to destroy the adhesion of the two layers as shown at C. For this reason too small pulleys should be avoided when using double or three ply belts.

Idlers as Tighteners

The use of idlers is often resorted to, but for the above reason, it is well to have these of fairly large diameter, especially where the idler contact is excessive, as the forces at work are directly opposed to those on the main pulleys, thus creating a destructive bending action in the fibres of the belt. For belt drives of this character it is advisable to maintain flexibility by means of some liquid preparation that will penetrate the fibres of the belt. When idlers are used they are invariably located close to the smaller pulley, so as to increase the arc of contact and likewise the driving power.

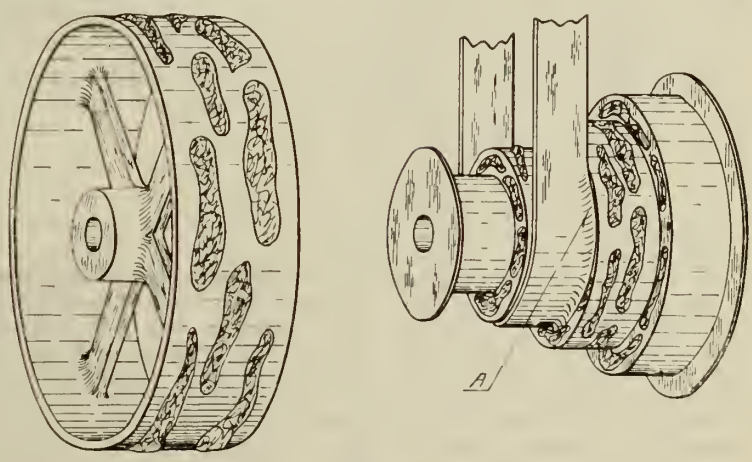


FIG. 13

Keep Pull on Under Side

In the installation of horizontal or oblique drives it is always advisable to locate the shafting so that the pull on the belt will be on the lower side. This will bring any slack on the upper portion of the belt and the sag will add to the lap on the pulleys. To the average

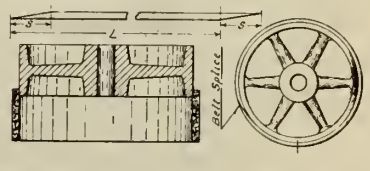


FIG. 14

man a tight belt is supposed to deliver the greatest power, and while in some respects this may be true, much of the power delivered is absorbed by the additional friction on the shaft bearings, so that the effective pull may be less than would have been the case with a little slacker belt. When the centre distance of a drive is relatively short it may be necessary to operate with a fairly tight belt, but in a long stretch a slack belt will give equal, if not better service than a belt that has excessive initial tension.

Have Plenty of Clearance

In many shops particularly those with low ceilings, the shafting may be placed in such a position that belts on large pulleys have very little clearance; in some instances it is necessary to cut a piece out of a beam or joist to allow the belt to operate. Frequently, this cutting is just sufficient to clear the belt, as shown at A in Fig. 10. When the drive is one of a fairly steady or uniform load this may be ample, but if the load on the belt shows a tendency to fluctuate it is more than likely that the belt will flop up and down, invariably resulting in the belt striking the joist. Such action is very detrimental to the life of the belt and especially the lace at the joint, as the rubbing will soon effect its destruction and repairs are required. This also applies to other possible points of interference, as pipes or rods passing either above or below the belt, as shown at B. Where points of interference are a source of annoyance, facilities should be provided to minimize the trouble, such as the giving of greater clearance, or the placing of rollers to prevent excessive wear on the belt or laces.

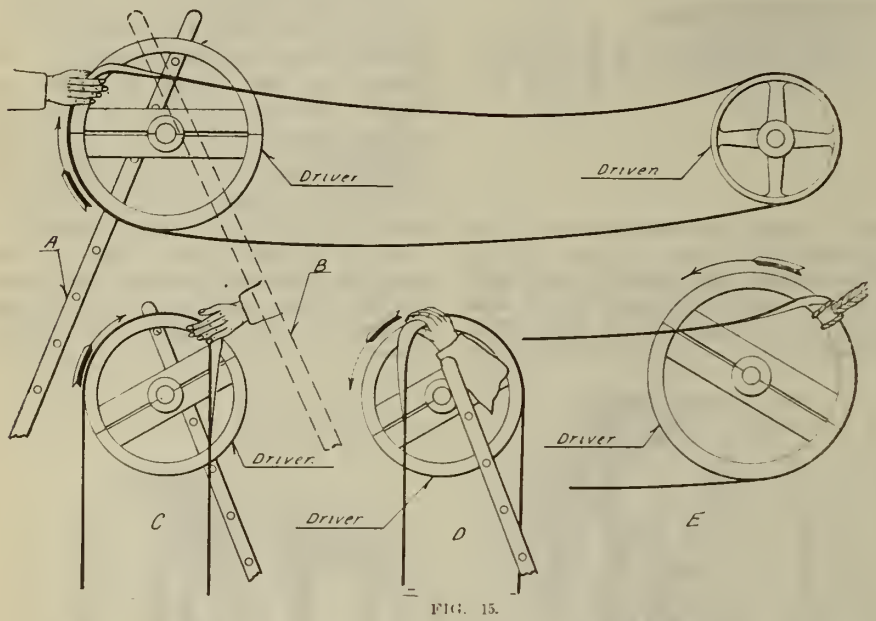


FIG. 15.

Crowning of Pulleys Important

Steady running of belt is essential to effective transmission. For continuous drives, belts are generally run on pulleys that are very little wider than the belt, and to maintain its position in the centre, the pulleys are invariably crowned. This crowning usually consists of two straight tapers meeting at the centre of the pulley face. The amount of the taper varies from ⅛ inch to ¼ inch per foot; that is, a pulley 12 inches wide would be about 1-16 inch larger in diameter in the centre than it would be at either edge. In a straight taper crown, however, it will be seen that the apex C, Fig. 11, forms a definite or pronounced breaking point; nothing very serious possibly, but with a tendency, especially in new and heavy belts, to provide an air space at the edges D. A better plan of pulley crowning is that shown at B, where the surface forms an arc; this method equalizes the bending stresses throughout the width of the belt and makes the surface contact more uniform.

Careful Use of Belt Dressing

To increase the driving power of a belt, or rather to increase the pull, the use of belt dressing is very frequently adopted, and when judiciously applied such dressing may add materially to the effective operation of the belt, but where careless or thoughtless application is made, the practice may not only prove inefficient but very destructive to the belt. The driving power of a belt depends upon its flexibility and adhesive qualities, therefore the object of a belt dressing must be such as to retain these essential features. The adhesive action may be increased by careful application of belt dressing, but pliability can only be attained by a liquid or semi-liquid preparation that will penetrate the pores of the belt. When properly used a surface dressing will very often pull one out of a hole, but if constant applications are required to maintain the "pull," steps should be immediately taken to eliminate this apparent necessity, which is generally nothing but neglect in maintaining the belts or pulleys in good working conditions.

Destructive Practice

Where the surface dressing—or as it is often called, the "belt stick"—is freely used, it is not uncommon to see pulleys in the condition shown in Fig. 12, with large patches of the dressing clinging to the face. As said before a belt derives its power from frictional contact with the pulleys and while the pull from a well "dressed" belt may seem better, the general efficiency has not been increased. This may be made more clear when one realizes the air pockets that must be formed between the patches on the pulley surface shown in Fig. 12. To this must be added the pull required when the belt is leaving the pulley. A stamp may be easily placed on an envelope but some action is required in its removal. At your next opportunity notice a drive of this description and listen to the noise when starting or stopping. Just like pulling a porous plaster from your back.

However, where the excessive and needless use of belt dressing is more pronounced is on cone pulleys, where belts are required to be changed from one speed to another. The action of the latter is very similar to that of the straight pulley, but where the greatest trouble is caused is on the flange or shoulder. The accumulation of the dressing at this portion soon attracts the edges of the belt, with the result that it shows a marked tendency to climb to the next higher step, and very often succeeds, the inevitable consequence being a broken belt or lace, generally the latter. At other times the belt may climb, but instead of taking the next step will flop or twist completely over, once or perhaps twice. The writer has seen this happen on several occasions. These conditions should not be allowed to continue, and pulleys should be scraped clean as soon as possible. Even without the presence of dressing, belts on cone pulleys may often show an inclination to climb, due to faulty belt or pulley alignment. To assist in the proper running of the belt the flanges or shoulders should be undercut as shown in Fig. 13 at B. This provides a point of contact for the belt at C, the edge being kept clear of the flange throughout the entire wrap of the pulley.

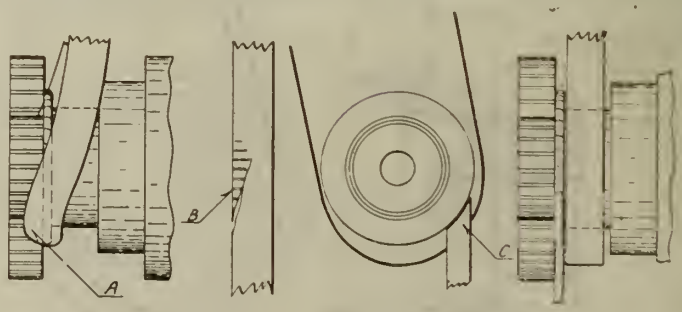


FIG. 16

Covering a Pulley With Leather

Many men resort to the practice of covering pulleys with leather to increase the adhesive power of the belt. When doing this the method generally adopted is to form an endless belt by means of splicing. First cut a piece of belting the required width to a length L, equal to

about ⅛ inch per foot less than the circumference of the pulley; connect the splice in the usual manner, and when set, place the ring over the pulley, starting it evenly all round. Coat both the inner surface of the belt and the outer face of the pulley with hot glue, then take the pulley up by the spokes and carefully work the leather ring into place by

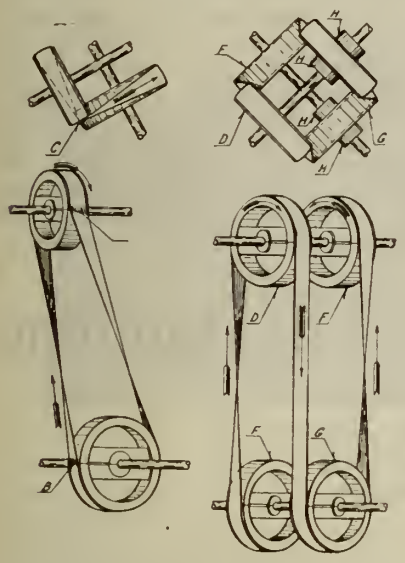


FIG. 17

bumping the edge on the floor or surface plate. Do this gradually to avoid kinking the leather, and quickly to prevent the glue from premature setting. If deemed advisable, a few copper rivets may be used.

Faulty Use of Nails

A leather-covered wooden pulley that came to the notice of the writer some few years ago was quite interesting and bears description. This pulley was located on the extreme end of a line shaft and was utilized to drive the countershaft of a buffing machine situated on the floor above. The buffer was subjected to very heavy service, frequently almost stopping at times, causing the belts to slip. Upon one occasion the writer was called upon to repair the main drive belt. Upon investigation it was found that the main drive was in a very dark storage room and the belt could only be seen by means of a special light taken to the ceiling. As stated, the pulley was found to be covered with leather, but a glance at the belt showed a strip right through the center on the inner side, that was in a deplorable state. Looking to the pulley for a cause it was discovered that the leather covering had been put on with nails, and several of these were protruding from ⅛ to ¼ of an inch. In this particular instance the nails were removed and replaced by fine wood screws, which proved successful. Probably the man that first covered this pulley thought that the belt would do its own driving.

Throwing Belts on Pulleys

A feature of factory operation that involves considerable risk to the workman, yet one that will likely never be discontinued, is that of throwing belts off and on the pulleys while the same are in motion. If shafting had to be stopped or even slowed down every time a belt required to be placed on or removed from a pulley, the suspension of production would be almost prohibitive, therefore the danger incidental to the maintenance of belts will always be with us. For this reason we should adopt the safest means of carrying out the work.

In the throwing off of a belt the risk is lessened by the fact that the belt comes off of its own accord in the greater number of cases, owing to slackness, poor alignment, broken lace, or one of many causes. When a belt requires to be thrown off a suitable stick is invariably used, but care must be exercised in its manipulation. Pressure should be applied at the leading side of the belt, that is, the side that is passing "on" to the pulley, and it should be seen that sufficient space is available at the side of the pulley to take the belt without it interfering with adjoining pulleys or couplings. If belts are thrown off regularly, other than for repairs, provision should be made to carry the weight of the belt so that it will not rest on the constantly-revolving shaft.

Proper Position of Ladder

When placing a belt on the pulleys it should first be located on the "dead" or driven pulley, as shown in Fig. 15, the actual running on of the belt being done on the driving pulley. As the latter is usually on the main shaft, in the majority of cases a ladder is necessary, and in placing the ladder, care should be taken to locate it on the outside of the drive, as shown at A. With the exception of special cases, where the drive shaft is located along a wall, the ladder should never be placed in the position B, and when such is absolutely necessary the shaft should be stopped and the belt run on at a very slow starting speed.

When standing on a ladder for this work the body should not be in a strained position, and one hand should be placed on a fixed object for support. For the lighter sizes of belts it is seldom that the speed of the driving shaft is reduced, as the knack is soon acquired of running the belt on. On the heavier belts the work is more difficult, but dexterity is attained with practice. When the belts are very heavy or extra tight, or with a load on the belt, "snapping on" is not so easy, and slipping of the belt is often necessary, while speed is accelerating. Under these conditions, however, care must be taken that the belt does not run off the driven pulley. On narrow pulleys there is always the possibility of the belt jumping off on the opposite side. Where possible, a good method is to place the ladder close to and on the opposite side, as at A, so that the lower edge bears against the pulley and acts as a guide for the belt.

Vertical Drives

If the belt is too tight or too heavy for the hand method, that shown at E may be adopted. By means of a light rope the belt is locked to the pulley and drawn on by slowly revolving the shaft. For vertical drives the same precautions are required. The correct method is that shown at C, where the belt is gathered up and placed on the far side of the pulley and drawn around to the near side, the ladder being placed as shown. A dangerous practice is that illustrated at D, where the belt is placed at the near side and followed on by the hand to the far side. This brings the arm in close proximity to the shaft at the final jerk of the belt as it takes the pulley, with the accompanying risk. When it is necessary to place the ladder in this position the workman should stand well up on the ladder, and it is also advisable to slow down the speed of the shaft. In the handling of belts, due consideration should be given to the surrounding conditions and at all times lean to the side of "Safety First."

Lathe Belt in Back Gear

A not uncommon occurrence in the operation of a lathe where the workman is not conversant with the proper knack, is that of the lathe drive belt jumping over the back cone flange and getting caught in the teeth of the gears, as indicated at A, Fig. 16. After this has happened the belt will have an appearance something like that at B. Where there is a danger of a belt running into gear trains, guards should be placed in suitable positions to protect the belt, as nothing will destroy a belt quicker than mangling it in the teeth of gears. For protecting a lathe belt a simple guard made of sheet steel, proves very efficient.

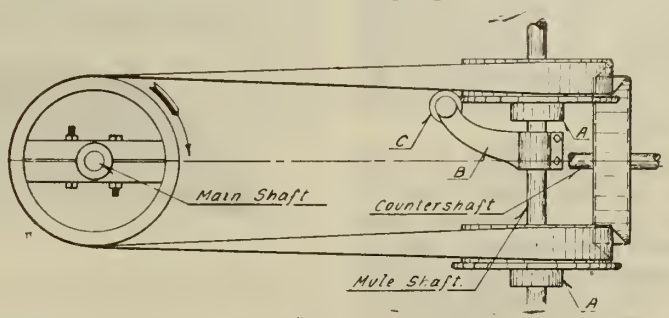


FIG. 18

Installing a Quarter Turn Drive

Drives other than those connecting parallel shafts are occasionally required, and local conditions must govern their installation, as a specific method is generally necessary for each individual installation. The most common is that of

the quarter turn drive, and it may be accomplished in a variety of ways. The simplest form is that illustrated at the left of Fig. 17, where the shafts are placed at right angles, with the pulleys properly lined. The fundamental requirements in a drive of this character is that the points A, B, where the belt leaves the pulley, will be on the same vertical line as indicated at C. This is essential, otherwise the belt will not remain on the pulleys without the use of guides. One great objection to the two-pulley quarter turn drive is the fibre stress resulting in the angle of the belt in leaving the pulley. This fault is less pronounced if the shaft centers are relatively far apart.

A better form of quarter turn drive, but one that requires four pulleys and about twice as much belt, is shown to the right of Fig. 17. In this case one of the pulleys on each shaft must necessarily be a loose pulley, running in the opposite direction to its mate and kept in alignment by the collars H. The unavoidable quarter twist is required in the belt, but the fibre strains are less pronounced. With this method the belt can be run in either direction, whereas that shown at the left can only be run in the direction indicated by the arrows.

The Mule Drive

Another drive that is occasionally used is that illustrated in Fig. 18. This is known as the mule drive and is adopted where a machine is to be operated at right angles to the line shaft and where a quarter turn drive is not permissible. In the mule drive the connected shafts usually lie in the same horizontal plane, invariably at right angles, where the prolongation of the counter shaft would intersect the main shaft. The intermediate pulleys revolve in a horizontal direction on a vertical shaft. When it is desired to run the belt in either direction it is advisable to have the two main pulleys of the same diameter. Collars are necessary on the vertical shaft to support the pulleys. One bad feature in a mule drive, where the load is a fluctuating one, is the tendency of the belt to run off the mule on the slack side. It is preferable to have the pull come in the lower side, but in either case the slack side should be provided with a guide pulley C, carried in a bracket B fixed to the mule shaft. This will aid in supporting the belt when the load is on the machine.

Power Plant Management; Coal and Ash Handling

PART III.

The Use of Continuous Belt Conveyors—Hoists—Hoist and Telpherage—Locomotive Cranes for Coal Handling—Skip Hoists—The Necessity for Adequate Capacity

By ROBT. JUNE

IN our preceding discussions we have considered the advantage of coal and ash-handling equipment from the standpoint of elimination of uncertain labor element, increase of coal storage capacity, and reduction of handling costs, and have called attention to the necessity for expert advice and detailed study in the selection of methods and equipment for any particular plant.

We have seen that the fundamental requirement of any proposed installation is that it shall satisfy the formula that O H I shall be less than H; that is, that the operating costs O, plus maintenance costs M, plus interest on money invested I, of the system, which it is planned to introduce, shall be less than the cost H, of doing the same work by hand, or by some other system. We have indicated that it was generally preferable, though not always necessary, to divorce the coal and ash handling on account of the destructive abrasive qualities of the ash.

Taking up the various type of equipment, we have considered spiral, flight and scraper conveyors, aprons and V-buckets, and pivoted overlapping dump buckets, finding that the latter, although the most expensive system to instal of any of the chain types, is generally regarded by power plant specialists, in both the operating and consulting fields, as the most economical for medium and large-sized boiler plants.

Leaving the chain group we now come to continuous belt conveyors.

Continuous Belt Conveyors

Here we have a type of equipment possessing the distinct advantage over any previously considered, of being driven from any point in its length. The importance of this feature will depend upon individual conditions, but it should never be overlooked in planning a system for an existing plant. Further notable advantages are the simplicity of drive—a motor with connecting belt to one of the pulleys, generally sufficing the almost unlimited capacity—the width of the belt depending only upon sufficient fibre stress in the materials of which it is composed, and the flexibility of the system. Conveyors 700 or 800 feet from centre to centre, and capable of handling 400 to 500 tons per hour, are in successful use. The angle of repose of the material is the only limiting factor to the inclinations at which belt conveyors may be operated.

Movable trippers are used when it is desired to discharge the load evenly along the entire length, as for instance in a continuous row of bins, while fixed trippers are employed where the load is to be discharged at certain and somewhat separated points. The movable trippers are made in two forms, "hand driven" and "automatic." In the former they are moved from point to point by means of a hand crank. The "automatic" tripper is propelled by the conveying belt through the medium of gearing. It reverses its direction automatically at either end of the run and travels back and forth, continuously

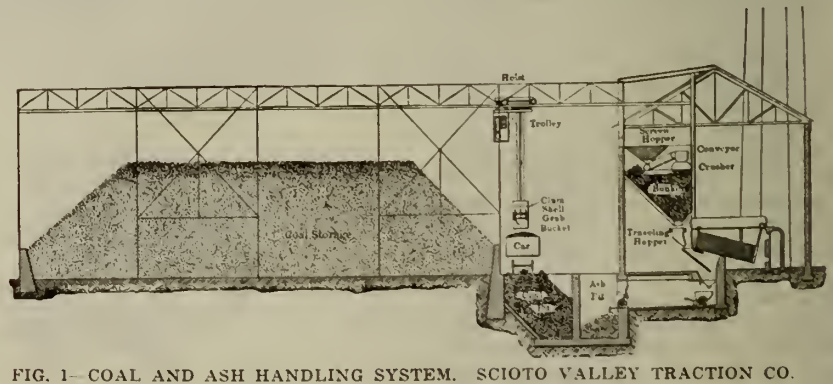


FIG. 1—COAL AND ASH HANDLING SYSTEM. SCIOTO VALLEY TRACTION CO.

In the Robins belt conveyor, which is typical of the best design and construction practice in this type, the material is discharged where needed by automatic tripping devices. The trippers consist essentially of two pulleys, one above and slightly ahead of the other, the belt running over the upper and under the lower one, the course of the belt resembling the letter S. The material is discharged into chutes on the first downward turn of the belt. The trippers may be movable or fixed, single or in series, distributing its load. It can be stopped, reversed, or made stationary at will.

As the material is actually carried it is possible to operate belt conveyors at much higher speeds than are possible with drags or any other types of carrying conveyors. The capacity of belts is therefore relatively much greater than those of other types of conveyors. It is the present writer's belief—a belief concurred in by many engineers, but not, be it noted by all—that belt conveyors should never, under any circumstances,

FIG. 2—SHEPHERD GRAB-BUCKET HOIST, POWER HOUSE, CITY OF HOLYOKE.

be used for the handling of ashes, for the following reasons:

1. High initial cost of installation.
2. Necessity for thoroughly quenching ashes before placing on conveyor to avoid destruction of belt by heat.
3. Rapid destruction of belt caused by abrasive nature of ash. There is an extremely good possibility of having to replace belts used for conveying ashes every six months, thus running the cost of maintenance up beyond all reason.

The power required to operate belt conveyors is stated by C. K. Baldwin in the following empirical formulas:

For level conveyors: $Hp = \frac{CTL}{1000}$

For inclined conveyors: $Hp = \frac{CTL}{1000} + \frac{TH}{1000}$

C equals constant as in Table I.
T " Load in tons (2,000 lbs.) per hour
L " Length of conveyors between centres.
H " Vertical life of material.

Belt conveyors may be regarded as better adapted to the requirements of large plants than to small.

Hoists

Of the various systems of hoists, such as hoist and hand car, hoist and cable car, and hoist and trolley, we can, in a general discussion, such as the present, dismiss the first two, since although there are several prominent installations of both types in the United States and Canada, the total number is comparatively limited, and it is apparent that these are types not likely to survive.

Hoist and Telepherage

The telepher is a type of hoist deservedly popular for small and medium-sized as well as large plants. In many ways the installation of the hoist and trolley systems appeals as one of the most logical and desirable solutions of the coal and ash-handling problem. It is, of course, used in connection with bucket or belt conveyors, as well as without. Where coal storage is desired and space adjacent to the boiler room is available, the hoist and trolley systems will generally prove the most economical installation, and the possibilities should be thoroughly canvassed.

Figure I, supplied through the courtesy of Professor Gebhart, shows the installation of a Jeffrey telepherage system at the plant of the Scioto Traction Company. With this arrangement, if the coal car is of the dump type the contents are discharged directly into the coal pit from which the coal is removed by grab bucket and transferred either to the overhead bunker or to the storage pile. If the coal car is of the gondola type the coal is removed directly from the car by the grab bucket. The bucket is hoisted and carried on the trolley into the building over the screen hoppers where it discharges its contents; the finer particles fall directly into the bunker and the larger lumps are automatically delivered to the crusher. The grab bucket will take about 98 per cent. of the coal in the car, leaving only 2 per cent. to be handled by hand. Coal is fed to the stokers by means of a traveling electric hopper which receives its supply from the overhead bunkers. The present capacity of the plant is 50 tons per hour taken from the car or pit to stock pile.

Where it is possible to use the telepher without employing some additional type of conveyor, notable economies in cost of handling can be effected. It would be hard to imagine a more effective or economical system for unloading coal from cars, storing it and supplying it to a battery of eight boilers than that illustrated in Figure II. An excellent feature of this system is that where the old boiler room is concerned, it can frequently be installed with fewer changes and at much less expense than would be possible with belt or bucket conveyors.

The hoist and trolley is one of the best forms of ash-handling equipment for use where ashes are produced in large quantities and are to be carried to a considerable distance from the plant. It is also an exceptionally good method for taking care of large, hard clinkers which cannot be broken small enough to be handled in other types of conveyors. For this reason it is particularly adapted to use with gas producers or other furnaces in which large clinkers and wet ashes are produced. In installing this class of equipment the trucks should be so arranged that the bucket can be dropped directly into the ash pit or directly in front of the ash door in hand-fired

TABLE I.

Width of belt	12	16	20	24	28	32	36
Constant C	0.234	0.220	0.205	0.195	0.175	0.163	0.157
Additional H.P. required for each tripper	0.50	0.75	1.25	1.5	2.25	2.75	3.25

TABLE II.

Additional power to be added to results of formula for friction of conveyor ends and driver.

Length of Conveyor.	25 ft.	50 ft.	75 ft.	100 ft.	200 ft.	500 ft.
Additional power required	80%	50%	30%	20%	10%	45%

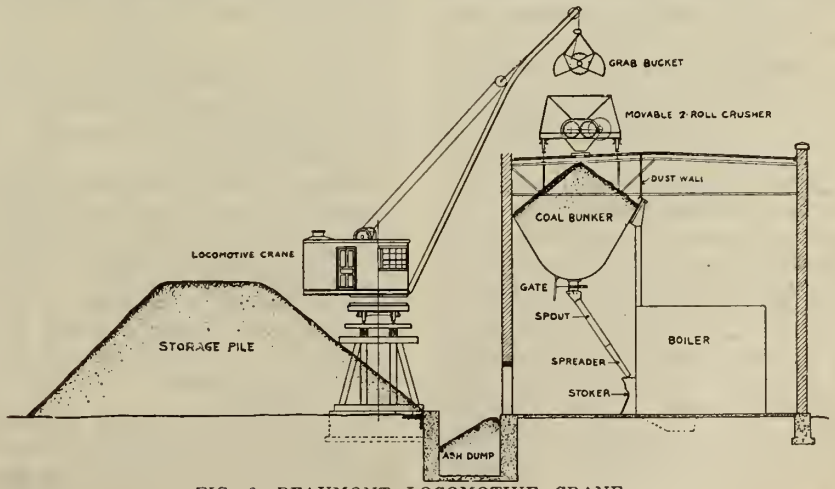


FIG. 3—BEAUMONT LOCOMOTIVE CRANE.

plants. The buckets should also be of sufficient capacity to remove the entire accumulation of ashes in one pit at one loading.

Locomotive Cranes

For small and medium-sized plants, where normal coal storage is desired, the locomotive crane is entitled to consideration. Figure III, supplied through the courtesy of the R. H. Beaumont

FIG. 4—BEAUMONT SKIP HOIST AND BUNKER, PHILADELPHIA SUBURBAN GAS AND ELECTRIC CO., PHOENIXVILLE, PA.

Company, shows a simple, effective layout for boiler room, with coal track and storage immediately adjacent. As between the locomotive crane and the hoist and trolley systems, local conditions and comparative costs of installation and operation, as worked out for the particular plant under consideration, will govern the choice.

Skip Hoists

As skip hoists are primarily ash conveyors we are brought, in discussing them, to a consideration of the desirability of divorcing the coal and ash-handling systems. As a general proposition this separation of the systems is emphatically desirable. Coal is, by nature, graphite and causes little wear to the conveyor. Ashes, however, are abrasive and may, in addition, be red hot or dripping wet. The abrasive quality produces excessive wear on chain conveyors. Red-hot ashes are practically certain to produce distortion and to some extent disintegration of the equipment.

A chain conveyor system which will handle both coal and ashes is expensive to instal, expensive to operate, and expensive to repair. The ashes get in the chain joints and therefore the system is subject to the abrasive action of the ashes even when handling coal. When handling ashes the entire apparatus must make a complete circuit in order to convey the ashes a short distance. Frictional losses are comparatively large for the work accomplished. Furthermore, in the usual installations no ashes can be removed when coal is being handled, or vice versa, and it is extremely likely that occasions will arise with considerable frequency when the equipment is urgently needed for both services at the same time.

If separation of the systems is a logical procedure the skip hoist is likewise a logical equipment for ash removal. The apparatus consists (see Figure IV) of a bucket running on inclined or vertical tracks and hoisted by means of a steel cable attached to a winding machine. The bucket consists merely of a rectangular steel box open at the top and fitted with guide and hoist bale.

The winding machine is usually driven by an electric motor.

The bucket is started upward by a pull on the starting rope or pushing a button. It discharges and returns automatically to the pit, where it stops. In some cases the skip reciprocates continually and is automatically filled.

The skip hoist is one of the best and most commonly used ash-hoisting devices. In connection with a small push or electric car to collect ashes from hoppers under the boilers it possesses the following advantages:

1. Durability: Ashes can be handled either wet or dry, hot or cold. The skip bucket is not materially affected by any of these conditions as are chain joints, elbows, exhausters, etc., constituting other types of ash-handling equipment. The hoist itself, being the only part that can be injured by the ashes, is always placed in a position remote from the skip so that dust or dirt cannot reach it.

2. Adequate capacity: A 35-cubic-foot trolley ash hopper car on 130-foot haul travelling 400 feet per minute, can make a round trip (260 feet) in two minutes including filling and dumping, assuming that ashes will flow by gravity into car. This equals twenty (20) tons per hour for the extreme haul, or forty (40) tons per hour for average haul. A skip, consisting of two buckets, one going up while the other is coming down, can make a trip in 90 seconds, including filling and dumping. If buckets are 35-cubic-feet capacity each the capacity would be 28 tons per hour at 50 cubic feet per ton and 50-ton lift. Plants producing large quantities of ashes are thus easily served.

3. The car and skip method is about the only successful method for handling extremely large and hard clinkers. The clinkers handled by this system need little breaking.

4. Power is used when ashes are being actually hoisted and is not wasted while ashes are being brought to the hoist.

5. The skip hoist can easily be designed and constructed so that it can be loaded or dumped at different levels. In this way it is possible to handle ashes from boilers on different levels in the same hoist, and also to discharge at different elevations.

The disadvantages of the skip hoist are comparatively high initial cost, so that the economical value of the installation is questionable where there is less, say, than 3,000 h.p. of boilers to serve. A further disadvantage is that the ashes must be moved from the boilers to the hoist by manual labor. The car and skip hoist system should never be considered for installation in a plant that is not provided with ash pits from which the ashes can be dumped directly into the cars, otherwise too much labor is required for loading the cars.

THICKNESS OF FIRES

The fire under a boiler should be kept as thin as practicable, in order to avoid the formation of unnecessarily large quantities of carbon monoxide gas. There is no loss from the production of this gas, if it is all burned again in the furnace; but when it is generated in great amounts, the escape of some sensible portion of it in the unconsumed form can hardly be avoided. Many persons believe that carbon monoxide is formed only when the fire is black on the top, from the addition of fresh coal. This is an error. The production of the monoxide is due mainly to excessive thickness of the bed of fuel on the grates, or to deficiency in the air supply; and it may be generated in large volumes from either of these causes, even when the fire is quite bright. So far as concerns loss by the wasteful production of carbon monoxide (as distinguished from the loss by direct distillation, noted above), the blackness of the fire on the top is objectionable mainly because there is then far more likelihood that the monoxide, when formed, will escape unburned. The air entering through the ash-pit combines with the coal in the lower layers of the fire and forms carbon dioxide, which escapes unchanged if the draft is good and the fuel-bed is not too thick. If there is an excessive thickness of fuel, however, or if the draft is poor so that the gases require too long a time to pass through the fire, a further chemical action occurs, the carbon dioxide taking up more carbon from the heated coal in the higher layers of the fire, and becoming thereby transformed into the monoxide—two volumes of the monoxide being formed, in this way, for each volume of the original dioxide. When the fires are at all thick, especial care should be taken to admit more air, so that the monoxide that is formed may have plenty of oxygen mingled with it to enable it to burn properly. As a rule, the fire should not be more than eight or nine inches thick when burning hard coal, but with soft coal the fuel-bed must be somewhat thicker. The fire should be thicker at the back end of the grate than at the front, because air draws up through the fuel more freely at the back end, if the thickness of the fire is everywhere the same. This condition is usually met by slightly inclining the grates, and keeping the upper surface of the fuel-bed level.

Factors Affecting Refrigerating Plant Engineering

In a Paper Read Before the American Society of Mechanical Engineers—The Author Gives Some Interesting Data Relating to the Efficiency of Refrigerating Plants

By VICTOR J. AZBE

THE cost of ice and of refrigeration is a composite figure of many different expenses coming under the heads of manufacturing, selling and general expenses. The cost of fuel is usually the largest item, and it may easily represent the difference between profit and loss.

During the last two years the cost of fuel per ton of ice has doubled, and many plants are now paying $1.50 to $2.00 per ton of ice for fuel alone. In spite of these conditions the majority of refrigerating plants are very wasteful of fuel as a result of improper design, run-down equipment or poor operation. While the possible savings are enormous and can usually be secured with little effort and slight expenditure, the necessity for improving equipment and operating conditions is not realized in the majority of plants.

It should be the aim to improve the economy of the plants from year to year by making necessary improvements to reduce costs of fuel and labor. Fuel cost, while most important, is not all-important, however, and there are ice plants having a very high fuel economy that are losing money. A high efficiency must be maintained generally in the design of the plant, in its load factor and in its labor and sales organization. There are far more plants making on the average, per year, 1.5 to 2.5 tons of ice per ton of fuel than plants making 5 tons, having simple non-condensing plants in mind.

In this paper the writer expresses himself frequently in terms of tons of ice per ton of 10,000 B.t.u. fuel, to equalize the value of the various fuels (semi-bituminous, bituminous, lignite, oil, etc.) since by a simple recalculation it places them on a common basis.

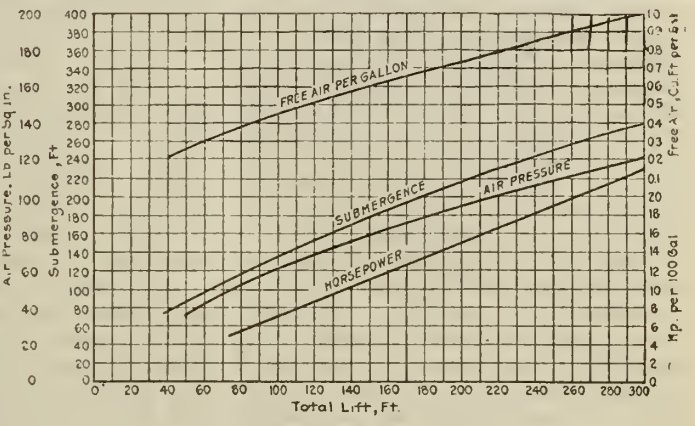


FIG. 2—STANDARD AIR LIFT PERFORMANCE

As the load factor of most refrigerating plants varies greatly, the boiler installation should be such as to give flexibility of operation. In small plants arrangements should be made to reduce the grate surface during the winter periods. Each boiler must be equipped with a draft gauge, and the draft should be maintained at the minimum and varied with the load. The boiler setting should be high, even with return tubular boilers, with a space of from 4 to 5 ft. between grate and boiler shell, and the combustion chamber should be so arranged that the benefit of this increased space is obtained. Gases tend to take the shortest path, and with most of the combustion chamber space devoid of drop walls there will be circulation of the gases and many eddy currents or dead spaces.

Any fuel can be burned if proper provisions are made—shavings as well as oil or semi-bituminous coal. The selection mostly depends upon cost and availablity. Lignite, for example, is a most excellent fuel for localities such as Texas. Burning this under return tubular boilers efficiencies were obtained of 63 to 68 per cent.

Prime Movers

The prime mover most generally used in refrigerating plants is the Corliss non-condensing steam engine. Next in order are the compound Corliss, electric motor, oil engine, and uniflow steam engine. If this order were reversed, however, enormous sums of money would be saved to ice manufacturers, for the following reasons:

In selecting the prime mover for an ice plant, the two most important items to consider are efficiency at rated load and efficiency at half load. While the average Corliss non-condensing engine consumes 20 per cent. more steam at half load than at full load, the uniflow engine uses only about 8 per cent. more. This is of great importance because of the great variations of load factor. Many engines can be found operating at one-eighth cut-off. This is the reason, also, why a steam cylinder should be adapted to the back pressure at which the compressor operates. It is most unwise to have a steam cylinder large enough for economical cut-off at 25 lb. suction pressure when the pressure to be maintained is 15 lb. or less.

Fig. 1 shows the results to be expected from various types of installations. The allowance made for auxiliaries ranges from one-half to one horsepower per ton of ice, depending upon conditions. The condenser pressure was taken at 185 lb. gauge, and it was assumed that at the suction pressure given the machine would operate at about full load.

In small plants preference should ordinarily be given to the use of superheated steam, since as high an economy may be obtained from a uniflow non-condensing engine operated with superheated steam as from a compound Corliss condensing engine using saturated steam, and the former equipment is a great deal simpler and necessitates less auxiliary power. Furthermore, the steam-consumption curve is flat and the efficiency of the plant will be maintained during the winter time.

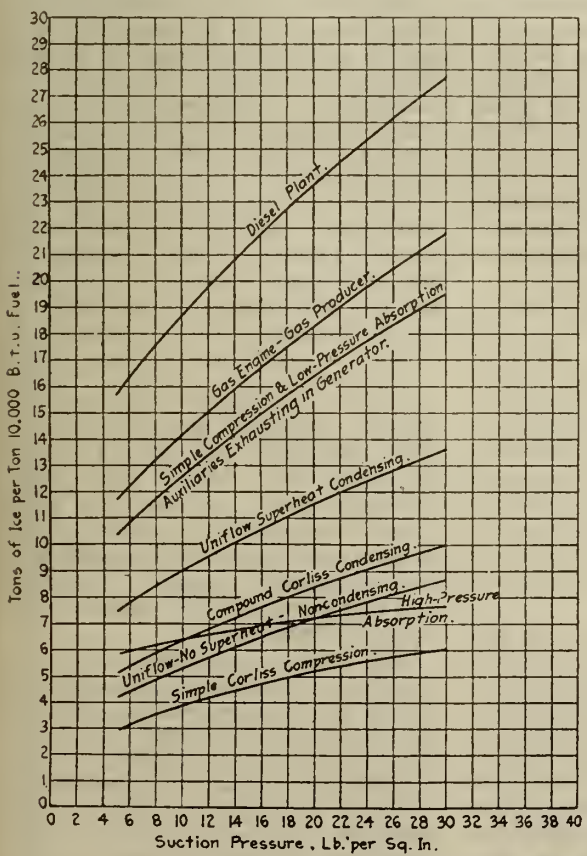

Diesel Plant.
Gas Engine-Gas Producer.
Simple Compression & Low-Pressure Absorption Auxiliaries Exhausting in Generator.
Uniflow Superheat Condensing.
Compound Corliss-Condensing.
Uniflow-No Superheat-Noncondensing.
High-Pressure Absorption.
Simple Corliss Compression.
Tons of Ice per Ton 10,000 B.t.u. Fuel.
Suction Pressure, Lb. per Sq. In.

FIG. 1—RELATIVE EFFICIENCY OF VARIOUS ICE PLANT INSTALLATIONS

Superheaters can be installed with facility even in existing installations, and since the gain is greater with simple non-condensing engines, uneconomical ice plants will derive great benefit from this procedure.

In order to gain in economy, a simple engine is often made to operate as a condensing engine. As a result, the temperature difference in the cylinder is increased and the cut-off is shortened, which increases the wall area at cut-off as compared to volume. This greatly increases cylinder condensation, which is directly proportional to the temperature difference and the area exposed. It therefore seldom pays to operate such a machine at more than 20 in. of vacuum, and if the plant is to be changed over to condensing operation, it is best to replace the simple Corliss by compound cylinders or by a uniflow engine and leave the rest of the machine intact.

Under proper conditions the ideal and most efficient prime mover for the ice manufacturer is the Diesel oil engine. By "proper conditions" is meant conditions of oil supply and cost, and kind of operating force to be employed. It cannot be over-emphasized that with the Diesel engine a high-grade engine-room force must be maintained, and especially during the overhaul period.

If the men in charge are intelligent, the Diesel engine is a very dependable unit. There is a plant in California that produces a ton of ice for 5 gal. of fuel oil, and this not under the best conditions. There are oil engine installations on record, not necessarily Diesel engines, that have given a ton of ice for less than 10 cents fuel cost, with oil at 2 cents a gallon.

With regard to the average results obtained with Diesel engines over a long period, the net work produced was 1,119,801 kw-hr. The auxiliary power represented the power required for injection in the air compressor, and in the water-jacket circulating pumps. The load factor having been highly variable, the results are not quite as good as they otherwise would have been, consequently the figures may be taken as being conservative and dependable.

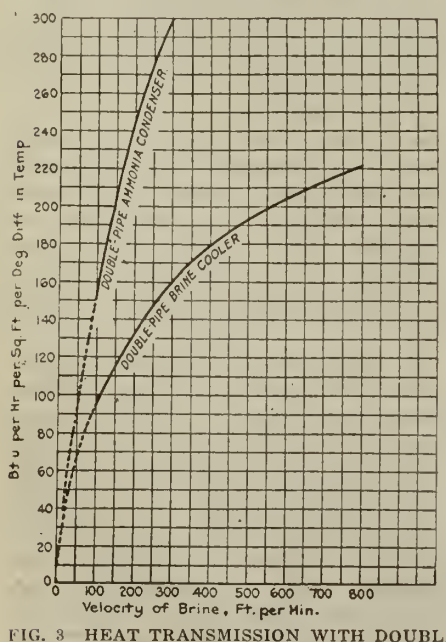

B t u per Hr per Sq Ft per Deg Diff in Temp
Velocity of Brine, Ft. per Min.
DOUBLE PIPE AMMONIA CONDENSER
DOUBLE PIPE BRINE COOLER

FIG. 3 HEAT TRANSMISSION WITH DOUBLE PIPE BRINE COOLERS AND AMMONIA CONDENSERS.

In many localities electric power can be obtained cheaply, and when this is the case electric drive is to be favored. The main advantage of an electric installation is that high efficiency can be obtained through the whole load-factor range and that economy increases as the load factor drops, contrary to the condition in ice plants.

Induction motors are not very well adapted for ice-plant work because of the high speeds required for high efficiencies. Synchronous motors, on the other hand, have characteristics that make them ideal, even for direct connection to refrigerating machines. Their efficiency curve is quite flat and their efficiency is rather high at part loads.

An electrically driven raw-water plant is a great deal simpler than a steam-driven plant. Many factors which influence plant efficiency are eliminated, and consequently the operating man does not have to be as high grade as for the efficient operation of steam plants. Labor cost and repair expenses and the cost of real estate, buildings and machinery are all less. Dependability is also fair, and with proper installation as good as in the case of a steam plant.

Auxiliaries

The curse of most ice plants is the auxiliaries. In many cases the steam consumption of the auxiliaries is as great as that of the engine running the compressor. In a certain ice plant of 100 tons capacity the following auxiliaries were found in operation: Electric-light engine; duplex circulating pump for ammonia condenser; duplex circulating pump for steam condenser; duplex brine pump; duplex boiler-feed pump; ice-hoisting compressor; single-stage single-steam-cylinder deep-well compressor; agitator engine and cooling-tower fan engine.

One of the most uneconomical auxiliaries as usually operated is the air lift. This statement is meant as no reflection upon the air-lift pump as such, but on the way in which it is usually operated. Fig. 2 shows the performance of properly designed air lifts; the efficiency decreases somewhat as the lift increases, but should not be less than 60 to 80 per cent., whereas, actually in some cases it will be found as low as 20 per cent.; the trouble is usually too great or too little submergence.

It is seldom advisable to use an air-lift pumping system for the circulation of water over the steam condenser because of the increased head required. The use of a cooling tower is ordinarily to be preferred, and any water needed for make-up may be taken from the air-lift system and passed over the distilled-water and liquid-ammonia coils, thus cooling the latter below the temperature of the circulating water proper.

For driving auxiliaries, electric current from generators driven by uniflow engines is to be preferred in the majority of installations, and the various units must be selected with a view to obtaining a flat efficiency curve between

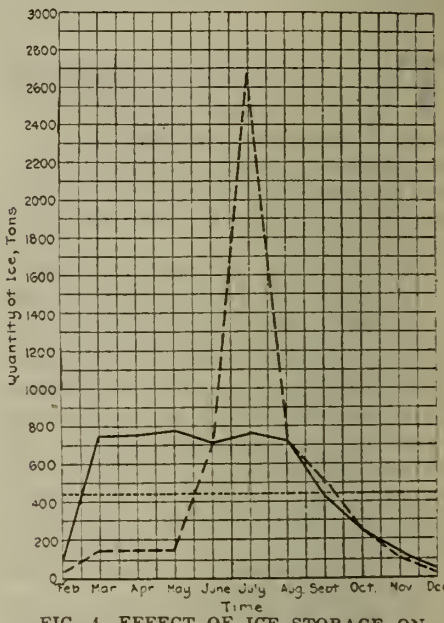


FIG. 4—EFFECT OF ICE STORAGE ON EXTREME LOAD FACTOR.

half and full loads; all motors on the larger units should have variable speed control. Duplex steam pumps or steam-driven deep-well pumps should not be used except possibly as a reserve.

Wet Versus Dry Compression

Theoretically, dry compression is inferior to wet, both in regard to refrigeration produced per pound of ammonia circulated and the work required for compression. The difference in economy ranges between 6 and 10 per cent.. being greater with low suction pressures and high condenser pressures. Practically, however, dry compression is the more economical; that is, it is capable of producing a greater amount of refrigeration per horsepower expended. The reason for this discrepancy is that when wet gas is admitted into the cylinder the liquid is not suspended, but accumulates at the bottom of the cylinder. There it evaporates so slowly during the compression stroke that the evaporation continues after the discharge valve opens, and often even after it again closes when the piston is upon the return stroke, thus causing a certain amount of re-expansion loss which tends to reduce compressor capacity. Any liquid that evaporates after the discharge valve opens is utterly wasted.

That there is no benefit in wet compression, as ordinarily practised, is proven by the compression curve and its relation to the adiabatic and isothermal curves when the machine is operated wet, even to such an extent that the discharge gas leaving the compressor is saturated. In such cases the compression curve will only slightly approach the isothermal, which proves that most

of the cooling of the gas by evaporation of the liquid is done after the compression valve opens and thus no benefit accrues from that time on. Liquid and vapor flow separated within the same pipe the same as in the case of saturated steam.

So long as theory indicates an advantage in wet compression, it would seem that further studies and experiments regarding its successful application are justified. Could not some

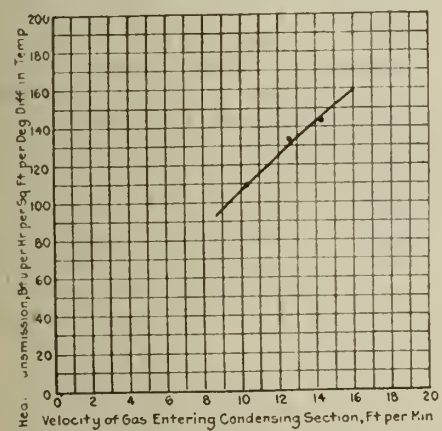


FIG. 5 EFFECT OF VELOCITY ON HEAT TRANSMISSION

method be devised to atomize the liquid before it reaches the compressing cylinder, or to inject it in the form of a spray during the compression stroke? In any event, precautions must be taken not to introduce liquid into the cylinder in an undivided state, otherwise dangerous accidents are likely to follow.

Wet compression is not only beneficial upon thermodynamic principles, but possesses a number of other advantages. By its use the temperature difference in the cylinder is reduced by practically two-thirds, which greatly lowers the cylinder superheat and consequently should increase the volumetric efficiency of the machine. Further, with wet compression far less oil is required for lubrication, and the oil does not vaporize, and thus is easily kept out of the condensing and evaporating coils. Wet compression represents also a saving in ammonia and, in addition, permits a somewhat lower condenser pressure.

Ice Tanks

All the details incidental to the process of ice making should be so regulated as to secure a high rate of heat transmission, coupled with a low temperature difference. The ice tank is a most important member of the ice plant. As far as handling is concerned, great improvement can be made. In a certain plant in St. Louis it was arranged to hoist a row of eighteen 200-lb. blocks by one operation, and the blocks were all thawed and dumped at the same time.

Circulation of the brine in the freezing tank is a very important item. This circulation is at times produced by centrifugal pumps, but ordinarily by propeller agitators. Often these agitators are very inefficient and tend more to churn the brine than to circulate it. It is ordinarily difficult to determine what the circulation in an ice tak, is due to the fact that the speed of the brine varies and its velocity in the lower part of the tank is not the same as in the upper part. About the most practical way is to measure the difference in the height of the brine in the tank on the suction and discharge sides of the bulkhead close to the agitator. With tanks as ordinarily constructed, 1 in. difference of level for each 10 cans of tank length is assumed by the writer as a standard. This method should be fairly accurate since brine flow is the result of difference in level.

In agitating the brine, its level should never be below the level of the water in the can. Too low a brine level will greatly reduce the capacity of the tank and also the plant efficiency. A wide, shallow hole in the top of the clock toward the end of the freezing period is always an indication that the can is too full or the brine too low.

Since with long tanks or very strong agitation, considerable brine levels difference is produced, in some cases as much as 5 in., it is best to construct long ice tanks with agitators on each end. Brine velocity is helpful in two ways; it increases heat transmission between the brine and the can, and between the evaporating coil and the brine.

The average transmission of heat from the ice in the can to the brine outside is very poor, only about 2.5 B.t.u. per deg. per hr. per sq. ft., due to the insulating effect of the ice. The thicker the ice, the slower the heat exchange, consequently tank brine velocity has not nearly so great an effect upon heat transmission on the can side as it has on the coil side. The heat transmission between ammonia and brine through metal is between 10 to 20 B.t.u. per sq. ft. per hr. per deg. This comparatively low figure is primarily due to the superheating of the gas in the coil, which causes one side of the surface to be dry, and secondly, to the low brine velocity.

Fig. 3 gives York Mfg. Co. curves showing heat transmission with double-pipe brine coolers and ammonia condensers. The curves were extended by dotted lines to show probable transmission at low velocity. These curves from their characteristics show the importance of velocity, an item which from the economy standpoint is certainly worthy of careful investigation.

Ammonia Evaporating Systems

With expansion coils in ice tanks and cold-storage rooms a high heat transmission is very desirable, and it can be obtained inside of the pipes either by flooding or using a high gas velocity. The objection to high gas velocity in this connection is pressure drop, which for thermodynamic reasons is rather more important on the evaporating side than on the condensing side. For this reason, the length of the evaporating coil should be limited so that the velocity will never exceed the average figure of 500 ft. per min. Some tank coils are 1,500 ft. long and their rather high velocity causes a great pressure drop. For long tanks 2-in. pipe is to be preferred, since the relative surface of 1¼-in. and 2-in. pipe is in the ratio of 1 to 1-5, while the sectional area is in the ratio of 1 to 2.2. Coils should be short so that they are thoroughly effective, and even flooded coils should be as short as possible. The size of suction lines leading to the machines should be governed by permissible gas velocity, friction, and radiation loss.

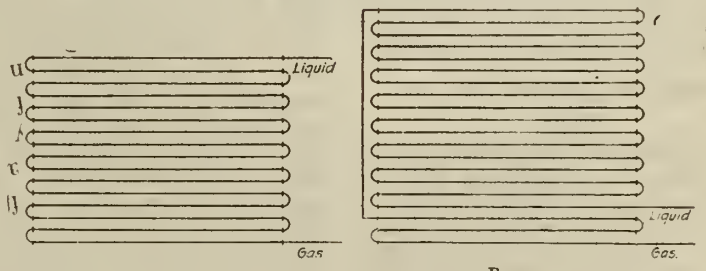
Ice Plant Load Factor—Ice Storage

Ice storage is profitable in most cases if the storehouse is filled to capacity during the winter and emptied entirely in the summer. The cost of storehouse will be from $6 to $12 per ton capacity and the investment will net a substantial return in most cases. The objections to it are the cost of refrigeration for the storage and the increased cost of handling the ice.

As far as plant economy goes, the value of ice storage is due to the equalization of the load factor. That is, the plant can be operated at higher rate during slack seasons and there may not be the necessity for forcing the plant beyond its economical limit in summer. The ice plant and ice storage can be so proportioned that the plant will have a load factor of 80 to 90 per cent., while without ice storage it would be only about 40 per cent., taking the whole year into consideration.

The small ice vault, or daily ice storage, exerts also quite an influence upon plant economy and it cannot be overemphasized that it is advantageous to make it amply large. The idea is to remove ice from tanks as quickly as possible—to use ice tanks for storing ice is a very poor practice.

In Fig. 4 the full line represents the output of ice; the broken line indicates the sale of ice, and the dotted line the proper rate of manufacturing ice. These curves were plotted from the figures



B

FIG. 6—AMMONIA CONDENSER TYPES.

actually obtained in a plant. An exact determination of the proper rate of manufacturing ice will permit stopping the plant altogether for a certain time and attending to repairs.

To operate with low suction pressure is far less economical than is indicated by the analysis of compressor performance alone, for the reason that the economy of the engine is also affected by the reduction of the load. For this reason, when the condenser pressure drops off during the cold season it is doubly important that the suction pressure be increased and the machine maintained fully loaded. The practice of

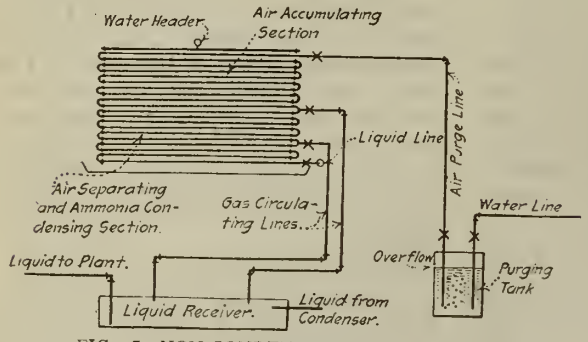


FIG. 7—NON-CONDENSABLE GAS PURGING ARRANGEMENT.

shutting down one or more ice tanks in winter should be strongly condemned, and no tank should be shut off (except in case of absolute necessity) until the back pressure is at the highest point. Efforts should be made to maintain a back pressure of 30 lb. in winter and the plant should be designed with that in view. The largest loss is occasioned by the non-adjustment of the various elements to the load factor.

The various rooms or tanks in an ice plant should either be maintained at the same temperature or designed especially for low temperatures. To try to maintain one or two rooms at a low temperature and sacrifice the economy of the whole plant is bad practice, since the suction pressure will always correspond to the lowest temperature. The temperatures should be maintained uniform. When this is not possible, and the difference in the various temperatures is great, then either a multiple effect or a booster compressor should be installed.

Forecoolers and Multiple-Effect Receiver

In a well-designed and efficiently operated ice plant the water to be used for ice making is cooled down to within a few degrees of the coldest circulating water, or ordinarily to a temperature of 70 or 80 deg. Fahr. This water then passes into the forecooler to be precooled by ammonia. The heat absorbed by the forecooler can be anywhere up to 30 per cent. of the total heat to be extracted in making ice, and the water will be cooled down to about 40 deg. Fahr. There are two methods of forecooler refrigeration: by feeding liquid ammonia directly into a coil, or by passing wet return gas from the tank through the water cooler. The first has the advantage that it can be connected to a machine working independently from the freezing tank and thus enable the maintenance of very high suction pressure. The only advantage of passing the suction line through the forecooler is that the expansion valves on the tank can be kept open wider, thus insuring that the freezing coils will work throughout their whole length without danger of getting any liquid to the machine. But this same thing can be accomplished far better by means of liquid separators and it is of greater advantage to use the high suction pressure which is possible with direct feeding.

Refrigerating plants should also be equipped with double-pipe liquid pre-coolers, cooling the liquid from the temperature of the coldest circulating water down to the temperature corresponding to the highest suction pressure used. In this connection a multiple-effect liquid receiver can also be used, by means of which a greater amount of work can be done at high suction pressure than by the use of the double-pipe cooler alone.

Every refrigerating plant should have an auxiliary compressor for high-pressure work. The size of this compressor may be relatively small for the reason that it will operate at double its rated capacity. One of the most valuable inventions ever made in the refrigerating field is the multiple-effect compressor, which allows gas of higher suction pressure to enter the cylinder after it has been filled with gas of a lower pressure.

Ammonia Condenser

There is no reason for a condenser pressure as high as 200 lb. It always indicates improper conditions, and even in a hot climate the condenser pressure should be below 175 lb.

The cooling tower should cool the water within three degrees of the wet bulb. The relative positions of the condenser and cooling tower should be such that five to six gallons of water can be pumped economically; that is, the pressure due to the head should be less than 15 lb. The condenser should give a heat transmission of at least 150 B.t.u. per sq. ft. per hr. per deg. There should also be sufficient surface, and if the condenser gives better results, less than the specified surface will be needed. In actual practice, results ordinarily are far inferior, due to the water being too warm, to the lack of a sufficient amount of water or of the required condensing surface, to the use of a poor type of condenser, or to the presence of oil or air in the condenser or scale on the outside.

The condenser should be located on the roof of the building, with the cooling tower immediately underneath and so placed that the coils will be parallel with the prevailing direction of the wind in the summer.

The cooling of the water over the condensers is important, not only because it simplifies the action of the cooling tower, but also because it produces a greater temperature difference between the water and the ammonia and thus lowers the condenser pressure. Theoretically the ideal arrangement would be for the initial and final temperatures of the water to be the same. This is often realized in winter and is also quite possible in summer in a dry climate with good wind velocity and sufficient condenser surface. It is important to protect atmospheric condensers from the sun

Condensing coils give a much greater heat transmission per degree difference in temperature than evaporating coils. Better results are obtained with the double-pipe condenser than with the atmospheric because of the higher water velocity of the former. Taking into account the question of initial cost, however, an atmospheric condenser, well exposed, should give, for the same expenditure, as good results as the double-pipe condenser.

TABLE 2—AMMONIA CONDENSER PERFORMANCE

No. of test	1	2	3
Type of condenser	A	B	B
Internal surf. per stand. sq. ft.	174	222	216
Refriger'n per stand. tons	13.8	5.7	6.5
Surface per ton of refrigeration, s. ft.	12.6	39	33.2
Water on, deg. fahr.	73	93	84
Water off last condensing pipe, deg. fahr.	98.5	94	90
Water off bottom superheat pipe, deg. fahr.	104	94.5	92
Condenser pressure, lb.	195	190	210
Condensing temp., deg. fahr.	98	97	103.4
Temp. entering gas, deg. fahr.	240	230	245
Temp. leaving liquid, deg. fahr.	98	97	100
Logarithmic temp. diff., condensing section, deg. fahr.	6.6	3.5	16.5
Logarithmic temp. diff., superheat section, deg. fahr.	24	37.5	57
Superheat extracting surface per stand, sq. ft.	21.7	22.2	32
Condensing surface per stand, sq. ft.	152.3	199.8	184
Entering velocity superheat section, feet per second	8.2	3.3	3.7
Entering velocity condensing section, feet per second	6	2.4	2.7
Mean heat transmission per deg., sq. ft. per hr., B.t.u.	155	91.6	26

Table 2 gives the results obtained from tests performed upon condenser sets in actual operation. Type A was a counter-current flooded atmospheric con-

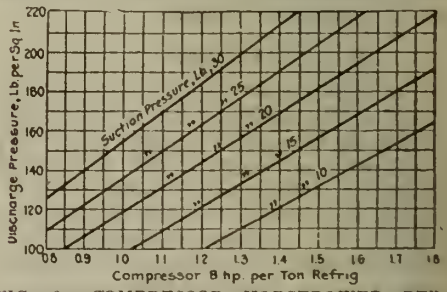


FIG. 8 COMPRESSOR HORSEPOWER PER TON REFRIGERATION.

denser. Type B was a condenser installation consisting of ordinary atmospheric condensers with three superheat pipes at the bottom of each stand. The result in tests 2 and 3 were obtained with type B. When test 2 was conducted the condenser surface was very clean both inside and outside and the

condenser was free from any non-condensable gases; this probably accounts for the favorable performance secured. The value in test 3 fairly agree with the ordinary performance of condensers similar to B. The writer possesses data of tests performed upon a dozen of these installations, which show practically the same figures.

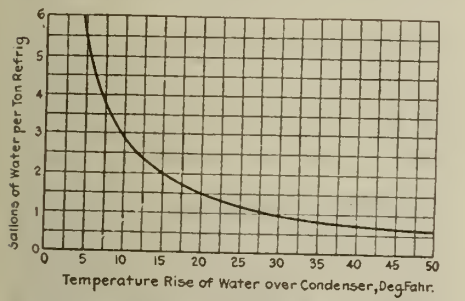


FIG. 9 — TEMPERATURE RISE OF WATER OVER CONDENSER WITH VARIOUS AMOUNTS OF WATER AND NO ATMOSPHERIC COOLING.

Fig. 5 presents the effect on the transmission of heat of the velocity of the water in the pipes of a condenser. The points in the graphs were plotted from values obtained with a 12-pipe condenser of the drip-pipe type.

The velocity of the water in the pipes of a double-pipe condenser may be increased by allowing a greater amount of water to flow through them. The gas velocity increases when the height of the stand is increased by the addition of more pipes. In selecting between high and low condensers, however, other factors must be considered in addition to the water or gas velocity. Generally speaking, high condensers are preferable when the available water is cold.

When a condenser is operated with superheated gas, this should not enter at the top of the stand, as is often done in practice. Type B in Fig. 6 is a convenient form of a condenser for use with superheated gas.

A rather frequent objectionable condition is the presence of air in the condenser. In order to be able to extract without interfering with the operation of the remainder of the system or losing much ammonia, the condenser must be provided with a suitable purging arrangement, as, for example, the one represented in Fig. 7, which was used with installation B, in test 2, table 2.

The presence of air in the condenser often causes the cessation of the flow of the liquid through the pipes and thus seriously impairs the efficient performance of the condenser. The author has had occasion to observe in certain plants he inspected that the condenser pressure dropped 20 to 30 lh. after the air was removed from the system.

Fig. 8 shows distinctly how the compressor horsepower per ton of refrigeration increases with the rising condenser pressure, and decreases with rising suction pressure.

Fig. 9 shows how the consumption of condenser water per minute per ton of refrigeration increases as its temperature range over the condenser is decreased, it being assumed that for each ton 350,000 B.t.u. must be removed per 24 hours, inclusive of the heat equivalent of the compressor horsepower.

Cooling Towers and Spray Systems

The economy of a refrigerating plant depends largely upon the temperature of the water circulated in the condenser. Water for ammonia-condensing purposes can be obtained from deep or surface wells, flowing streams or city distribution systems; or by recirculating water that is being cooled in forced-draft, natural-draft or atmospheric cooling towers or spray cooling systems. Which method is to be preferred depends upon the temperature of the water, the dependability of the supply and the relative pumping level. The cost of pumping water from wells is ordinarily so great that a recooling system is preferred.

The proper construction of a cooling tower is far more important in a refrigerating plant than in a steam plant. In the latter we can get 25 in. of vacuum with water at 105 deg. Fahr.; but in the refrigerating plant, with the same temperature, the ammonia condenser pressure would be about 280 lb.

The limit of atmospheric cooling depends upon the wet-bulb temperature. The rate of cooling depends upon the vapor-pressure difference between the dewpoint and the temperature of the cooling water as modified by the wet-bulb depression. Roughly speaking, each degree of water temperature is equivalent to three pounds of condenser pressure.

The use of a properly designed cooling tower is preferable to pumping water from a well, except when the well water is very cold. In summer, in even the hottest and most humid parts of the United States, the temperature of the water in the cooling tower will hardly ever be 85 deg. Fahr.; it will ordinarily be below 80 deg. Fahr. an din winter 50 deg. Fahr. and even less. In fact, with a cooling tower it is not impossible to obtain in winter a condenser pressure of of 65 lb., while with well water, the temperature of which keeps more uniform throughout the year, the pressure is higher in winter. The towers should not be built square but rectangular, twice as long as they are wide, and should be placed so that the wind strikes on the lower side.

The proper relative position of the cooling tower, as regards the condenser, is a most important feature. It must be remembered that the auxiliary power should be kept down to the minimum of ½ h.p. per ton of ice, also that if the head is reduced more water can be pumped with the same power and thus lower condenser pressures are obtained. In many plants the cooling tower and condenser are placed on the same level with the result that two circulating pumps are operated in place of one. The relative position of the cooling tower and the condenser should always be one above the other, with the preference of the condenser being in the higher position, since unobstructed air access is more important with an atmospheric condenser than with a cooling tower. Both are more conveniently located upon a roof.

The spray system has recently been introduced in connection with ammonia condensing systems and very good results are being obtained. Its cooling efficiency varies from 45 to 70 per cent., depending upon humidity, wind velocity, fineness of spray and pressure at the nozzles. In the calculations which must be made for designing a spray system, however, it is advisable to figure its operating efficiency at 50 per cent. This value has been assumed in the preparation of the curves in Fig. 10, which show the value of the temperature of the water before spraying and the corresponding values after spraying, for various wet-bulb temperatures.

The advantage resulting from the use of a spray system in an ammonia condensing installation is that it reduces the power required, because a spray system does not involve the action of a fan, and a pressure at the nozzle of only six or seven pounds, that is, the equivalent of a lower 14 ft. high is sufficient. Also, the cost of construction and maintenance is less for a spray system than for a cooling tower.

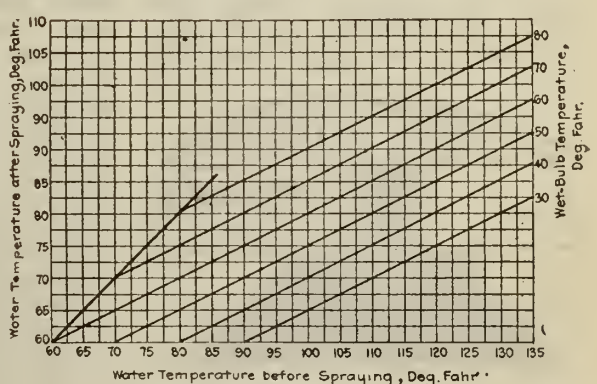

Water Temperature after Spraying, Deg. Fahr.
110 105 100 95 90 85 80 75 70 65 60
Wet-Bulb Temperature, Deg. Fahr.
80 70 60 50 40 30
60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135
Water Temperature before Spraying, Deg. Fahr.

FIG. 10—PERFORMANCE OF SPRAY SYSTEM

Distille dand Raw Water Systems

The advisability of using water evaporators should be carefully considered before adopting a raw-water system in a steam plant. Where the quantity of the available water is such that raw-water ice cannot be made successfully, the installation of evaporators is highly desirable.

There are two types of evaporators, high-pressure and vacuum. Under proper conditions both give satisfactory service and neither one develops as much trouble from the formation of scale as is ordinarily assumed. The writer knows of evaporators operated successfully in a region where the water contains a large amount of salt, a large amount of carbonates, and considerable calcium and magnesium sulphate.

The Oxide Film Lightning Arrester

A Recent Development in the Protection of Electrical Apparatus From the Effects of Lightning. An Interesting Principle is Involved

THIS article gives a brief summary of the scientific principles underlying a new type of lightning arrester called the "oxide film arrester." The functioning of this arrester depends upon the fact that certain dry chemical compounds can be changed with extreme rapidity from very good conductors of electricity to almost perfect non-conductors by the application of a slight degree of heat. Lead peroxide is a good example of such a substance. It has a specific resistance of the order of one ohm per inch cube. The resistance varies with the pressure to which it has been compressed. At a temperature of about 150 deg. cent. the lead peroxide (PbO_2) will be reduced to red lead, commercially known as minium (Pb_3O_4). This has a specific resistance of about 24 millions ohms per inch cube. At slightly higher temperatures this minium will be reduced through the sesquioxide (Pb_2O_3) to litharge (PbO), which last named is practically an insulator. [A megger reading of infinity is obtained on a column 3 millimeters long (0.11 in.) and 5 square millimeters area (0.2 sq. in.)]

Again the oxides of bismuth give similar characteristics. There are, furthermore, several other compounds

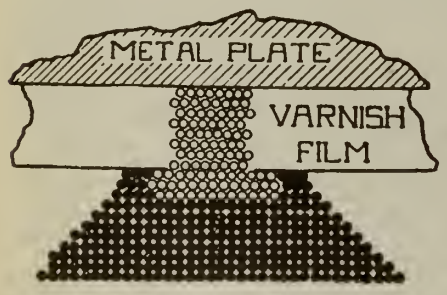


FIG. 2—DIAGRAMMATIC REPRESENTATION OF FILM ACTION.

and mixtures of compounds that will give these same results.

Lead peroxide is normally in the physical state of a powder. If this powder be placed between two electrodes and a current passed, the temperature due to the resistance at the contact of the peroxide and the metal will cause heat to be generated locally at the surface. When this heat is sufficient to create a temperature of about 150 deg. cent. a film of the lower oxides of lead forms, producing a film of insulation which stops the current. This method of film formation over any large area is rather irregular, and, of course, the oxide is not used in such a fashion in the commercial arrester. Instead of this formation of litharge film any insulating film may be put on the electrodes initially. As insulating film spread on the metal plates there have been used thin layers of the following: glass, water glass, halowax, cloth, balsam, shellac, oil, paints, lead paints, varnishes, and lacquers of all available kinds. In all cases the results are similar, varying only with the voltage at which puncture of the film of insulation occurs.

The foregoing statements define the principle of the commercial oxide film arrester. It comprises two sheet metal electrodes set about 0.5 in. apart, one or both covered with a thin insulating film and the space between the plates filled with some such substance as that described above as, for example, lead peroxide. At a permissible voltage of 300 volts per cell the insulating film prevents any appreciable current flowing under normal conditions. As soon as the voltage rises slightly above normal the film punctures in one or more microscopic points, the lightning charge meets with practically no resistance and flows to earth, Fig. 1. The dynamic current starts to follow, but because of the fact that the insulation was punctured in such fine points, the current density near these points is exceedingly great. This results in a localized heating which speedily raises the temperature to a value sufficient to change to insulating litharge all the conducting peroxide in this minute path of the current flow in contact with the electrodes. The film consequently reseals, stopping the further flow of dynamic current. This action is so rapid that its duration cannot be measured on an oscillograph giving two thousand cycles per second, that is to say, the action of resealing occurs in less than one four-thousandth part of a second after the excess of lightning voltage has ceased.

Fig. 2 shows a magnified, imaginary representation of one of the films on one metal plate. As shown, the film is punctured by a spark and filled with a litharge plug which is represented by the open circles. The cross-section in the discharge path, a short distance away from the metal electrode, is sufficiently expanded to make the current of low enough density not to heat the peroxide to a temperature of reduction to litharge. The peroxide is represented by the solid dots and only those in the path of the discharge are shown. At the other electrode, not shown in this magnified diagram, a similar effect may be taking place, although there is a difference between the positive and negative crators.

This film can be made of litharge itself, as well as any of the insulating materials above named. For example, metal plates may be inserted in any of the well-known lead electroplating solutions, and thus a very thin lead peroxide film (measuring a few hundred thousandths of an inch) formed. By proper

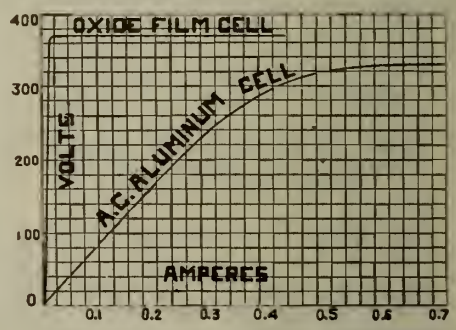


FIG. 1—CHARACTERISTICS OF ARRESTER.

heating this will be changed to litharge and this form of electrode can be used. Peroxide may also be sprinkled over any metal plate and the plate heated, which will reduce the peroxide to litharge. Again, the metal chosen for the electrode itself may be lead and if heated in the air a thin film of litharge will be formed on the surface. Again, an aluminum electrode may be put in any of the common electrolytes, and a thin aluminum film be built up. This may be used with the peroxide powder. Of these methods of forming the film the most preferable is by dipping in varnish or lacquer highly burnished surfaces of brass, steel, or copper, and is consequently used in the commercial arrester. The ohmic resistance of the arrester during discharge is quite low (less than 1 ohm per cell). Thus, when the insulating film is punctured the arrester offers very slight impedance to the flow of energy at abnormal voltages.

There is a certain range of voltage necessary to pierce any given insulation. The exact voltage depends not only upon the thickness of the insulation and its dielectric strength, but also on the relation of the dielectric spark lag to the duration of the super-spark potential and the frequency of alterations of the transient surge.

If an arrester is to give protection of insulation in shunt with it, the arrester must relieve the abnormal electric pressure before damage is done to the insulation. Although tests are frequently made with the arrester and the insulation it is to protect in parallel, a more convenient method has been standardized and is known as the equivalent sphere gap test. Both the insulation and the arrester are compared by comparing each to the equivalent sphere gap.

The equivalent sphere gap of the oxide film arrester may be analyzed, as in other cases, into separate and distinct parts. First, there is the equivalent sphere gap of the main gap to initiate a discharge through the insulating film on the plate surface of the cell. Third, there is the equivalent sphere gap of the resistance drop of the current discharging through the powdered peroxide in its path. Fourth, there is the equivalent sphere gap of the inductance of the arrester.

Commenting on these factors in their relation to this arrester, the main gap is itself a sphere gap which has the fastest spark of any practical gap. The gap setting, like that of the aluminum arrester, is only slightly above that of the normal voltage of the circuit.

The equivalent sphere gap of the film is several times greater than the thickness of the film because solid material has a greater dielectric spark lag than air, but with this multiple of the thickness of the film the equivalent sphere gap is still low. Since peroxide is a good conductor, the series resistance in the path of the discharge is insufficient to give an undesirable voltage drop. As to the inductance of the arrester, it has a minimum value due to the fact that each cell is only 0.5 in. long, and these cells are placed one on top of another. In other words, the total length of the arrester (which constitutes the inductance) is short as compared to the necessary length of conductor from line to earth.

One of the obstacles that had to be overcome in the making of this arrester was the increase in the resistance after a great many heavy discharges had passed through it. The predominant reason for the increase seems to be explained by the following theory: The current passing through this small puncture in the film heats up very rapidly not only the powder but also the air contained within the interstices of the powder. The particles are thereby thrown out of contact with each other, thus producing a fluffiness. The decrease in the number of contacts decreases the actual cross sectional area of conduction and hence increases the resistance. This raises the equivalent sphere gap. This action is accelerated, of course, by the giving off of the oxygen itself evolved in the reduction from lead peroxide to the lower oxide. If, however, this same arrester be violently jarred or the filling powder be compressed, or any other method utilized to restore the particles to their previous intimate contact, the equivalent needle gap will fall again. While increased fluffiness appears to be the predominant cause of change of the equivalent sphere gap, the increased thickness of the film of litharge at the point of puncture of the film is finally a factor of moment. The total area of the film must be sufficient to give a reasonable number of years of life to the arrester. There are other factors relating to the details of manufacture which give a limited degree of control over this change in equivalent sphere gap.

In all the commercial oxide film arresters used for alternating current the power factor is nearly unity. For special purposes, however, the power factor can be made anything desired from 10 per cent. to unity. This is obtained by combining with the conducting oxide other non-conducting materials. This principle has been made use of for condensers but it has not been found desirable to incorporate it in the arrester.

To summarize—an arrester operating under a new principle has been made which comprises in essence one or more metal electrodes covered with an insulating film, and separated by a conducting powder, which has the peculiar characteristic of becoming a non-conducting powder upon the application of heat. Voltage higher than that which can be withstood by the insulating film punctures it in one or more points of about 0.005 cm. diameter. Dynamic current flowing gives a high current density in the conducting powder adjacent to these punctures which in turn heats it up rapidly, reducing the powder to a non-conductor, and sealing the holes in the film. The powder being a poor heat conductor localizes this action, so that very little more powder is reduced than is actually necessary to seal up these minute punctures.

The critical spark voltage and that part of the equivalent sphere gap controlled thereby is a function of the thickness and kind of material used for the film.

Comparison of the "Oxide Film" With Aluminum Arrester

The earliest form of non-electrolytic film arrester was known as the dry aluminum arrester. It was a direct attempt to utilize the dry film which forms on the surfaces of pure aluminum immediately after it comes in contact with the oxygen of the air. The hydroxide film is easily formed in electrolyte and on drying becomes a dry film which gives sufficient action to prevent a discharge up to a given critical voltage, depending upon the thickness of the film. The film can also be formed by a spark or arc of a conductor in contact with a plate. Naturally this conductor should be of a non-metallic nature. In the earliest form tried powdered carbon was used mixed with dioxide of manganese which gives a liberal supply of oxygen at the heated point.

One of the objects of the development of this arrester was to decrease the cost of manufacture and it was found with the new principle involved in the oxide film arrester, where the powder furnishes the film rather than the plate, that the aluminum could be replaced by a cheaper metal, such as steel, and, as already described, the initial film known in the early stages of development as the "paint skin" type could be furnished by a layer of varnish. On first sight, knowing the extreme thinness of the hydroxide film on wet aluminum cell it might not seem that the dry cell would give the same general characteristics as the wet cell. But a comparison of the volt-ampere curves shows the same general characteristics. For a. c. voltages of 300 volts average per cell the current in the dry cell is of negligibly small value up to 40 milliamperes. The power-factor is nearly unity and the current flow is due to very slight leakages through the films. In the case of the aluminum electrolytic cells there is an equivalent condition, the d. c. leakage current of the order of one milliampere being due to leaks through the hydroroxide film. In the a. c. aluminum arrester the leakage current on the plate area used is much greater, due to the destructive action of the alternating current on the hydroxide film. Furthermore, the wet cell with its thinner film is a condenser of appreciable capacitance which takes a charging current of about 0.5 ampere at 60 cycles. When the voltage reaches a certain critical value which is between 300 and 400 volts for the wet aluminum cell and between 300 and 500 for the oxide cell (or higher if the paint film is made thicker) the current is allowed to pass freely through the cells, limited only by the ohmic resistance of the cell independent of the film. Since the oxide film arrester has no dissolution of the film, as occurs in the wet aluminum cell charging is not only unnecessary, but undesirable. This extends the use of the oxide film arrester to localities where there are no attendants.

Although the wet aluminum plate becomes frosted to an appreciable thickness by the passage of current in long use, the actual thickness of the film, as represented by the critical voltage, is not changed. In the oxide film arrester, however, the film less than one 1 mil thick initially thickens up by the addition of successive spots of litharge for each successive discharge. This represents the wear on the arrester and limits its total life. Fig. 1 shows comparative volt-ampere characteristics of the oxide film arrester and the a. c. aluminum arrester. Since both of these arresters have a leakage current which wears the plates of the cells when arternating current is supplied, it is necessary, as previously stated, to place a spark gap in series with the cells. This spark gap is set at a value slightly above the normal potential of the circuit so that nothing but abnormal voltages will cause a discharge.

Mr R. S. Wright, Sudbury, Ont., writes: "I have always looked on POWER HOUSE as our own country engineer's journal, and it is up to us stationary engineers at this time to show our patriotism and support home industry."

Methods of Mounting Motors on Ceilings

By Mounting Motors Near the Ceiling or in the Roof Trusses Valuable Space is Saved and Economies Effected in Transmission Where Group Drive is Employed

By RALPH G. BRADSHAW

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IT very often occurs that the most desirable location for a motor for a group drive is at or near the ceiling of the room. In such a location the motor does not occupy valuable floor space, and is immune from meddling by the unauthorized. There are two possible objections to such a location. One is that the space near the ceiling is always the hottest part of the room, which is undesirable, because a motor placed in such a location may become unduly overheated. The other objection is that unless proper provisions are made, a motor near a ceiling may be difficult to inspect and repair. The last objection can be nullified, provided proper ladders and platforms are installed, from which the inspector can work.

Where a small motor is to be placed it can be bolted, inverted, directly against the ceiling. Timbers can be secured against the ceiling, into which lag bolts, passing through the bolt holes in the motor frame, can turn. Lag bolts should, however, never be used to support a motor, hence the preferable and only dependable method of supporting a motor at or near the ceiling is to fix the supporting bolts so that they will pass entirely through the floor. The most effective way to raise an inverted motor to a position against the ceiling is to thread two lines or falls through diagonally opposite holes bored through the ceiling, as above suggested. In boring these holes care must be taken to place them so that they will exactly fit over the holes in the motor frame. The lines are passed through from the storey above to the floor of the room below. The motor to be mounted is turned upside down on the floor, and each of the two lines is threaded through a bolt hole in the motor frame corresponding in position to the hole in the ceiling above through which the line passes. Then a knot is tied in the line below the motor frame so that when the lines are pulled on the knots will sustain the weight of the motor. Then helpers on the storey above pull on the lines and draw the motor in position against the ceiling. Bolts are inserted through the remaining holes in the floor and through the motor bed plate and the nuts are set up on these bolts, holding the bed plate firmly in position. Then the lines are removed and supporting bolts are pushed through the holes in the floor from which the lines have been taken and through the motor bed plate, and their nuts turned up on them.

With larger motors it is necessary to build a shelf or platform upon which the motor may rest and upon which the inspector may stand while cleaning and adjusting the machine. Fig. 1 shows a simple motor platform that has been found very satisfactory in practice. A number of supports similar to this were used in the Omaha shops of the Union

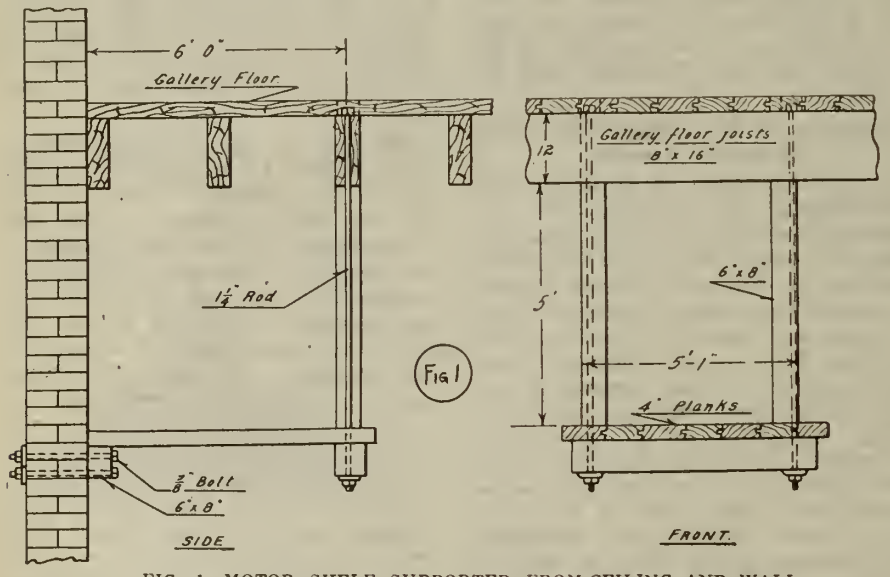


FIG. 1—MOTOR SHELF SUPPORTED FROM CEILING AND WALL

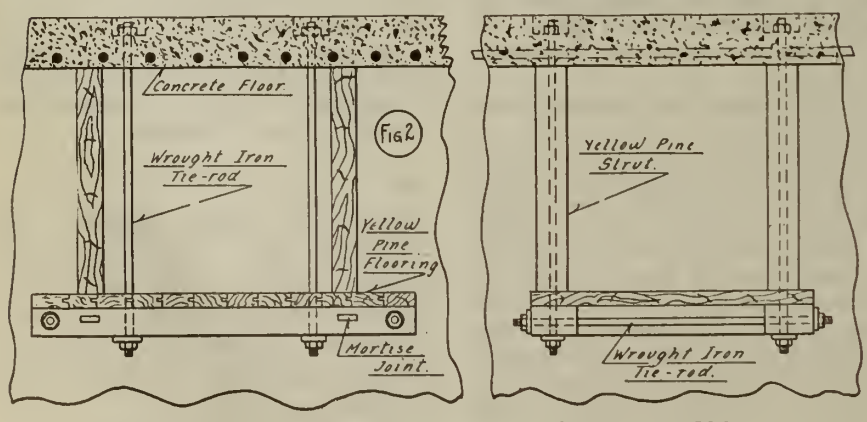
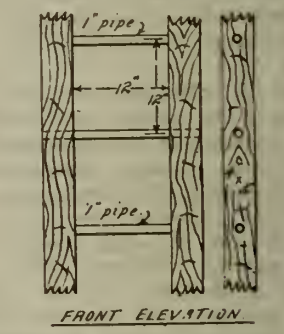


FIG. 2—MOTOR SHELF SUPPORTED FROM CONCRETE CEILING



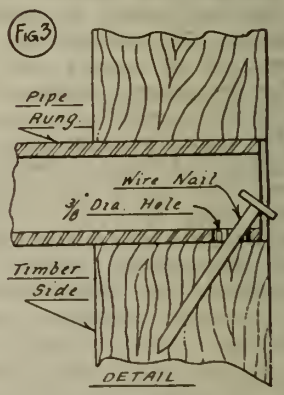


FIG. 3—CONSTRUCTION OF A LADDER WITH PIPE RUNGS

Pacific Railway. Group drive motors of outputs in the neighborhood of 20 h.p. were mounted on the platforms. It will be noted (Fig. 1) that all of the platforms were arranged along the side of the building, so that a 6x8 in. timber held to the brick wall with ⅞-in. bolts formed a support for one edge of the platform. An 8x8 in. timber formed a beam carrying the outer edge of the platform. This timber was in each case

held from the floor above by two 1¼-in. tie rods that passed vertically entirely through 8x16 floor joists. Care was taken to so locate the motor platforms that the tie rods would, in every case, pass through holes in the floor joists, because the holes in the joists in which the tie rods snugly fitted provided lateral support for the platform structure and tended to minimize vibration. A 6x8 strut was clamped in at the side of each tie rod between the platform floor and the gallery floor joists. A slot was cut in the side of each of these struts for the accommodation of the tie rod, which maintained each strut in its correct position.

A platform that has been successfully used for supporting motors to ceilings in reinforced concrete buildings is shown in Fig. 2. The tie rods pass, as they should in every case, entirely through the floor, so that they will be substantially supported from above. The timbers comprising the frame upon which the floor is laid are mortised and tenoned and are held together with iron tie rods, eliminating any possibility of the shaking asunder of the frame. Where there is a considerable side pull occasioned by a belt drive from a motor platform, it may be necessary to install braces for a platform like that shown in Fig. 2, to prevent the platform from being pulled out of its position laterally. Ordinarily, however, such braces are not necessary if the platform is well constructed and the nuts of the tie rods are set up snugly.

It is, however, essential that a good ladder, or some other means of access, be provided to every motor platform. If it is difficult for the inspector to reach the platform, the motor will probably not receive the attention that it should. A splendid form of ladder that will not wear out, and which can be readily constructed is shown in Fig. 3. The side pieces are 4x4 timbers and the rungs are 20-in. lengths of 1-in. pipe. Pipe that can not be used for any other purpose, because it is rusted, or cracked, can be utilized for rungs of a ladder of this type. The 12-in. distance between centres of rungs provides a convenient spacing, but this can be increased or decreased in accordance with the practice prevailing in the plant where the ladder is installed. The holes through the 4x4 timbers for the reception of the pipe should be so bored that the pipe will fit into them very snugly, and a nail should be driven, as shown in the detail in Fig. 3, through a hole in the end of each pipe to prevent its turning as a man mounts the ladder. The nails also keep the rungs from slipping sideways out of the timbers. The nails should always be driven in far enough so that they will not extend and cut the fingers of a man using the ladder.

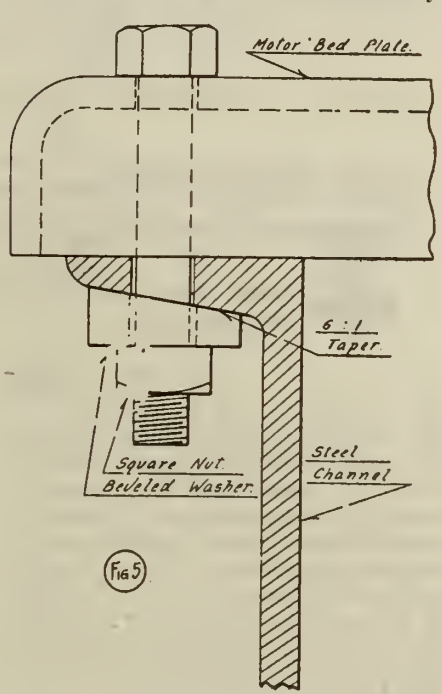


FIG. 5—DETAIL SHOWING HOW BEVELED WASHER IS USED

Ordinarily, ladders about an industrial plant are made with 2 x 4 vertical timbers, and 1 x 4 rungs and such are, of course, cheaper, in first cost at any rate, than the ladder in Fig. 3, but the rungs in wooden ladders wear out, and sometimes they break and injure a man and thereby involve a damage suit. It is for the reason that the pipe rung ladder is always safe and will practically never wear out that it is probably more economical in the long run than a wooden ladder. The pipe rungs can be cut and drilled in the pipe shop at times when the mechanics have no other work to do.

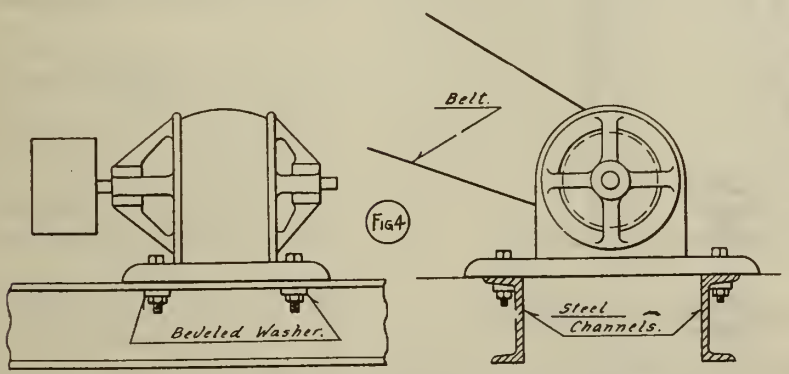


FIG. 4—SMALL MOTOR CLAMPED WITH BEVELLED WASHERS

In modern plants the practice of using structural steel for supporting motors is every day becoming more popular. In some shops wood construction, and, in fact, any construction that is combustible, is not permitted.

Structural steel is used instead and provides a permanent, rigid, and fireproof frame for the motor platforms. Small motors can be conveniently mounted on a couple of channels, as suggested in Fig. 4. The holding-down bolts of the motor pass through holes in the channel flanges and are held therein by nuts turned on at the lower ends of the bolts. Inasmuch as the sloping surfaces of channels and I-beams always slant with a 6 to 1 pitch, it is necessary to insert so-called beveled washers between the holding-down bolt nut and the flange face, as shown in Fig. 5, so that the nut will have a horizontal surface upon which to slide. Fig. 7, in connection with Table I, shows dimensions of beveled washers for use with I-beams and channels that have been found satisfactory in practice. It is not usually possible, so far as the writer is aware, to obtain these beveled washers on the open market. They can sometimes be secured from the structural steel companies, but if many are to be used it will pay any concern to make a pattern like that shown in Fig. 6 and have the washers cast at the nearest foundry. It will be noted that in the pattern of Fig. 6 a deep groove is cut between adjacent washers. A strip of a half dozen or more washers is cast from one pattern and then the washers can be broken off along the grooves as they are required.

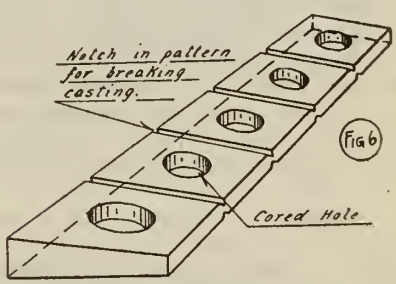


FIG. 6—METHOD OF CASTING CHANNEL WASHERS

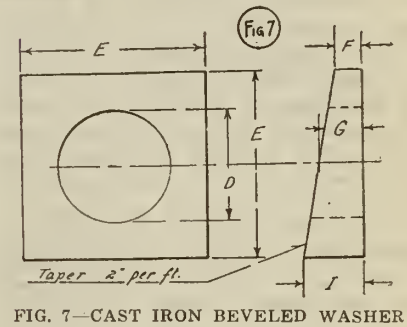


FIG. 7—CAST IRON BEVELED WASHER

With larger motors, it is not feasible or desirable to bolt them directly to the flanges of steel sections as shown in Fig. 4. The disadvantage of this Fig. 4 method is that the holes must be drilled accurately in the channel or I-beam

flanges for the accommodation of the holding-down bolts, and furthermore, that after the holes have been drilled only one position of the motor is possible. The arrangement of Figs. 8 and 9, wherein cast iron channel washers, Fig. 10, are used for clamping the structural steel members together, eliminates both of these disadvantages. No drilling is required in the channels that comprise the supporting frame, and the character of the construction is such that the motor can be readily shifted along the two channels upon which it rests, and these two channels can in turn be shifted along the members upon which they rest, so that the motor can be readily aligned with the pulley which it is to drive.

As suggested in Figs. 8 and 9, two channels are always used to form a supporting beam where the channel washers are utilized. The channel washer has two functions. The first is that it provides a means of clamping the two channels that fit into it to some other member, and the second function is that it maintains these two channels at a given distance from one another. The protection, G, in Fig. 10, maintains the channels at a given distance apart. It is seldom possible to obtain these channel washers on the market, and for this reason Table II is given to show some dimensions that have proven satisfactory in practice. These channel washers can be used for other size sections than those shown in the first

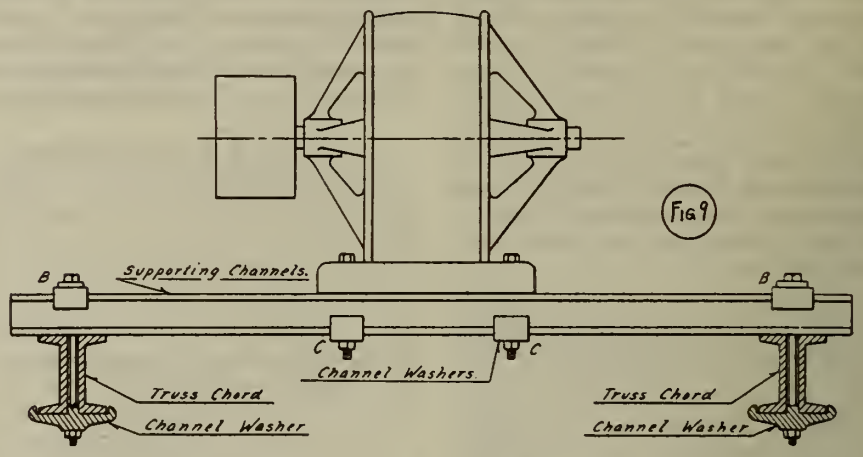


FIG. 9—SECTION A-A OF FIG. 6

tural steel frame of the building. A man standing on such a floor is, therefore, liable to receive a severe shock. It is for this reason that it is probably usually the best practice to place a wooden floor on a steel platform around the motor, particularly if it is high up in the roof trusses, because if a man fell from such a location it would probably be fatal. The amount of wood in such a floor should be maintained at a minimum.

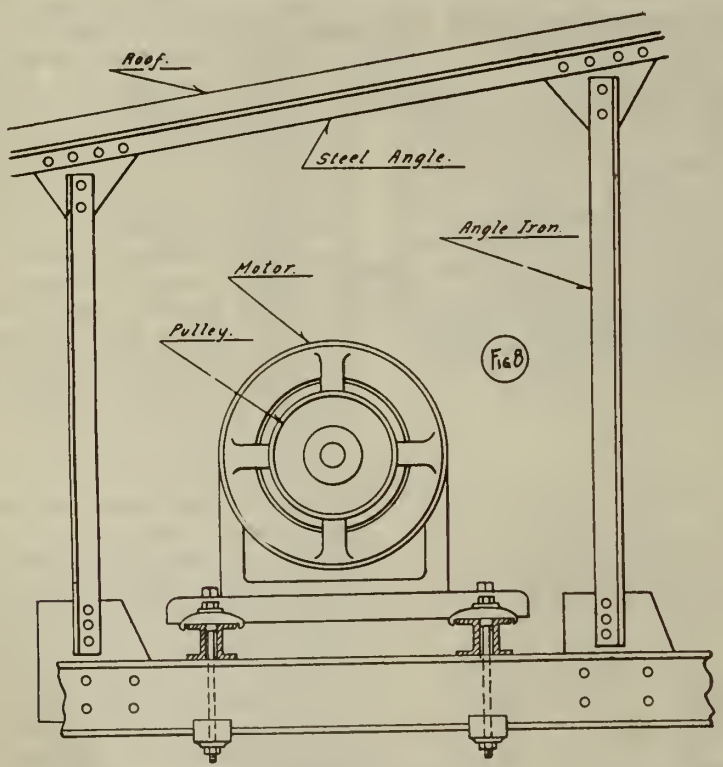


FIG. 8—MOTOR MOUNTED ON CHANNELS CLAMPED TO STRUCTURAL STEEL ROOF TRUSS.

column of the table, and also in combination with small I-beams.

No floor is shown in the motor platform in Figs. 8 and 9, because practice differs in regard to floors on structural steel motor supports. Some concerns insist rigidly upon the elimination of wood, in which case floors of standard checkered steel plate can be used. Such floors are, however, of necessity always grounded on the struc-

CONVERTING A PIPE THREADING MACHINE INTO A LATHE

By J. M.

The following description as to how we made a pipe-threading machine serve the purpose of a lathe may be old to some of your readers, but on the other hand it may be new to others. We had occasion to use some lengths of 2¼ in. round iron as shafting, the ends of which had to be turned down to 2 in. to fit the couplings, and to suit the supporting bearings the shafting had to be turned down to 2 ins. at various places.

Having no lathe capable of doing the work, resource was had to the pipe-threading machine, and with fairly satisfactory results, notwithstanding that the machine was old and somewhat the worse for wear. The gripping chuck served as a driver, and the guides in the die head supported the shafting just where support was required. Two tools (right and

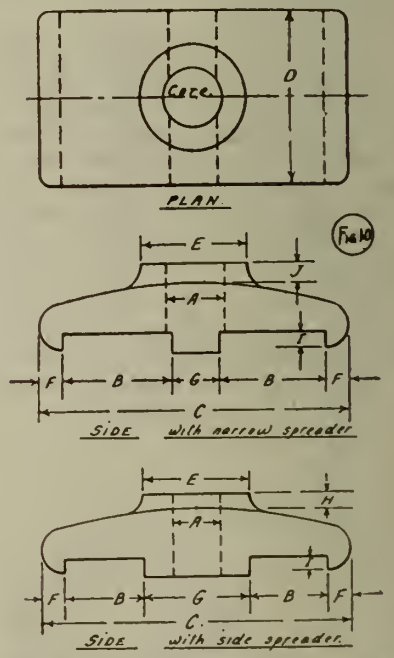


FIG. 10—CAST IRON CHANNEL WASHERS

left hand) were made to fit the tool slide rest, where the cutting-off tool usually fits, and by substituting a nut and screw arrangement for the rack and pinion gear we had a very serviceable lathe for the work in hand.

Mr. A. R. Dooley, Leitchville ,Sask., writes: "I am very much in favor of the change to a semi-monthly paper. I enjoy POWER HOUSE."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before The House

If a tube in your boiler developed a slight leak, as through a pitting that had gone through the tube, or a small sand hole, how would you stop the leak without dropping the pressure?

You have a compound engine, 11x19x 12 in. stroke, running at 260 revolutions per minute. Cut off in the high pressure cylinder is a ⅝ of the stroke. Cut off in low at 3-4 of the stroke. What is the horse power aproximately?

In the case of the above engine, what is the probable steam consumption per hour, and what size would you have to make a pump to supply the water consumed to the boiler?

10. Why is a horizontal engine, running over, provided with guides top and bottom? Which guide does the pressure act on, and why?

11. A cylinder 24 in. bore, carrying an initial pressure of 100 pounds per square inch. Allowing 5,000 pounds per sq. inch on the studs, how many would be required, and what pitch should they be set at?

12. The stays in a horizontal tubular boiler have an allowance of 6,000 pounds per sq. inch. If the segment is 24 in. high and the boiler 72 inches diameter, what is the number and diameter of stays required?

Questions Answered

2. The amount of lift possible in any pump is governed by the pressure of the atmosphere, and the degree of efficiency in the mechanical parts of the pump. Strictly speaking, such a thing as lift does not exist, or suction either. The pump plunger partially exhausts the air in the suction pipe, and the pressure of the atmosphere acting on the free surface forces the water into the vacant space. The pressure of the atmosphere is approximately 14.7 lbs. per square inch. This corresponds to a height of 33.8 feet, and if a pump were perfect, and could create a perfect vacuum in the suction, it would "lift" from this height. Practically, the average pump is limited to about 25 feet, due to leakage through glands, valves, pistons, etc., and friction in the pipe. The fitting of a foot valve is in no way a help when the lift has approached the limit, as in this case the valve represents an additional load for the pressure to lift.

In pumps which have a long suction pipe, but not necessarily a great lift, the fitting of a suction foot valve is a great help. By the help of this valve the pipe is kept full of water, and the first stroke of the pump creates an empty space and the atmospheric pressure is amply sufficient to overcome the resistance of the foot valve and pipe friction.—T.H.F.

9. Assuming initial pressure to be 90 lbs. per sq. inch. Cut-off takes place at ⅝ of stroke, giving a ratio of expansion of 1.6 in the high pressure.

90÷1.6=56.25=Mean pressure during stroke.

This is expanded at the end of the stroke into the L.P. cylinder which has an area in the proportion of 1.3 of the high pressure cylinder. The cut-off takes place at ¾ stroke, giving a mean pressure in the L.P. cylinder of 14 lbs. The M.E.P. of high pressure will be 56.25 less 18.75=37.5 lbs.

$$\text{The M.E.P. referred to low will be } \frac{\text{M.E.P. of High}}{R} + \text{M.E.P. of Low} =$$

$$\frac{37.5}{3} + 14 = 26.5$$

$$\text{H. P.} = \frac{19^2 \times .7854 \times 26.5 \times 11 \times 520}{33{,}000 \times 12} =$$

108.5 I.H.P.

An engine of this type would consume, say, 25 lbs. steam per H.P. per hour.

108.5×25 = 2,712.5 lbs. per hour.

$$\frac{2{,}712.5}{62.5 \times 60} = \text{cubic feet per min.} = .723 \text{ C.F.}$$

.723×1,728 = say, 550 cubic in. per min.

Allowing the pump to be 75% efficient, that will be

$$\frac{550 \times 4}{3} = \frac{2{,}200}{3} = 733 \text{ C.I.}$$

Allowing a piston speed of 50 feet per minute we have at, say, 50 strokes per minute a stroke of 12 inches which gives a diameter of, roughly, 8¾ inches.

11. A cylinder 24 inches diameter will have an area of 452.39 square inches. The total pressure on the studs will be

452.39×100 = 452.39 lbs.

Studs are allowed to carry 5,000 lbs. per square inch.

$$\frac{45{,}239}{5{,}000} = 9.04 \text{ square inches}$$

The circumference of the pitch circle will be

(24+2) × 3.1416 = 81.6816 inches.

Allow pitch of 3 inches, giving, say, 27.2. Make number of studs 28. Divide 9.04 by 28 = .323 sq. inch. for each stud. This corresponds to ⅝ in. dia. nearly.

28 studs — ⅝ in. diameter.

12. The area of the segment will be

$$\frac{4h^2}{3} \times \sqrt{\frac{d}{h} - .608} = \frac{4 \times 24 \times 24}{3} \times \sqrt{\frac{72}{24} - .608}$$

4×8×24×√(3—.608)=1,843 sq. inches.

At 100 lbs. per sq. inch total pressure = 184,300 lbs.

184,300 ÷ 6,000 = 30.7 sq. inches.

A pitch of 10 square inches would give 18.43 stays. Make stays 19 in number. 30.73 ÷ 19 = 1.6 sq. inches per stay. Say 19 stays of 1½ inches diameter.

PERSONAL

Frank J. Tone has been made president of The Carborundum Company of Niagara Falls, succeeding the late Frank W. Haskell. George R. Rayner has been made vice-president, succeeding R. B. Mellum of Pittsburgh. F. H. Manley retains the office of treasurer.

Lieutenant R. A. Fisher, U.S.N.R.F., for the past eighteen months connected with the Flying Corps, has joined the sales and engineering force of the J. R. Stone Tool & Supply Company, Detroit, Michigan. Lieutenant Fisher, before entering the Service was connected with the Curtis Aircraft Corporation and the Continental Motors Corporation, Detroit and Muskegon.

Progress in New Equipment

PORTABLE CONVEYORS REDUCE COST OF HANDLING COAL AND ASHES

TO secure economical operation and greater efficiency in handling material, labor must be supplanted by machines, and those selected which are best adapted for the particular work. Men with wheelbarrows are too costly to use in storing, moving or loading material, but, at the same time, the old style conveyors required a great deal of labor in shovelling the material up into the receiving hoppers.

A new type of portable conveyor, which cuts the labor of feeding one-half, is shown in the accompanying illustrations. The most distinctive feature of this machine, called the scoop conveyor, is the scoop on the feeding end, which can be pushed or completely buried in

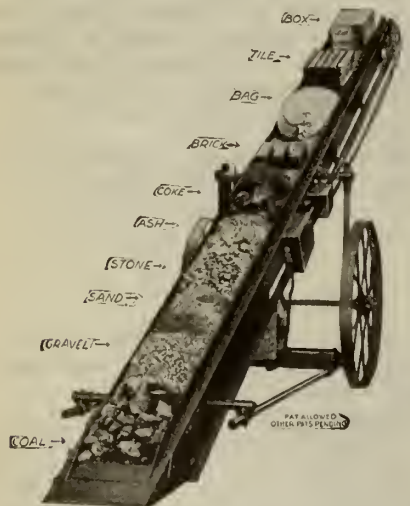


FIG. 1—A 19 FT 8 IN. CONVEYOR EQUIPPED WITH 16 IN. WIDE BELT AND DRIVER BY 2 H.P. MOTOR.

the material to be conveyed. This makes it possible to simply scrape the material onto the carrying belt, instead of lifting it up by shovelfuls into the feeding hoppers of ordinary conveyors.

Another exclusive feature of this machine is the construction of the sides or skirt plates, as they are called. These form a trough, which enables a 12-inch wide belt to equal in carrying capacity a 20-inch ordinary troughed belt. This is readily understood when one remembers that on a troughed belt the material is carried in the centre or trough, that on the sides falling into the trough or rolling back, whereas the side plates on the scoop conveyor hold the material together, giving the whole width of the belt carrying effectiveness. It is due to the skirt plates, also, that a 24-ft. long scoop conveyor will convey material as high as a 30-ft. troughed belt. The resultant saving in belt expense is considerable, as two new 12-inch x 24-ft. scoop conveyor belts can be purchased for the price of one 20-inch x 30-ft. troughed conveyor belt.

Actual Savings

The money savings resulting from the use of a scoop conveyor are due, first, to the saving in labor; second, to the speed at which material is conveyed. In comparison with handling material by hand, one or two men with a scoop conveyor will do the same work as from four to twelve men, depending upon conditions. The scoop conveyor will load trucks in one-fourth to one-sixth the time required by men shovelling. It often enables one truck to do the work of two trucks and of getting two days' work done in one day.

Storage capacity is another factor of saving attributed to this machine, as it increases the available capacity of a shed or yard space by enabling the men to pile higher.

FIG. 2—UNLOADING FROM WAGON TO STORAGE PILE.

A few statements of actual savings made by the use of portable conveyors may be of interest:

Gay Bros. Co., (Cavendish Woollen Mills), Cavendish, Vt. One man now used instead of four to pile coal for storage and to move it into boiler house. Average saving is $7 per day.

Baird Machine Co., Bridgeport, Conn. Reduced yard force from five men to one. Now unload coal from cars quickly, without having to pay demurrage charges.

FIG. 3 LOADING TRUCKS WITH A CONVEYOR.

Fonda Glove Lining Co., Fonda, N.Y. Load from 2 to 3 tons of soft coal from ground into auto trucks in from 3 to 5 minutes.

Colonial Steel Co., Pittsburgh, Pa. Unload coal from hopper cars with scoop conveyor at 50 per cent. of former cost. They figure machine has paid for itself more than once in a year.

J. L. Prescott Co., (shoe polish manufacturers), Passaic, N.J. Former cost of unloading coal from cars and putting it into storage bins was 28c per ton. It is now done with a scoop conveyor at 4c per ton, or a saving of 85 per cent.

Marcus S. Wright, (miner of foundry sands and clays), South River, N.J. Before using the scoop conveyor employed 6 men to load railroad cars. Now do the work with 3 men and get out larger tonnage. Load 150 to 175 tons of silica sand into cars with scoop conveyor in a 9 hour day with 3 men, which was impossible with 6 men working without the machine.

FIG. 4—UNLOADING FROM COAL CAR TO STORAGE PILE WITH A SCOOP CONVEYOR.

Capacity and Uses

The carrying capacity of the scoop conveyor, based on handling coal, is one ton per minute, provided a sufficient amount of coal is maintained at the receiving end of the machine. If the storage pile is of sufficient height, one man can easily feed one ton in one and a half minutes, or if the pile is low, he may require from two to four minutes. Where speed is required two men may be provided for feeding. In unloading hopper bottom cars the machine and one man can remove one ton per minute.

Large size coal, coke, crushed stone, etc., fed by one man, require from three to six minutes for one ton, or half that time with two men.

The scoop conveyor is used principally for storing, reclaiming and loading bulk material and light articles. There are an unlimited number of uses for the machine, in addition, such as elevating material to tanks or platforms in chemical and industrial works, feeding from cars and delivering into fixed conveyors or stoker magazines at power plants, etc. Almost any kind of material can be handled, such as coal of all kinds, ashes, sand, earth, crushed stone, blast furnace slag, ore, fertilizer, salt, chemicals, grain, bags and light packages.

The scoop conveyor may be used singly, in tandem or in triplicate, as may be required. The employment of sets of two or more allows for an increase in height of the storage pile or conveying distance. Fig. 5 illustrates three machines unloading coal from hopper cars up a long steep incline.

Construction

As may be seen from Fig. 1, the scoop conveyor is strongly constructed, light in weight, compact and portable. The steel frame holding the rollers and conveying belt is mounted on the wheels so the balance is perfect. One man, by inserting the pipe handles into the ends of the horizontal members, can easily lift and move the machine around.

FIG. 6—ONE MAN CAN MOVE THE SCOOP CONVEYOR FROM PLACE TO PLACE.

The electric motor or gasoline engine mounted under the frame transmits power to the conveyor by means of a chain and sprocket connection to a shaft extending beneath the conveyor. From a sprocket on the other end of this shaft the power in turn is transmitted to the driving sprocket, located at the upper end of the conveyor.

The carrying belt is a high grade of heavy duck and rubber conveying belt and duck cross strips. These transverse cleats are provided to prevent the material from slipping back down the incline.

The scoop conveyor is made in three different sizes: 13 ft. 8 in., 19 ft. 8 in., and 24 ft. The width of the conveying belt on any of these sizes may be either 12 in. or 16 in. wide, as desired. Size 13 ft. 8 in. elevates to a total height from the ground of 5 ft. 9 in.; the 19 ft. 8 in. size may be adjusted for any height from 6 feet to 9 feet, and the 24 ft. size may be adjusted for any height from 9 feet to 12 feet. The machines are furnished with either electric motor or gasoline engine, or where customer prefers to furnish and install motor himself, motor support and drive from motor shaft are provided.

For catalogue and other information address the manufacturers, The Portable Machinery Co., Inc., Passaic, N.J.

CUTTING STEEL UNDER WATER

An oxy-acetylene blowpipe of special construction has been used for some time past by a French firm for cutting steel under water, a feat hitherto considered practically impossible. The apparatus consists of a cutting blowpipe supplemented with a small diving bell to which compressed air is admitted to expel the water. The pressures of oxygen and acetylene required are much higher than those usually employed, and, naturally this pressure will depend upon the depth at which the apparatus is worked. At the trials now being carried out, ships' plates have been cut at a depth of 27 feet under water. It has been proved that arc cutting can be carried out in a similar way, but the apparatus is slightly more elaborate.

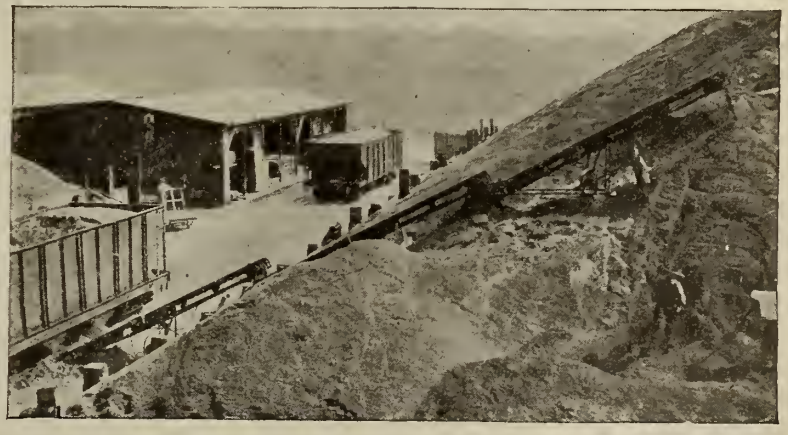


FIG. 5—USING THREE SCOOP CONVEYORS TO UNLOAD FROM HOPPER BOTTOM CARS TO LARGE STORAGE PILE.

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Condensers or District Steam Heating

AN interesting problem in power plant economics has arisen in England where the super station located at the coal mine will likely be the plant of the future. These stations will supply the surrounding towns and cities with electrical energy generated in the most efficient plants that present-day practice makes possible.

A counter-proposal has been worked out whereby every little community, village and town would have its own electric station from which it will distribute power, light, heat and hot water at a cost of one-quarter of the best a super-electric station can possibly reach. This economy is made possible through the well-known fact that 90% of the heat supplied to an engine goes to waste in the condenser water and the use of exhaust steam for district steam heating would enable the power company to sell 50% instead of 10% of the heat value of the fuel.

The consumer would benefit through the comfort, cleanliness and saving of labor which would result.

Post-War Economy

WHILE the engineer is not again likely to have war necessities put forward with considerable emphasis as a reason for conservation, the necessity for economical operation still exists and the lessons learned should not soon be forgotten. The coal pile has assumed an importance in the eyes of the plant-owner commensurate with its ever-rising value, and the engineer will, of necessity, be judged by the use made of its possibilities for the production of power.

The power plant is an excellent example of man's ability to apply abstract science to commercial ends, and it is in the application of the chemical phenomenon of combustion and of the laws of thermodynamics that economies are effected or waste occurs. Any given plant can never be more efficient than its design permits, but anything short of maximum efficiency is in many cases easily remedied.

The engineer now has available excellent recording and testing equipment, and by keeping close check on the performance of the boiler room and engine room can pay for the equipment necessary over and over again.

Do You Keep Records Like This?

MUCH waste is due to want of records. As District Engineer to the Controller of Coal Mines, A. E. Edwards, in a recent address given in England, said he was much struck by the absence of records in all classes of steam plants, and cited an example of those which he occasionally ran across. At one place he was shown very careful records of the cold water used for a number of years but the manager had not the remotest notion of why they required 70 tons of coal a week, how they burnt it, or what duty they got from it; indeed, they knew they burnt 70 tons a week by dividing their annual purchase by 52.

THE British Admiralty is advertising in some of the papers that it has a number of German submarines for sale cheap, the only stipulation being that they shall be broken up. There are quite a heap of folks who would with pleasure tackle the breaking-up job.

AN agitation is on in England, and it promises to gain strength, the object of which is that husbands shall pay wages to their wives. But in the case of the well-trained man, who simply comes home and tosses his pay envelope into his wife's apron, what is going to happen? Will some courageous individual arise and suggest that the husbands shall be allowed a certain amount as salary?

Dollars Wasted in Pipes and Fittings

By T. H. FENNER, Associate Editor Canadian Machinery

INDUSTRIAL plant managers have been brought to a sense of realization of power plant costs during the last two years. The result has been a tightening up of supervision, and a close analysis of fuel, water, maintenance, and wages costs, with an appreciable reduction in these items in many cases.

There is another item which it is more difficult to keep adequate trace of, but which is responsible for many hundreds and even thousands of dollars loss in a year, according to the size of the plant.

Hard to Keep Track Of

The modern factory contains many thousand feet of piping, wrought iron, copper, brass and galvanized, and this piping is being constantly renewed, repaired, or altered. From one to twenty steamfitters and helpers are kept busy on this work, varying with the extent of the buildings, and keeping track of all the material used becomes a matter of great difficulty, unless a very rigid system is in force. This applies to the power plant itself and to all the piping through the factory.

Generally speaking, it is in the smaller plant that the greatest waste of both time and material takes place, owing to want of a proper system, but even in many large plants, where the organization is on a much better basis, the loss, though smaller in proportion to the general expense amounts to large sums in the aggregate.

The Case of the Small Plant

Take the case of a small plant of from 100 to 200 horsepower, which are in the majority in this country. A plant of this kind may employ a steam fitter, or the man in charge of the engine and boiler room will attend to the repairs himself. In this case the element of time does not enter into the question so much as the man is usually employed on a standing wage basis.

There will be piping in a plant of this kind ranging from ⅛ inch diameter to six inch, and fittings for all these sizes. All fittings, pipe, packing and tools will be kept in the engine room, and the man in charge will have complete control of the ordering of material, and the using of it. He will be directly responsible to the manager, who cannot in the nature of things have much idea of the requirements of this department; and has to depend entirely on the engineer's judgment.

In a plant of this kind it is not usual to carry a large stock. As a rule, there will probably be from one to three lengths of each size of pipe up to 2½ in., the larger sizes not being carried, but ordered as required. Fittings for all these sizes will be on hand, and a collection of valves of various kinds. Now the number and variety of fittings would surprise a good many people who have not given the matter much thought.

There are elbows, forty-five degree elbows, tees, crosses, reducing bushings, couplings, unions, flange unions, locknuts, plugs, caps, side outlet elbows, etc. These are made in three different kinds; cast iron, malleable and galvanized, all suitable for different classes of work. Whether the right kind for the particular job is used or not depends on the knowledge of the man doing the job, and the durability of the job depends also on using the correct material.

The stock of these fittings carried on hand also depends on the good sense or otherwise of the man in charge. To be short of some particular fitting when it is badly needed, may result in the shut down of the whole plant, while on the other hand, to carry a large stock means tieing up money which could be better used elsewhere. In how many of these small plants could the engineer give a reasonable idea of the stock on hand at any particular moment, without a wild scramble through his stock? Very few, it will be found. What usually happens is that he takes a look in the bins when getting some fitting out, and orders a dozen of a few different kinds, to keep up the stock. This results usually in a surplus of the particular variety in most use, and a shortage of most of the others. Then the time comes when a particular fitting is needed, and needed badly. It is not there. The job can't wait, so what happens? Instead of using the cast iron fitting a galvanized fitting of the same size, and costing about 30% more, is taken. If that is not available then a larger one is used, and the difference made up by the use of reducing fittings at each end. This, again, brings up the cost of the material, and if there are several fittings on the job it may easily cost double. The time occupied in doing the job is increased, and even if the man's time does not count, the delay to a department of perhaps 25 to 50 hands is considerable. Then when the job is done, instead of examining the fittings that have been taken down, to see if their usefulness is entirely over, a hundred to one they are thrown into the scrap heap.

Can be Used Elsewhere.

Now, a fitting that may not be of much use on a high pressure steam line would be of use on an exhaust heating line, or a low pressure steam line. The same applies to the pipe. Although one part may be bad, the rest of it might well be used in some other part of the system. There being no check on the material used, or a very inadequate one, a number of fittings and several pieces of pipe are wasted on that one job alone. Now take the case of valves. Here is one of the most prolific sources of waste in most plants. To begin with, it is usual to find every make of valve known to industry represented on the system. This is bad in itself, for if a valve of one make is removed from a line, and another one substituted, there is nearly always a difference in length. This means that the length of pipe has to be pulled together or sprung apart, which entails a straining of fittings, which sooner or later results in another repair job. Again, a valve has a defective spindle. There is no spare spindle on hand, therefore, the whole valve has to be taken out of the line, and another one substituted. This usually entails the taking down of two or three lengths of pipe and fittings before a flange or union is reached. What becomes of the body of the valve, which is perfectly good? Mostly it is thrown in a corner and forgotten, and when another valve gives out on the body part the same procedure is gone through. Now if all valves when taken out of the line were carefully dismounted, and the bonnet, gland nut, and spindle put into separate bins or boxes, a good deal of money could be saved in the course of a year. In addition to this, one make of valve should be determined on as the most suitable, and whenever an old valve is replaced it should be by one of this standard pattern.

A Standardized System

In this way the whole of the system will be gradually standardized. Furthermore, a straightway gate valve should never be employed on a steam line, as it is almost impossible to keep them steam tight. Another source of waste is that of cutting a length of pipe, only to find it too long or too short by a ½ inch when put up. This means it has to be either cut and screwed all over again, or else the springing method so much in favor among steamfitters is resorted to. They get the pipe together, but it is in no condition to take up the normal working stresses, having been considerably strained already. The result is another repair job very shortly.

What About the Large Plant?

If this is all true in the small plant, what about the

large ones, where the extent of the piping system is multiplied many times?

Here the stock is usually carried in a special stock room, and the engineering department makes requisitions on the stock room for the material required. An adequate stock is usually kept on hand, and a card index system is employed which keeps a record of stock drawn and stock on hand. The stock room puts in its own requisitions on the purchasing department to replenish the stock. Even with this it occasionally happens that the stock room clerks allow some particular stock to get too low, and before their order has gone through a demand arises for the particular article that is out of stock. I have seen a whole section of a factory without heat for three days in the middle of winter, for lack of a seven-inch fitting. It is always well for the chief engineer or foreman steamfitter to keep tabs on the stock himself, and remind the stock clerk when anything is getting low.

So far as the stock room goes the the system is all right, and the chances of over or understocking not very great. However, when we come to the requisitioning of stock by the steamfitting department, the same elements of waste arise as in the smaller plant. We will take a case in point. The chief engineer receives a message that a bad blow of steam is occurring in a certain department. He sends a hurry-up call to the steamfitting shop, and a man is despatched to find the trouble. He sees the break, gets the steam shut off and starts in to make repairs. He sends his helper to the pipe shop for some fittings. The ones he wants are not there. There is no time to get an order signed by the chief, so the helper is sent to the stock room for such and such material, for which an order will be returned later. On the steamfitter's time slip will appear so much time, and so much material on this particular job. No record of material saved from the job, or whether the material charged was actually used, or some of it thrown back in the pipe shop, or how much scrapped. The only record is so much material issued from stock and charged up on the job.

Now, supposing some of the fittings have not been actually used on the job, some of the old fittings having been used again. These fittings are, as far as the books are concerned, gone, and their value written off. They may be returned to the pipe shop, or if the job is in an out of the way spot, left lying around. The result of this is that there is an amount of stock lying in the pipe shop which there is no trace of. Now, it is surprising, how much of this stock will find its way out of the gate. In a large factory men are dropping in to the pipe shop every now and again for a half-inch tee, or a two-inch elbow, and as the stock has not to be accounted for they get it. In the course of a year this amounts to a considerable sum.

If a new line is to be put up the same thing occurs. The man who is to do the job figures out what fittings he wants, gets a requisition signed, and receives the material. Anything over goes into the pipe shop, not back to the stock room, and the department is charged for the full amount. The same things occur with regard to valves, etc., as in the small plant, but on a larger scale.

The Remedy

The way to remedy this, in both large and small plants, is simply to check up closer on the material used, and this can be very easily arranged. Instead of simply having a time slip, with the material used entered in, a properly marked slip could be used, which would be a complete history of the job. First of all, it would be necessary to take stock of the material on hand, accounting for everything, good or bad. What is no good can be weighed, and put on the scrap heap. The next step is to have properly marked and classified bins, or stands, with two divisions for each class of fitting, one for old and one for material already used once. You are now in a position to keep track of your stock, which is, in other words, your money.

When a new line of pipe is to be put up, instead of issuing orders to put it up, get an estimate on the job from your staff, whether in a large or small plant, just as you would from an outside firm. Let them (or him) go over the job, see the best way to run it, and measure up the quantity of pipe and the number of fittings required. The accuracy of the estimate will, of course, depend on the man, but at least there is something to go on.

When the job is done, a return should be made shewing exactly how much material has gone into the job, and how much scrapped. This material should be checked off from your inventory, if the plant is too small for a stock room and a card index system, and a copy kept in the office, and one given to the man in charge.

If a repair job, the slip should show:—

Feet of pipe taken down.....
Number and size of fittings taken down .....
Feet of new pipe installed .....
New fittings installed .....
Pipe scrapped .....
Fittings scrapped .....
Pipe returned to shop for second use .....
Fittings returned to shop for second use .....

This is checked up against your inventory, and the fitgings scrapped added on to your scrap pile. This is surely not much trouble, and a monthly, two monthly, or six monthly checking up of your new, second-hand, and scrap material should pretty near account for every pound of material brought into the plant.

A system of this kind involves no extra bookkeeping and no extra clerical labor. It is just as easy for the department clerk to handle as the other one of merely charging up material used (or supposed to be used).

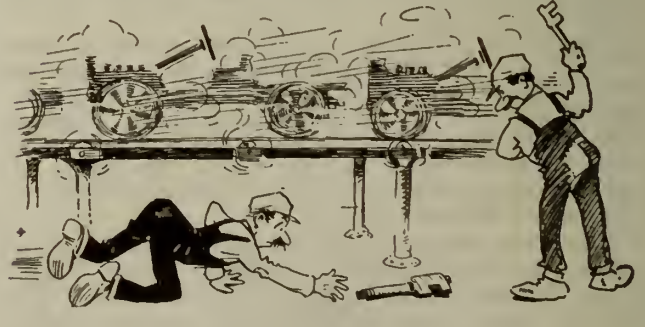
Whether the plant be large or small the amount saved in a year in this department would probably be a surprise to most managers, and in these days of high-priced material, every source of waste should be carefully guarded.

He Dropped the Monkey Wrench

HE sauntered into the office of the employment person. Lots of folks do the same thing. In fact the man in the employment office is some pumpkins these days. For the last three or four years folks haven't paid much attention to him, but things are a bit different just now.

However, this chap in question was looking for a job. He didn't have one—in fact that's the reason why he was lookin' for one.

Of course it's proper now to ask a few questions. For some time it's simply been a case of going in and having the employment person hug you and pass you on to the



boss. He, in turn, hugged you and advised you not to work too hard. But they're gettin' more particular now.

"Where've you been workin'?" was the first query.

"Ford's."

"How long?"

"Year."

"Quit or fired?"

"Canned."

"Why?"

"Dropped my wrench and seventeen machines went past before I could pick it up."

The Operators' Point of View

HANDY HOMEMADE LEVELING DEVICES

Figs. 1 to 5 show homemade levels, which will answer for all ordinary purposes, four of them are on the same principle. They have all been used in emergencies for many years. A few

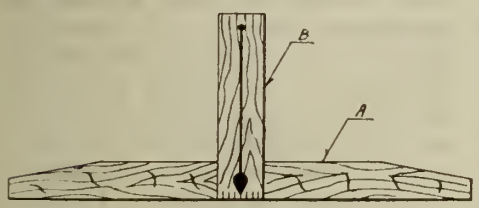


Fig. 1.

pieces of wood and a few nails, with a little work, will put any one of them together, ready to use.

To make Fig. 1, take a piece of wood, A, any desired length, nail on the upright piece B; drive in a nail and hang on the plumb-bob, as shown. When the line hangs exactly in the centre with the board on a test level space, turned either end, it is ready for use.

Fig. 2 is made from one piece of board. First nail on the plumb line and bob, place the board on some flat surface and draw a heavy line, A, close to the plumb-bob line; reverse the board and draw the heavy line B at the other side. With the plumb line exactly between these lines the level will be shown.

Fig. 3 is built on the same plan. A and B are the lines, the angle of the top is immaterial.

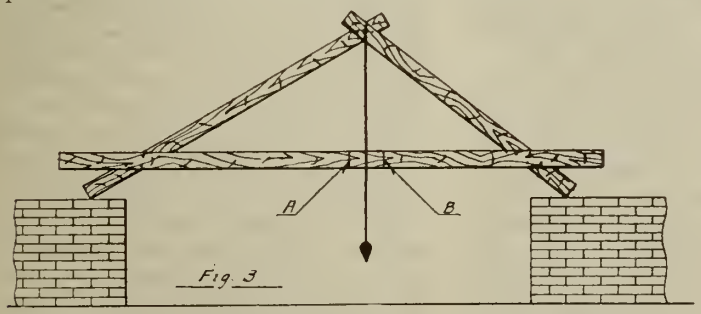


Fig. 3

Fig. 4 shows a leveling scheme often used by tile layers. It enables them to direct the grading of a trench with little climbing in and out of same. Of course, the length and height of the frame can be made to suit the desires of the maker.

Fig. 5 is on the same lines as the others. A hole is made on the bottom board instead of lines. A square of wood is nailed on the angle at A to strengthen it.

JAMES E. NOBLE,
Portsmouth, Ont.

PAPER HANGING BY STATIC ELECTRICITY

For trick or demonstration purposes, to stick a piece of paper to the wall or ceiling without mucilage or any visible adhesive, take a piece of newspaper, say, 2x6 inches. Heat it over a lamp, stove or other source of heat, but do not scorch it. Place it under your arm above the elbow and pressing it between your sleeve and side withdraw it rapidly and quickly place it against the wall. If done in the best way the paper will have a sufficient charge of static electricity to hold it in place for from five to

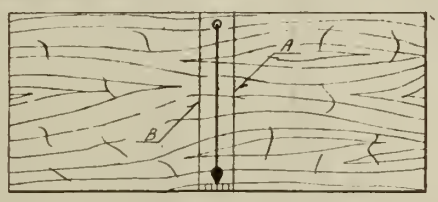


Fig. 2

thirty minutes. If it does not stick, do not attempt to make it do so by pressure; give it another passage between your sleeve and side, turning it end for end, for the second passage is an advantage. First attempts are sometimes unsuccessful, owing to not being quick enough, not pressing hard enough, or pressing so hard as to cause the paper to tear. After a very little practice one can cause the paper to adhere to the ceiling or the under side of a shelf or table for some time, or to a perpendicular surface for half an hour. Thick paper is not so suitable as newspaper, due to the greater weight for a given surface. Pieces of larger size can be worked by placing them between two sheets of paper and passing a heated flat iron over them, as though doing laundry work, then removing the said centre piece and placing it where de-

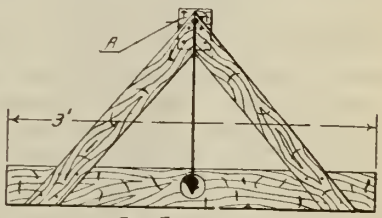


Fig. 5

sired. Of course, the surface to which it is applied must be a non-conductor of electricity, else it will not adhere.

J. E. Mc.

REPLACING WORN ECCENTRIC—BRAINS vs. BRAWN

An eccentric on an old engine had become worn somewhat oval, as old eccentrics do, and in addition to this the threads in the holes for the set-screws had become very bad. I was advising the getting of a new eccentric, but lamenting how big a job it would be to strip the crankshaft enough to permit of slipping the old eccentric off and slipping the new one on, then replace everything else that had been taken off. One who heard me said: "I wouldn't undertake all that." When she was going to be shut down for a few days I would just knock the old eccentric in two with hammer and cold chisel and take it to M— (the foundryman) for a pattern, and let him make a new split one to fit. Split pulleys were an everyday thing with us, but the idea of a split eccentric had not occurred to me, yet the advantage in this case was just as great. Of course, his way was much ahead of mine. It saved so much really needless work.—By J. E. M.

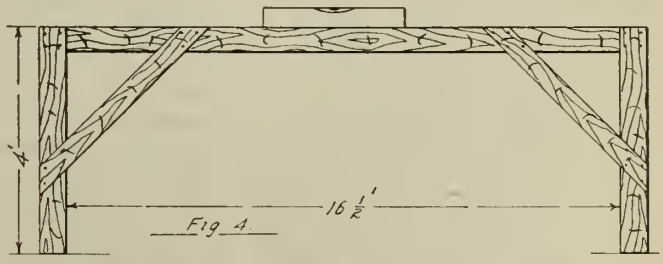


Fig. 4

An Engineer Runs Into All Sorts of Jobs

How a Structural Steel Tower Was Lowered Four Feet With Very Little Equipment or Staff to do it With—Essential Thing Had Been Overlooked in the Plans For the Work

By T. H. FENNER, Associate Editor Canadian Machinery

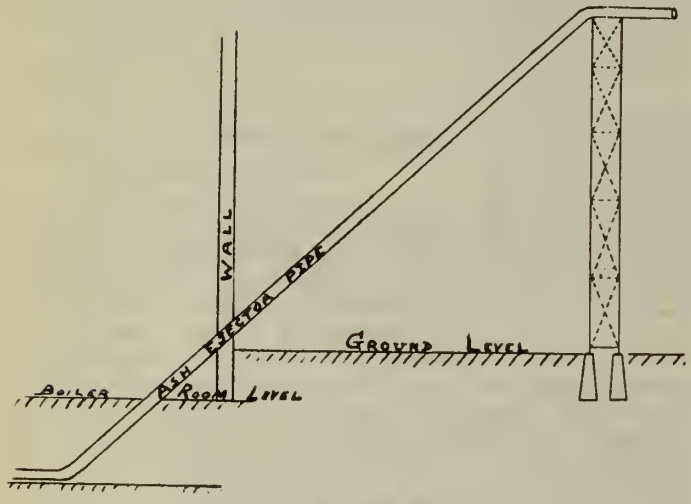
AS an instance of the unexpected propositions a mechanical superintendent is liable to run into, the following will be of interest.

A large industrial corporation was making an installation of coal and ash handing machinery for their power plant, and in connection with the ash ejector it was necessary to have erected a structural steel tower to carry the pipe from the boiler room by means of two channel irons resting on the tower and on the boiler room wall. The location of the tower and beams had been determined by the firm supplying the equipment from blue prints of the power house supplied them by the customer. The arrangement as originally submitted differed materially from that finally adopted, and in making the change one material factor was overlooked by all the parties concerned. The original and final arrangements are shown in the sketches accompanying. The tower was not to be supplied by the concern selling the ash handling equipment, they merely furnishing the design and location to suit their equipment. The factory engineering staff were looking after the erection of all the machinery. Feeling, however, that building structural was perhaps a little out of their line, the job of building and erecting the tower was given out to a constructional steel company. The approximate dimensions of the tower were thirty-five feet high, three feet in width at the bottom in one direction by ten feet wide in another, as shown in the sketch. The main posts were made of 3½ x 3½ x 5-16 angle iron, and the cross bracing of 1½ x 1½ x 3-16 angle iron. The corner posts were bolted at the bottom to four concrete piers, 5 ft. long, by 1 foot square at the top, by 18 inches square at the bottom

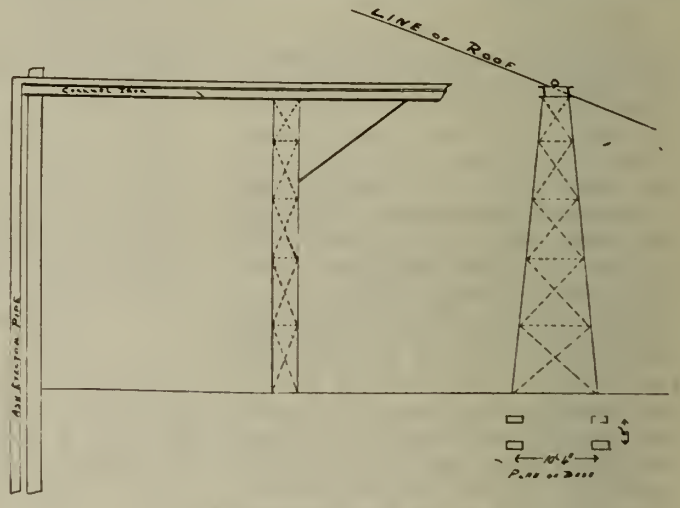
The foundations were placed by the factory staff in accordance with the drawings made by the firm supplying the equipment, and the steel construction people were notified that they could erect the tower and channel irons as soon as they were ready. In due course the gang arrived with the sections of the tower loaded on a large motor truck and men enough to make short work of the erecting. They started in right away to unload the truck and went at the job of coupling the sections of the legs together. The legs were made in two lengths of seventeen feet six inches, making when coupled together the required thirty-five feet. Two sides were laid on the ground with the base close to the foundation. Two or three angle irons were bolted across the posts to hold them together, and they were ready to raise up. Here an object lesson was obtained on the versatility of a well behaved motor truck. The two posts, comprising one side of the tower were raised by the combined efforts of the erecting crew till high enough to enable the truck to back in under them. They were then allowed to rest on the car and the car continued to back, thus raising the posts, when at an angle about forty-five degrees they were blocked up and the guy ropes fastened to the top end. A trestle was then put on the motor truck, catching the posts about half way up, and the car again backed up, this time raising the posts almost to the vertical. A good pull on the guy ropes and the two posts stood up in their place, and one side of the tower was erected. Everything was going fine, and in a very short time the other two posts were raised and the men started putting the bracing on.

The Trouble Started

The next operation was to put up the channel iron beams, and here was where the unexpected happened. It was discovered that one of the beams, instead of passing through the wall below the roof, would come out on top of the roof, while the other one would be under the roof, but too close up to it. How had this occurred? A hurried look over the drawing in the light of this new condition disclosed the fact that in altering the plans the angle of the roof had not been taken into account with the result already mentioned. The next question was, what was to be done? The steel men, anxious to get their job done and get away were for cutting the roof. As this roof had been re-slated only the year before at a cost of several thousand dollars, cutting holes in it was not desirable, especially a hole large enough to allow for the beams and the pipe on top of them. The contractors then washed their hands of the job and left, without any further comment. The chief engineer of the plant then decided he would lower the tower bodily just as it stood, lowering the foundations first and then bringing the tower down to them. It would have been easier to take down the tower first if he had the men available, but the staff at his disposal was woefully small and not particularly suited to a job of that kind, and the time necessary to dismantle and re-erect after would have entailed too much expense. The chief thing to guard against in performing the operation of lowering



ORIGINAL ARRANGEMENT

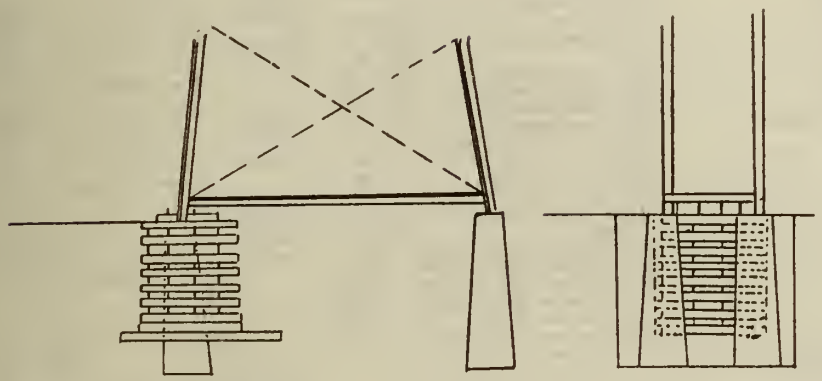


ARRANGEMENT AS ADOPTED

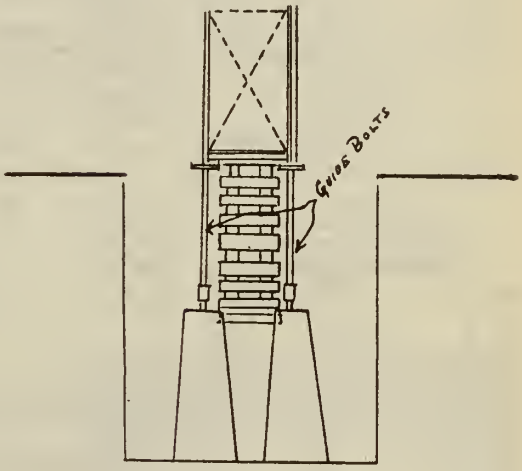
the tower lay in its capsizing on the narrow base, it being fairly stable on the 10 feet direction.

How it Was Done

The method adopted was as follows: Guy ropes were attached to the tower near the top, leading at right angles to the long base to counteract the tipping action on the short side. The ground was dug away from between the foundations to a depth sufficient to allow for the complete amount of lowering required. A crib work of 3 in. planks was then built in this space till it supported the tower on its lower cross-angle irons. The nuts on the holding down bolts of the two side piers were then taken off. The bolts projected through the base of the tower about 3 ins., they having been left long to allow for adjusting, after which they were to be cut off flush. A strong wooden horse, or trestle, which was in use around the mill for general millwright work was brought over to the job and placed close up to the posts of the tower parallel to its narrow axis. Two pair of triplex chain blocks were hung on the trestle and made fast to the base angle close to the post on each side. By heaving up on these blocks the base of the tower was raised to clear the foundation bolts on the two piers, the two on the opposite side being left fast to act as a counterweight. As soon as it was raised high enough to clear the bolts it was blocked up in this position and the chain blocks let go. One was made fast to the chain block and raised out of the pit, making room for a man to get down and dig. The ground was dug out where the pier had been to a depth of four feet and the companion pier was moved from its position and dropped in the hole. This saved lifting it out, and still left room enough for a man to work, making the excavation for the other pier. When this was done the earth was levelled off between the two piers, leaving the floor level at the new depth, and the first pier was dropped down into the place vacated by the second. Two long studs were made, six inches longer than the depth of the new excavation, and these were fitted with a screwed sleeve at one end, which sleeve also screwed onto the top of the holding-down bolt in the pier. The bolt was passed through the hole in the base of the tower and an efficient connection made between the tower and the pier, although they were four feet apart. This served to make one side secure, while the piers were dropped from the other side and the excavations made. (These precautions were necessary as the tower swayed considerably and there was at times a strong wind). When all the piers were in place and the long bolts in position, the tower resting on the blocking, all was ready for the lowering proper. A second trestle was brought up and placed on the other side and two more pair of blocks used. This made it possible to tip the tower on any of the four corners. The first move was to take the weight of one side of the tower on the blocks and remove one course of three inch blocking, then lowering till the tower rested on the next course. Having been level at first the tower was now three inches lower at this side than the other. The strain was kept on the long bolts on this side, and the chain blocks on the opposite side tightened up till the wooden blocking was free. This side was now lowered six inches, making it three inches lower than the side first lowered. This process was repeated alternately on each side till the full four feet had been attained and the tower rested on its foundations again four feet below its original level.



BLOCKING BEFORE MOVING PIERS.



READY FOR LOWERING

CURIOUS INJECTOR OPERATION

While with a prospecting company the increasing demands on our steam supply resulted in the ordering of a second boiler to the plant, and of a size equal to that of the one already there. The feed water was drawn by injector from a spring of water about 125 feet away, the total rise being perhaps eight feet. The water from the pumps in the pit was unfit for boiler use. By the time the second boiler was set up there had not yet been pipe enough arrive to run a line from the second injector to the spring and the line already there was only as large as the injector connections. Both injectors were of the same size. By way of getting the second boiler into operation without further delay, its injector was connected into the existing line by using a tee, the supposition being that by this means one boiler could be fed at a time. This device worked O.K. except that when only one injector was working (and it did not matter which one) there would be air enough leak in through the other injectors' overflow to cause the working injector to spit somewhat like a cat, perhaps twice a minute. When both injectors were working at the same time there was no spitting and apparently the two injectors, working together on the size pipe line normally supposed to serve only one, had no difficulty in each getting plenty of water through for its needs.—J.E.M.

SUBSTANTIAL ARMATURE STANDS

By Joseph D. DeWitt

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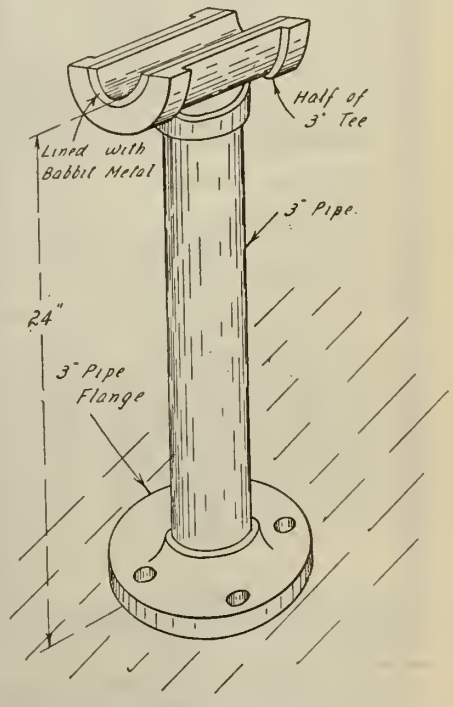
The best and most substantial support for small armatures that I have ever seen was made of pipe fittings. One



ARMATURE STAND.

of these stands is shown in the attached illustration. Two like this are required to support each armature. The upright is of 3 inch pipe and the base or foot is a 3 inch reducing flange. An old flange may be used. Screw holes are

(Continued on page 49)

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$28 00	$.....
1¼ in.	32 00	.....
1½ in.	35 00	28 00
1¾ in.	35 00	28 00
2 in.	40 00	28 00
2¼ in.	43 00	30 00
2½ in.	45 00	35 00
3 in.	52 00	40 00
3¼ in.	.....	47 00
3½ in.	62 00	48 00
4 in.	70 00	60 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$5 50	$4 50
Tank plates, 3-16 in..	5 75	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 58	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	65 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 75
Steel bars, base, Toronto ...	5 00
Steel bars, 2" to 4" base...	6 00
Iron bars, base, Montreal ..	4 85
Steel bars, base, Montreal..	5 05
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 25	$ 6 25
Sheets, Black, No. 10.	5 25	5 25
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 85
Premier, 10¾ oz.	....	8 50

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1....	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws.....	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less...	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. bd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, brigbt..	72½
Wood screws, O. & R., brigbt	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly 0	35
Solder, guaranteed 0	40
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums 5	20
White lead, pure, cwt. 15	20
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D," per lb..... 0	03
Rosin "G," per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 15 oz. and heavier ..	45 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 15 oz. and heavier	45 00	45 00
Braziers' in. sheets, 6x4 bsse	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd..	$0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless.....	0 55
Tubing, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

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RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	15
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer bead bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add 40,	10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper ...	17 25	19 00
Tin	60 00	58 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 50
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided ...	$0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila..	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb extra.

SUBSTANTIAL ARMATURE STANDS

(Continued from page 175)

not necessary in this flange. The grooved top, which holds the armature shaft, consists of a 3 inch pipe tee, which has been cut in half on a shaper and babbitted so that the armature shaft will not be damaged. These stands are very rugged and are of little value except for holding armatures, so there is little trouble keeping them in the shop.

NEW AGENCY

E. J. Philips and Sons, Hamilton Trust Building, Queen Street, Toronto, have been appointed sole Ontario representatives for the Blonck Efficiency Meter and the Republic Flow Meter. Mr. Philips is well known to Canadian engineers and has a wide knowledge of the stationary engineering field. The Blonck meter is well recognized as one of the most efficient aids for the securing of efficiency in the boiler room. The Republic flow meter for measuring the flow of water, air, steam and gases, owing to its use of an electric registering and indicating circuit, is free from the errors usually encountered in flow measurement.

NEW PUBLICATION

"Over 1,000 Scoop Conveyors" is the title of a 20-page folder just published by the Portable Machinery Co., Passaic, N. J. This folder, replete with illustrations showing the various uses of the scoop conveyor, describes clearly the labor, time and money-saving features of the machine in storing, reclaiming, loading and unloading material, such as coal, coke, ashes, sand, gravel, crushed stone, fertilizer, cement, chemicals, etc. Thirty-two letters from users are printed testifying to the merits of the machine and eighty-four letterheads representing additional concerns who have written commendatory letters, are reproduced.

Copies of the folder will be sent gratis to those interested upon request to the manufacturers, the Portable Machinery Co., Passaic, N.J.

STEAM CONVEYOR vs. MANUAL LABOR—RELATIVE COSTS OF ASH HANDLING

Many engineers and power plant executives have been surprised when they quietly sat down and figured out for themselves the saving that resulted when their ash wheelers were replaced by a steam jet ash conveyor.

The American Steam Conveyor Corporation, Chicago, recently received a letter from the manager of the Big Mine of Canada, which is owned by the Canada West Coal Company, Ltd., Taber, Alberta, in which comparative figures were given showing the relative costs of handling ashes by the two methods.

The boiler plant of the Big Mine contains a battery of one 500 and five 150 horsepower boilers operating continuously. An American steam ash conveyor was installed, replacing the use of men and horses. The ash handling costs before and after the steam ash conveyor are as follows:

Cost of Ash Disposal Previous to Installation of American Steam Ash Conveyor Per 24-Hour Day

2 ash wheelers	$ 5.44	$10.88
1 teamster	4.08	4.08
1 horse and feed	1.50	1.50
		$16.46

Cost of Ash Disposal After Installation of Conveyor

1 laborer (9 hours)	4.08
Saving, 24-hour day	$12.38

(This laborer acts between fire cleanings as assistant fireman and boiler room helper.)

The ashes are left on the boiler room floor in front of the boiler until the cleaning is completed, and are then put into the conveyor, which handles the complete cleaning in about seven minutes. The boilers are cleaned every two hours.

It will be seen that the actual time the laborer spends at work handling ashes is relatively small. If the time spent on other work was charged against that operation the savings would be decidedly greater.

These figures bring home forcefully the economy that results from the installation of labor-saving equipment and emphasize the importance of carefully watching every item of boiler plant expense.

EFFICIENCY IN BELT DRIVES

By D. Street

In almost every factory and machine shop a certain amount of power is wasted in transmission through driving belts, the percentage of loss depending on the attention paid to the matter. Slipping, the trouble most frequently encountered, is common to all classes of belting, and generally speaking the remedy applied is to cut and tighten, or "take up" the belt so that it will run free from slackness with a better grip of the pulley; but probably more belts are broken and prematurely destroyed in this way than by actual use, not to speak of the additional load thrown on the engine and the consequent waste of power. To overcome slipping, many engineers incline to the principle of using belts wider than is actually necessary. This permits a heavier load to be carried, but when the practice is generally adopted all over a machine shop with fifty or more belt drives, the cost is very considerable. There is, however, a growing tendency to run belts slack, as not only is friction thus reduced and the life of the belt increased, but no power is wasted and the strain on the prime mover is considerably reduced. Immediately the tension is reduced the friction is proportionately lessened. Further increase of the arc of contact round the pulley (after the belt has been sufficiently slackened to have no initial tension) will not lessen the friction, but the load-carrying capacity of the belt is increased. As an example in many engineering shops it has been found that cuts 50 per cent. heavier can be taken on lathes where the arc of contact has been increased from 180 deg. (with a tight belt) to as high as 220 deg. (with a slack belt) and in one instance with a corn-crushing machine the increase in output was over 50 per cent. To permit of driving belts being run slack a proper belt dressing should be employed. Many belt dressings rely almost entirely on their capacity to "stick," due to the inclusion of rosin or tar in their composition, but others take the form of a non-sticky preservative

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An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.
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or belt food free from acid or alkali action, which is absorbed into the belt, rendering it pliable and highly effective, and at the same time protecting it from the effects of moisture, dryness, or chemical fumes. Such a preparation properly applied tends to give belts a velvety cling through the setting up of a vacuum suction between the belt and the pulley face, and will permit of slack running without fear of slip, even under the heaviest loads.

KNOCKING IN GAS ENGINES

By M. M.

A knock in a gas engine is frequently a warning of approaching breakdown. For this reason, it is generally inadvisable to allow an engine to continue running a moment longer than it absolutely necessary when a knock is heard. It would be interesting to know how many disastrous breakdowns, entailing personal injuries and stoppages of work, might have been prevented, had the engineer-in-charge not failed to heed the warning given by a knock in some part of the engine.

In probably the majority of cases, knocking is the result of lost motion in some part or other of the engine. For instance, the connecting rod brasses may have become worn, or the fly-wheel keys may have worked loose, and so on. As a general rule, the first thing the average engineer does when he discovers any knocking is to close up the big or the small ends of the connecting rods, or both ends if necessary, and in many cases this will cure the trouble.

It will occasionally happen with large engines, however, that, after fitting new connecting-rod brasses, a new and heavy knock will develop in the engine cylinder. This may usually be accounted for in the following way: The continual motion of the piston to and fro in the cylinder has worn away some of the metal of the liner, leaving a ridge at the part where the first piston ring moves up to each stroke. Since the new brasses are thicker than the old ones, the effect is to cause the piston to move a little further up into the cylinder each stroke, with the result that the first ring strikes against the ridge each stroke, causing a heavy knock. Of course, if the engineer in charge has taken the precaution to fit liners behind the brasses, as wear has taken place, so as to maintain the correct centres, the trouble in question is not liable to arise.

To prevent this new knock, it will be necessary to remove the ridge referred to by chipping and filing. If it be impracticable to do this early, the first ring may be removed from the piston until such time as the true remedy can be applied.

Sometimes the piston rings themselves will cause knocking or rattling through their being loose, and it is not always an easy matter to trace the knocking caused in this way. When, therefore, a knock cannot be at once located, it is advisable to test if the piston rings are a good fit in their grooves.

Looseness of the fly-wheel keys is a somewhat common cause of knocking in gas engines. The conditions of working in a gas engine are of course severe, much more so than is the case with a steam engine, and with the increased pressures and speeds now in vogue, it is no easy matter to get the keys to remain tight for long periods of running. The slightest amount of slackness is obviously serious, as in addition to giving rise to more or less severe knocking, it involves risk of damage to the keys, and fracture of the wheel boss, and possibly the crank shaft. Loose keys are always liable to be met with if the wheel boss has been bored slightly too large or at all out of true.

It is not sufficient that the fly-wheel keys be quite tight, but they must be a perfect fit. In numerous instances, the keys have been found as tight as possible, but the fly-wheel was, nevertheless, slightly loose, and a heavy knock occurred in consequence. An interesting example presented itself, when a large gas engine was reported to be knocking, and the owners, who were unable to locate the knock, arranged for a firm specializing in engineering repairs, to look into the matter. The firm's men commenced their investigations by first removing the connecting-rod and piston, with the object of closing the brasses, but this was found to have been done already by the owners. The piston-rings were next examined for slackness or breakage, but these were found to be in good condition and to fit perfectly. The fly-wheel key was then examined, but proved to be quite tight. As the cause of the knock could not be located, those concerned decided to give the engine a thorough overhaul, yet after the work of overhauling had been completed, the engine, on being started up again, knocked as badly as ever. The cause of the trouble was, however, discovered shortly afterwards by chance. The engine had been stopped again, and the man in charge of the job happened to place his foot on one of the arms of the fly-wheel by way of a rest, and in order to think the matter over. Whilst in this attitude the man felt a distinct knock on the sole of his boot. This gave the clue to the solution of the trouble; obviously there must be some slackness or lost motion in the fly-wheel. Although the key had previously been found quite tight, a close examination of the key and its keyway were now made, and the examination served to show, not only was the key badly proportioned and badly shaped, but the keyway had been badly cut, being narrower in the middle than at the ends. In short, only a short length of the key was really effective in securing the wheel to the shaft, and this was the cause of the whole trouble.

It has already been pointed out that the continual motion of the piston to and fro in the cylinder gradually wears away some of the metal of the cylinder liner, leaving a ridge at the end of the travel of the first piston ring. In extreme cases the wear is so pronounced, that the piston becomes quite slack in the liner, and this will sometimes prove to be the cause of the knock. Thus, when the explosive mixture is fired, the force of the explosion causes the piston to shake against the internal surface of the liner, and a knock is thus liable to be heard each explosion stroke. A knock of this character can scarcely be regarded as a serious one, since no undue stresses are likely to set up on any of the parts. What is perhaps of more importance than the knock is the loss which will probably occur by leakage of the explosive mixture past the piston. The remedy for the trouble is, of course, to re-bore the cylinder liner and fit a new piston, or else to fit both a new liner and a new piston.

One cause of knocking in gas engines, but one which is usually easy to discover, is undue clearance between the spindles of the different valves, and the levers which oprate the valves. When the valves are properly adjusted for lift, they are first opened very gradually by the cams which work the levers, and then more rapidly. When, however, there is a considerable amount of clearance between the valve spindles and the levers, the latter, instead of coming into contact at a moment when they are moving very slowly, only do so when the rate of motion has become comparatively great. The result is that the levers, instead of coming into gradual contact with the spindles, bang against them, thus tending to cause a knock. If now the valves lift easily, the force of the blow is relieved, and the knock will be of little importance, but if, on the other hand, much force is required to lift the valves, the knock is liable to become somewhat severe. In the case of the gas and air valves, comparatively little force is required to open the valves, because each valve opens at the commencement of the suction stroke, when the piston is really reducing the pressure against which the valves have to lift, and so assisting in opening them.

Now the case is quite different with the exhaust valve. This valve has to open at the end of the explosion stroke.

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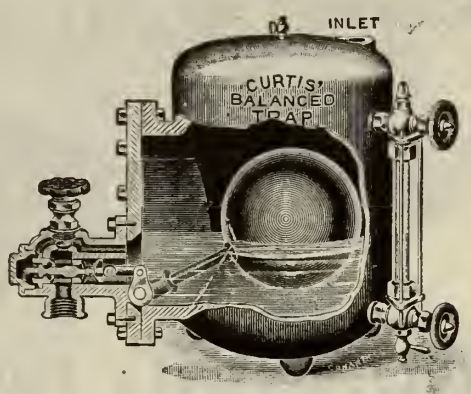

Five Superior Features of the Curtis

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when the pressure in the cylinder is considerable. Since, in addition to this pressure, the pressure of the spring which keeps the valve down on its seat during the admission, compression and explosion strokes have also to be overcome, not to speak of the weight of the valve itself, it is not difficult to understand that the force required to open the valve is considerable. Hence, when there is much clearance between the exhaust valve spindle and lever, the knock resulting may prove to be somewhat serious. The force of the blow is, of course, transmitted to the teeth of the skew wheels, which drive the cam shaft, and if these teeth are much worn, as they frequently are in engines which have seen much service, risk of breakage of the teeth is incurred. Knocking of a somewhat similar nature to the above will sometimes occur as the result of undue wear of the rollers, against which the cams work, the latter banging against the rollers once each cycle. Indeed, in old engines, where all the cams have become badly worn, the working of the engine has, in consequence, sounded like the rattling of a basket of pots.

Another somewhat common cause of knocking in gas engines, is early firing of the explosive mixture. Thus, if the charge is fired much before the piston reaches the end of the compression stroke, the general effect is to tend to check suddenly the motion of the piston, so that if there is the slightest lost motion in the moving parts, a more or less severe knock is liable to occur each cycle.

Too early firing may of course be caused through improper adjustment of the ignition arrangements, but it will sometimes occur when the adjustment is quite in order. The trouble will then generally be due to the deposit of carbon on the valves, the cylinder end, and on the piston.

When the trouble referred to is experienced, it is therefore well to look for evidences of carbon deposit, and should any be discovered, it should be removed at the earliest opportunity. Satisfactory removal can, as a rule, only be effected after the piston has been withdrawn. It is far from wise merely to loosen the deposit and trust to this being blown out through the exhaust valve. Unless the deposit is positively removed by hand after the piston has been withdrawn, there is every probability that the engine will soon suffer severely from scored piston rings and cylinder walls.

The Bureau of Mines, Department of the Interior, Washington, have issued papers Numbers 207 and 219. Paper 207 deals with combustion experiments with North Dakota lignite and gives an exhaustive summary of the results of numerous tests and trials which have been conducted with this fuel. Technical paper number 219 deals with subject of gas analysis and the necessity for it in the maintaining of proper combustion.

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These improvements add 25% to the usefulness of the tool.

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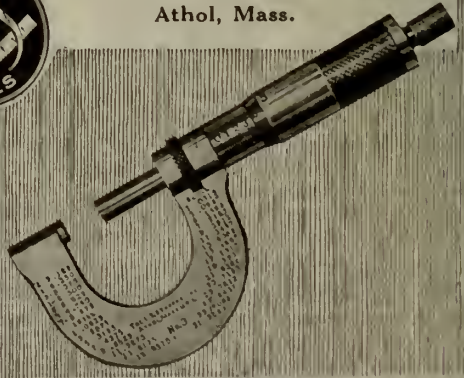

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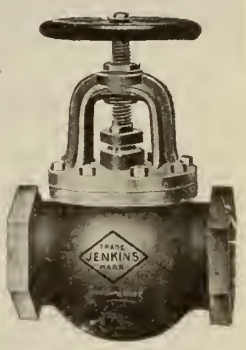

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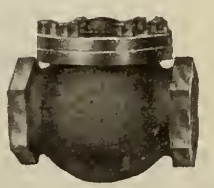

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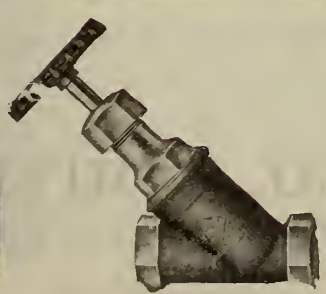

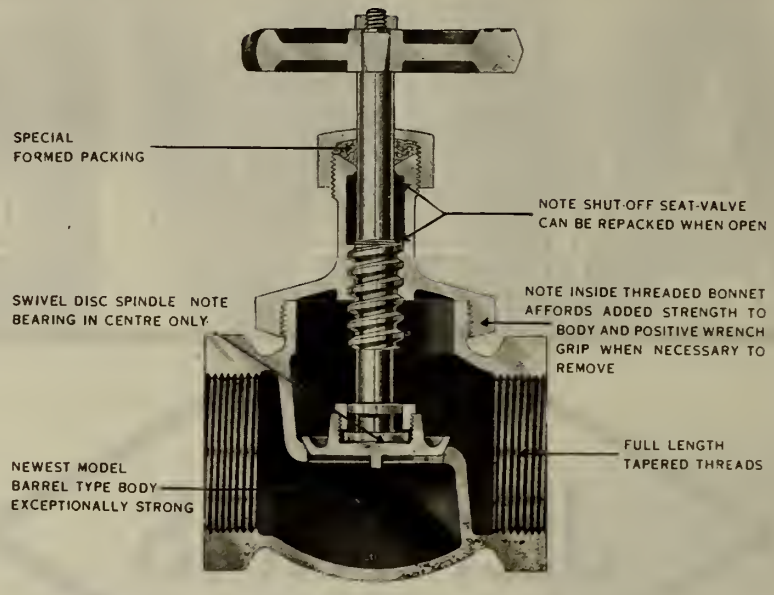

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The packing is a feature in itself; a specially formed, properly lubricated braided packing of flax reinforced with a lead core and copper wire strands; filled with graphite, absolutely sure in action; long-wearing and positively leak-proof.

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We will gladly send you a sample valve for trial. Provincial Authorities have passed this valve—allowing a pressure of 175 lbs. We will be especially glad to receive requests from engineers for full particulars and samples of this valve.

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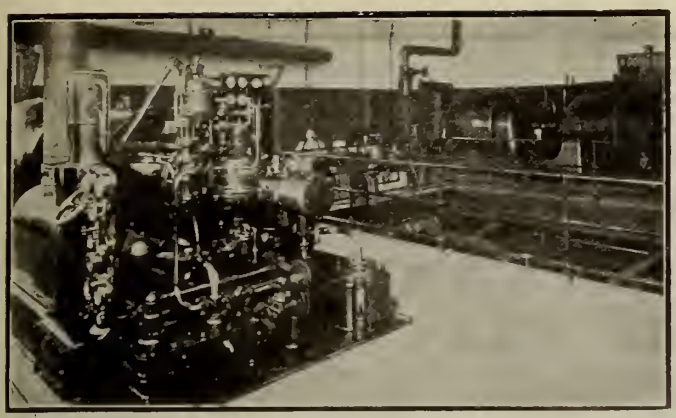

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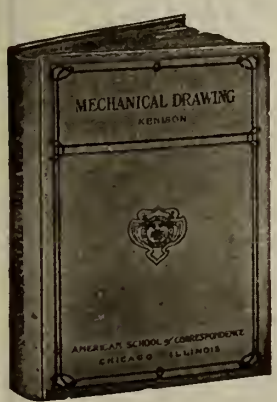

Mechanical Drawing

By Ervin Kenison, S.B.

Instructor in Mechanical Drawing, Massachusetts Institute of Technology

176 pp., 140 illus. Cloth binding. Gives a course of practical instruction in the art of Mechanical Drawing, based on methods that have stood the test of years of experience. Includes orthographic, isometric and oblique projections, shade lines, intersections and developments, lettering, etc., with abundant exercises and plates.

Price, $1.00

MacLean Publishing Co.

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143-153 University Ave., Toronto

Description
1. Packing ring forced against the leaky joint.
2. Inside split ring forced against the packing.
3. Clamp fits over rings. Set-screws hold all in a leak-proof unit

You Can Stop That Leak

—And stop it permanently—with a Yarway Pipe-Joint Clamp (formerly the Simplex).

It does not make much difference how big the opening may be—provided, of course, it is not beyond repair. Nor does it matter a great deal what is in the pipe—water, steam, gas, air, oil, ammonia, brine, etc.—the leak will be stopped absolutely.

And as long as the Yarway is left in place that joint will remain tight.

The principle of the Yarway Pipe-Joint Clamp is very simple. There are but three parts, as shown above—one packing and two iron rings.

Any workman can make the attachment without difficulty in a few minutes.

As an example of the way in which this serviceable clamp makes good, read what one user says:

The fact that from the date of its installation we have not realized that there is a steam joint at the point where placed, is sufficient evidence that it fills the bill.

Try a Yarway for 30 days subject to return if not satisfactory in every way Write to-day stating size of line.

YARNALL - WARING COMPANY

Chestnut Hill **7604-20 Queen St.** **Philadelphia**

A. McLellan, 103 St. Francis Xavier St., Montreal, Que., Canada; Cunningham Hardware Co., New Westminster, B.C.; Jas. Robertson Co., Montreal, Canada; Gorman Clancey, Grindley Co., Calgary, Alberta.

YARWAY PIPE-JOINT CLAMP

Formerly the SIMPLEX

MORSE DRIVES THE WORLD AROUND

MORSE CHAIN COMPANY ITHACA, NEW YORK

About 2½ MILLION HORSE POWER in WORLD-WIDE SERVICE

MORSE CHAIN CO. Largest Manufacturer of Silent Chains in the World **ITHACA, N. Y.**

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KANSAS CITY, MO..Morse Engineering Co., R. A. Long Bldg.
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LICENSEES FOR EUROPE & EASTERN HEMISPHERE
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For Severe Service

JEFFERSON UNIONS

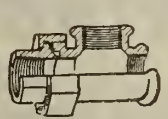
Pumps—frequently hard to reach—must chug away hour after hour, day after day, without stopping and without attention. Leaky unions have no place in pump service.

JEFFERSON UNIONS are particularly adapted to meet successfully severe service. The Brass Seat Ring makes the brass-to-iron joint which will not corrode and is easily disconnected no matter how hard or how long the union has been set up.

The Spherical Ground Joint makes possible an absolutely tight joint even though the line is not exactly straight on account of settlement or any other cause.

There are many other reasons why you should use "JEFFERSONS." They are not "just" unions and the name JEFFERSON stamped on the nut protects you from the doubtful variety. You'll find it mighty difficult to plug a leaky joint with a "just-as-good" promise.

Jefferson Swing Union. Allows widest variety of connections, ranging from a slight offset up to 90 degrees. For angle connections that cannot be made with simple elbow unions.



Jefferson Union Tee, with union or outlet. Has union end threaded either male or female. Should always be used where a union is desired near a tee.

All Male Union Saves two pipe joints between two female threaded parts.

Your Jobber will be glad to show you his stock of "JEFFERSONS." Your inspection will convince you of their merits. Write to-day for our Catalog "UNIONS" which shows the complete Jefferson Line.

Jefferson Union Company

Lexington, Mass.

Jefferson Union Co., Lexington, Mass.
Gentlemen: Mail me postpaid, and without any obligation to me, copy of your New Catalog.

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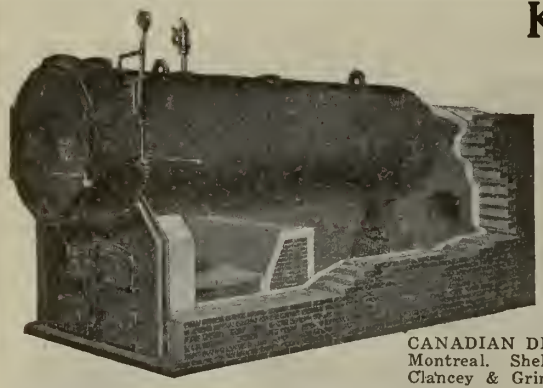

Keep the Heat Where It Belongs

PLIBRICO keeps the heat in the furnace, because it forms a jointless one-piece lining in your front door arches, entire fronts, side walls, arches, bridge walls, etc. This lining is gas and airtight, saves fuel while at the same time greatly reduces your furnace upkeep, will last longer, give better satisfaction and can be more easily repaired than a lining constructed of fire brick and fire clay.

Write for free copy of 36-page book of useful information on furnace building & maintenance

Jointless Fire Brick Co.
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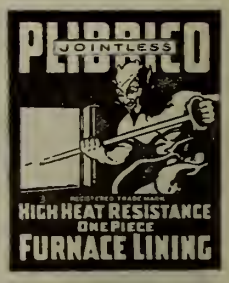

TRADE MARK

Williams "Agrippa" Chain Pipe and Fittings Wrench

THEIR narrow, single jaw, with saw-tempered teeth for file sharpening when worn, gives these wrenches unequaled facility for holding and turning cramped and irregular fittings, flanges, short nipples, etc., etc., because:—

They grip upon surfaces where ordinary tools cannot—"Their grip does not slip."
They do work which tools with broader jaw will not.
They give more and better service than any screw-adjusted wrench made.
They "start" rusted fittings when all else fails—just the service to be logically expected of a fully warranted tool.

Remember, each Chain, like those in our well-known "Vulcan" Wrenches, is "proof-tested" in a standard tension machine to two-thirds of its catalog strength, and is certified. We guarantee absolutely every tool that leaves our factories. 7 sizes for ⅛ to 12" pipe and fittings.

Your dealer will serve you. Ask for Booklet.

J. H. Williams & Co.
"The Drop-Forging People"
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THE A. G. LOW CO., LTD., 78 Pacific Ave., Saskatoon, Sask., Agents for Manitoba, Saskatchewan, Alberta and British Columbia

Self-Lubricating

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SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

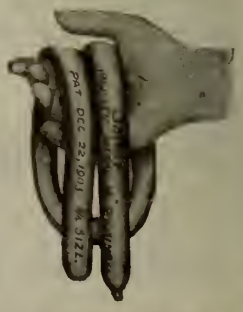
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

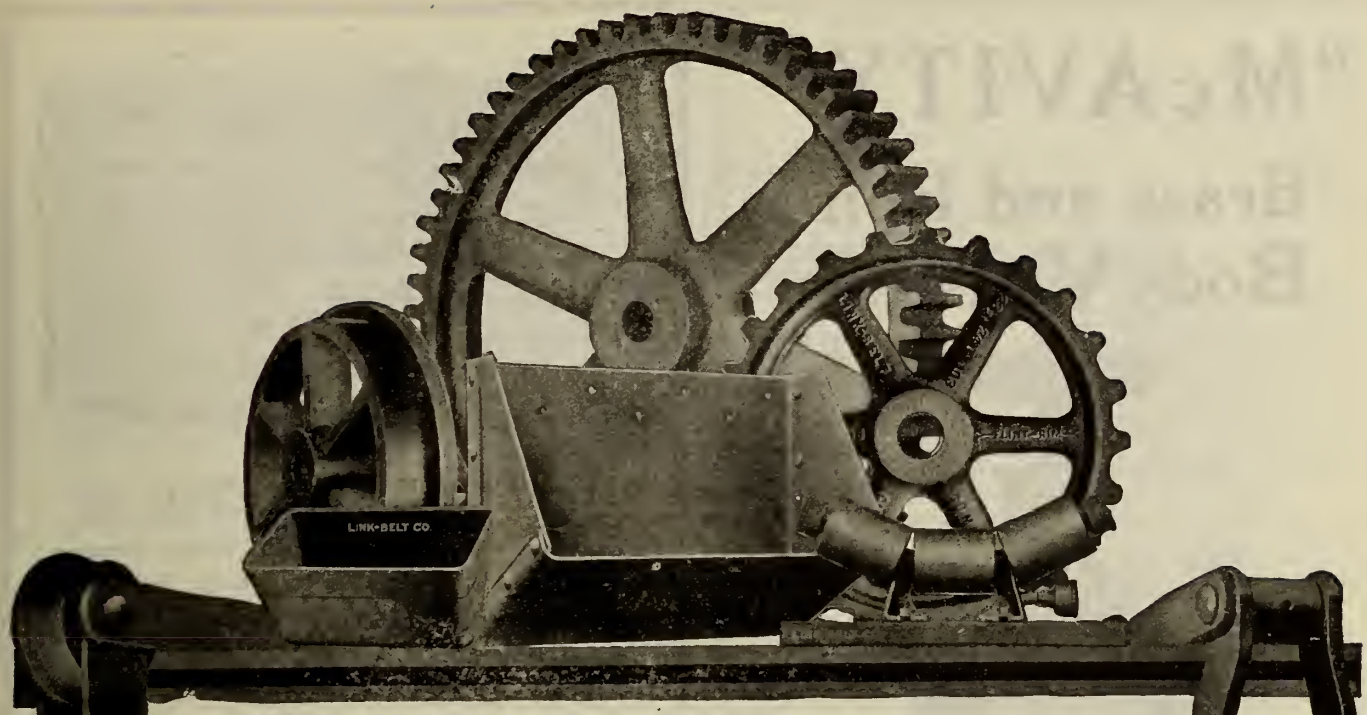
STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes



Need Repairs ?

DELAY in securing necessary repairs only means inefficient service and usually, in the long run, greatly increased repair expense.

We furnish repair parts for elevating and conveying equipment, including buckets of various kinds, belt conveyor parts, such as idlers and belting, Link-Belt and sprockets, gears and pinions, power transmission equipment, silent chain drives, roller chains, detachable Link-Belt, hangers, pulleys, pillow blocks, steel chutes and spouts, etc. Are all of high Link-Belt standard.

Our **FLINT RIM** Sprocket Wheels are made by a special process, providing a smooth, hard bearing surface for contact with the chain links. These sprockets last several times as long as ordinary sprockets and also greatly increase the life of the chain.

Write us about your requirements—no matter how large or how small.

CANADIAN LINK-BELT COMPANY, LIMITED

Wellington and Peter Sts., Toronto

LINK-BELT
Industrial Equipment

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
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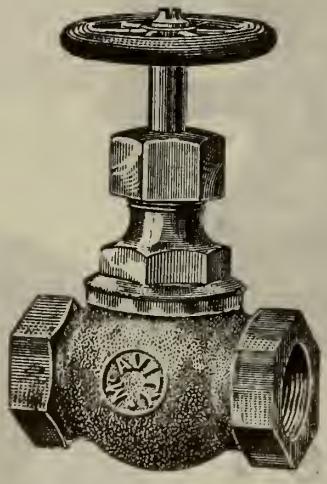
- ☐ Wagon Loaders
- ☐ Coal and Ashes Systems

Write for Catalogs
Place X in Square

"McAVITY"

Brass and Iron Body Valves



McAvity's Improved Jenkins Disc

Suitable for all pressures 125 to 500 lbs.

Suitable for all purposes Steam, Air, Water, Oil or Gas.

Every valve is guaranteed of the best workmanship and absolutely tight before leaving the factory.

To insure obtaining the best, specify "*McAvity*."

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WINNIPEG

I have always said to power plant owners years ago;- if we only had something we could would in place to take the place of fire bricks, blocks, etc., it would be what we needed. I did not then know about your material.

THE CHIEF REALIZED

that the weakest points of a boiler furnace lining are the joints between the bricks.

So he set out to find a way to remove this weakness, and he "discovered"

BETSON'S

REG. U.S. TRADE MARK PAT. OFF.

PLASTIC FIRE BRICK

Now he is not only a Betson user, but a Betson booster.

There is no mystery about Betson's. It is the pioneer and proven Plastic Fire Brick that has made practicable the one-piece furnace lining without joints. It has a record of 20 years' satisfactory service under all sorts of trying conditions.

You, too, can benefit by its use.

IT COMES IN A YELLOW TOP BARREL.

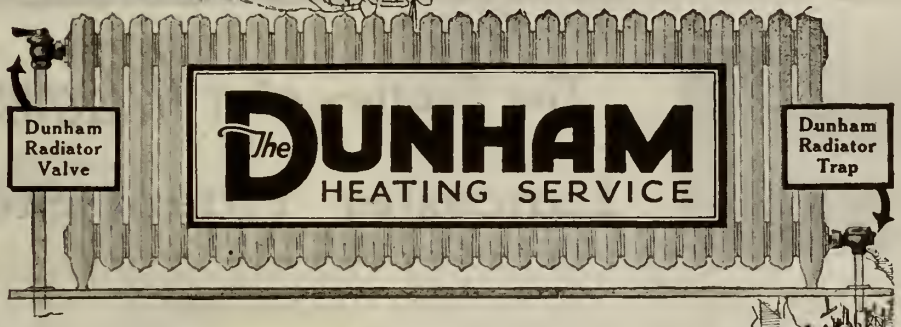
Investigate--Write for our literature. It will help you.

International Chemical Company

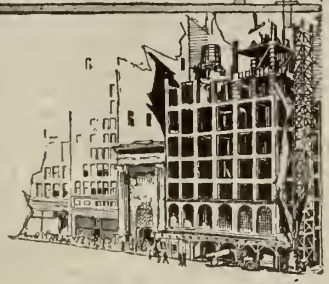
44-46 Lombard Street
TORONTO, ONT.

A Solid One-piece, Jointless, Leakless Lining.

In All Kinds Of Buildings



From every ton of coal put under the boiler, Dunham Heating Service gives the maximum of heating comfort—not only in large buildings but also in small homes, thus proving that the fundamental principles of Dunham Heating Service are correct. It all goes back to the fact that the water and air that collects in the system must be quickly and automatically removed. This, Dunham Heating Service does by correct designing and the use of the exclusive Dunham specialties. Write for special data.



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HALIFAX OTTAWA WINNIPEG VANCOUVER CALGARY MONTREAL

DRAFT Forced or Induced

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

due to their superior design are highly efficient and run at the best speeds for direct connection to either turbine or motor. They have been thoroughly tested and are being operated in most high-grade power plants both for forced and induced draft.

Let our engineers show you what "Radial Flows" can do.

GREEN'S ECONOMISER, LTD.
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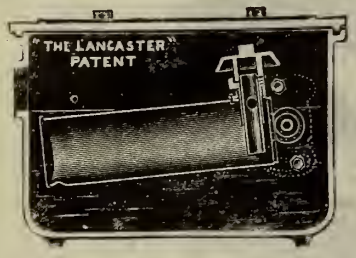
WILLIAMS & WILSON, LIMITED
Montreal, P.Q.

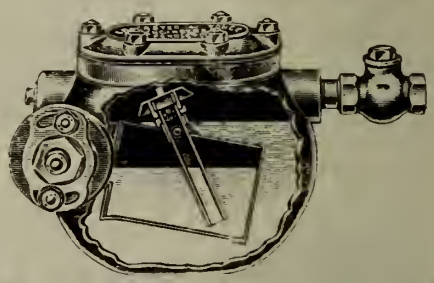


The Feature of Williams & Wilson's
Lancaster Patent Steam Trap

consists in the loose Disc Valve at the orifice of the discharge pipe in connection with a quick threaded screw motion, worked by the float. This valve is frictionless in action, and, being loose cannot stick to its seat. It is very prompt in its movements for opening and closing the discharge pipe, and the working parts are very simple and easily examined. It also acts as a Safety Valve, as any excessive pressure exerted against the face of the loose disc valve would, by virtue of the Quickness of the Screw Thread, force it open.

The Float being cylindrical and extending full length of the box gives greater capacity and at the same time permits the use of a smaller and more compact box. ⅜ in. trap is 8⅜ in. high, 10⅛ in. long, 6½ in. wide over all.

Write for full particulars.



"The Lancaster" Lifting and Marine Steam Traps

Similar in construction and action to "The Lancaster" Steam Traps, with the exception that being made with a much stronger box and fast lid, they will raise the discharging water 2 feet for each 1 lb. pressure of steam. The condensed water and air pass away with the greatest ease.

They cannot stick and have never failed under most Service Tests.

The Williams & Wilson, Limited, guarantee as well as that of the manufacturers stand back of every trap we sell.

We ship promptly. FULL particulars on request.

WILLIAMS & WILSON, Limited, 84 Inspector St., Montreal
Agents for Canada

READ THIS

When called on to justify our demand for steel to manufacture our appliances, we had to show cause why, in the face of the abnormal demand created by war necessities, we should continue to receive our supplies.

WE SHOWED CAUSE, RECEIVED OUR SUPPLIES and CARRIED ON

We show you here an extract from our letter to the Fuel Controller, of Canada.

"We manufacture these appliances for the specific purposes of producing Fuel Economies in industrial steam plants and Private Steam Heating Systems.

Our records show that during the past year we have built and installed Condensation Return Traps and Automatic Boiler Feeders in Steam Plants to an aggregate of approximately 20,000 horsepower.

Our reports show that the average Fuel Economy effected in these plants, ranges from 10% to 25% of the fuel formerly used by the plants. This does not include small private heating plants.

Based on an average fuel consumption of four pounds of coal per horsepower hour, and a ten-hour daily run for three hundred working days, these plants would formerly use one hundred and twenty thousand tons per annum.

Under their new conditions with our appliances they are now consuming an average of 17% less fuel and doing more work.

THE APPROXIMATE AMOUNT OF FUEL SAVED IN THIS DISTRICT DUE TO THESE CONDITIONS WOULD BE ABOUT TWENTY THOUSAND, FOUR HUNDRED TONS."

We do not think we need to tell *you* any more.

The above savings are due to efficient handling of Steam Condensation and Boiler Feeding.

Do you want to share in these fuel economies?

If so, write us and get particulars of how it was done by means of our Return Traps.

This is the Return Trap

GEO. W. COLE, LIMITED
Engineers Specialties
2002-4 Dundas Street West, Toronto

HOMESTEAD
Quarter-Turn Valves

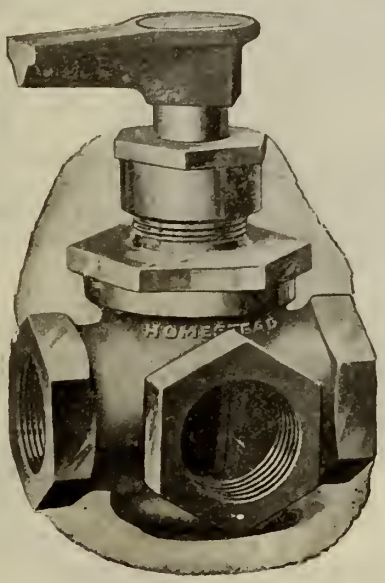
The Valves for Hard Service

Expert workmanship and the quality of material used in the manufacture of Homestead Valves, together with their practical utility and long wearing qualities, have brought insistent demands from all fields.

The harder the service the more you need the Homestead Valve.

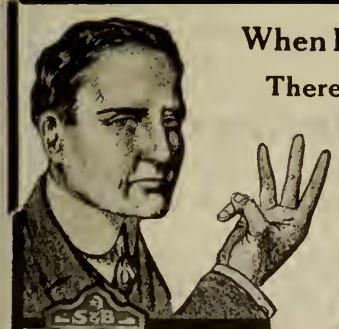
They are made for all pressures, in Straightway, Three-way and Four-way styles. They are made to suit all classes of material to be handled, and are, therefore, of brass, semi-steel and semi-steel with brass plugs.

Instal a Homestead Valve on your most troublesome line and note satisfactory results.



Homestead Three-Way Type

Homestead Valve Manufacturing Co.
HOMESTEAD, PENN.



When Buying Thermometers
There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

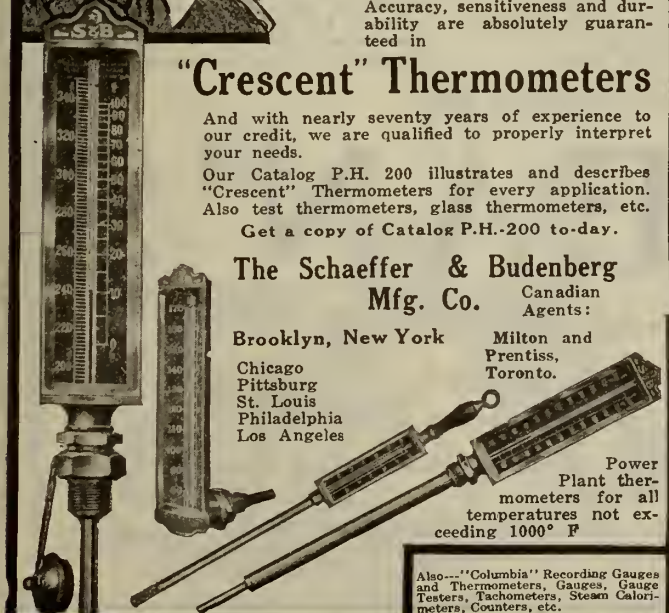
Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H.-200 to-day.



The Schaeffer & Budenberg Mfg. Co.

Canadian Agents:

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

Milton and Prentiss, Toronto.

Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

Why you get

better service
from
LUNKENHEIMER
"VICTOR"
GATE VALVES

THE disc is a solid wedge, seating on rings which are threaded into the body in exact alignment with the disc faces; the disc is guided by ribs cast in the body, and travels to practically a closed position before coming in contact with the seatring faces. "Dragging" of the disc across the seatring faces is thereby eliminated, preventing the wear so prevalent in valves employing loose parts.

When wide open the top of the disc seats directly beneath the stuffing box, relieves the packing from pressure and permits repacking while pressure is on.

The gasket between the body and bonnet flanges is an exclusive Lunkenheimer feature. It consists of a seamless copper wire partly embedded in a groove in the body flange; will not blow out and is practically indestructible.

Bearings are bronze bushed and all parts, including the seatrings, are renewable.

Inside Screw Stationary Stem and Outside Screw and Yoke Rising Stem types for working steam pressures up to 350 pounds.

Installing Lunkenheimer "Victor" Gate Valves means permanence and satisfactory service.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI

WRITE FOR DESCRIPTIVE LITERATURE

NEW YORK
CHICAGO
BOSTON
LONDON

WILSON FEARED THE BRITISH

THE American President crossed the Atlantic in the first place with the idea in his mind that his ideals would be thoroughly in accord with those of the French statesmen; but he was rather afraid of a conflict with the British delegates. He found in reality that his plan for peace terms was as far removed from the French plan as the two poles. Then he crossed to London and was surprised to find that the ideas of the two Anglo-Saxon powers were identical.

This situation, according to J. W. Dafoe in the May issue of MACLEAN'S MAGAZINE, explains much that has developed at Versailles. Further, it contains the promise of a close *rapprochement* between the two great English-speaking democracies for all time to come.

Mr. Dafoe has contributed a remarkably interesting article to this number of MACLEAN'S, lifting the curtain on many of the puzzling situations that have arisen overeas. As editor of the Manitoba *Free Press,* he is the dean of Canadian newspapermen; as the representative of the department of Public Information on the Canadian Mission to the Peace Conference, he was in a special position to learn what was transpiring. He tells of the really big part that Canada has played in the Proceedings and points out that Canada's status as a nation was firmly established in the eyes of the world when she was allowed separate representation.

A Dozen Other Features---Nationally Important

This May issue is full of articles of unusual significance for Canadian readers.

"SOLVING THE PROBLEM OF THE ARCTIC"
—By Vilhjalmur Stefansson

The second instalment of his remarkable story of the four years of exploration that he undertook for the Canadian Government in the region of the "Pole of Inaccessibility"—a harder place to reach than the North Pole.

"ORGANIZING FOR PEACE"
—By George Pearson

An article of the Great War Veterans' Association by a well-known author-soldier.

"THE CANADIANS IN SIBERIA"
—By Capt. W. E. Dunham.

A graphic story of what our forces did in combatting the Bolsheviki, by an officer who has just returned.

"SAFE IN THE SADDLE"
—By J. K. Munro

A review of affairs at Ottawa in which the opinion is expressed that Union Government for the time being is safely entrenched.

The National Idea

The articles in this issue of MACLEAN'S reflect the national idea—Canada's part in the Peace Conference, the political situation at Ottawa, the exclusive report of Stefansson's national explorations, the national organization of our returned men, the work of our forces in Siberia. The reader of MACLEAN'S gets a broad idea of what Canada as a whole is doing. The value of this issue—and of all issues—is very great, therefore, from an educational standpoint.
MACLEAN'S is the one magazine that should be selected for young Canadians to read.

Four capital stories by famous authors—W. A. Fraser, Lloyd Osborne, Frederic S. Isham and C. W. Stephens.

The Review of Reviews

An unusually fine array of articles is given in this department, selected from the best in magazines and periodicals the world over. Some of the titles are:

Planned to Destroy British Fleet.
How Mackensen Was Caught.
Events of War Foretold by Stars.
What is Life Like Beyond the Grave?
A High-born Bolshevik.
The New Life in Dry America.
Germans Were Ready to Capitulate.
Japan's New Foreign Policy.
The Many Kings of Jerusalem.
Is British Foreign Office Against League?
Ambassador Tells Story of Peace Ship.
Hindenburg—After the Armistice.

Over 65,000 Canadian Families Buy

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"CANADA'S NATIONAL MAGAZINE"

MAY ISSUE *Now On Sale At All News Dealers*

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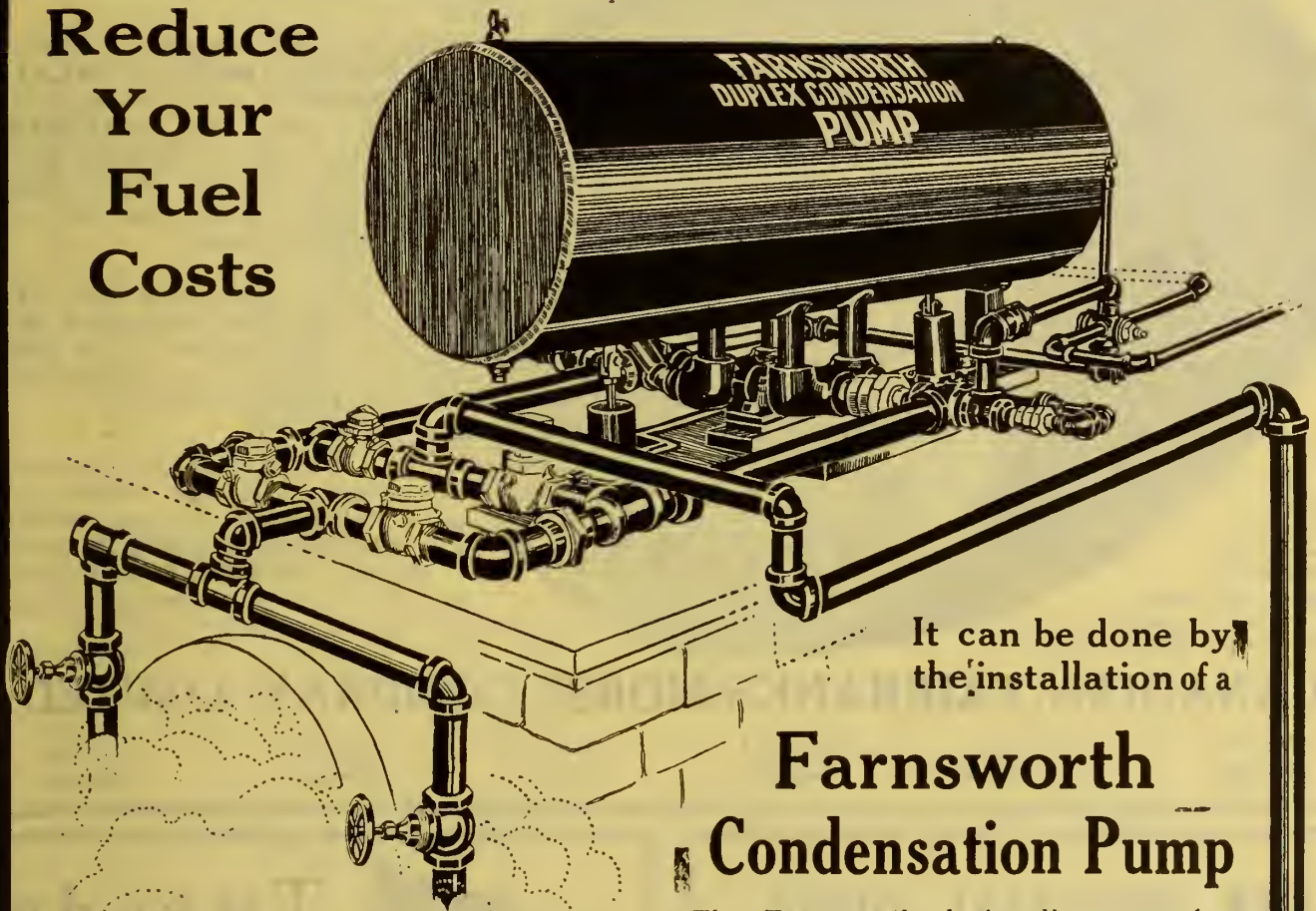
Dealers who have not been handling MACLEAN'S should secure copies at once from their nearest wholesaler.

If there are no newsdealers in your town, or if your newsdealers cannot supply you, send 20 cents for a sample copy or $2.00 for a whole year's subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto, Canada.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Reduce Your Fuel Costs



It can be done by the installation of a

Farnsworth Condensation Pump

The Farnsworth drains lines carrying high vacuum between the engine and the condenser and will discharge the condensate to atmosphere or by the use of a small high pressure steam connection will pump the condensate to any point of use.

Large capacity provides a special service for taking care of any slugs of water that might accumulate in the exhaust line.

When the machine is in a filling position or receiving the condensation, the tank is equalized with the exhaust line and applies either high pressure steam to pump the condensate out of the tank or opens a vent valve to allow the condensation to flow to atmosphere by gravity.

This same machine will handle condensation from the exhaust line if the line should instantly change from a high vacuum to a low pressure and will pump the condensation to any point of use or to atmosphere.

HOT WELL ELIMINATED.

The Canadian Fairbanks-Morse Company Limited

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

It will pay you to send for the booklet of METLSKIN. It describes the method of feeding, the principle of action, and other vital information.

Scale Prevention

By the logical principle of the **BOILER METAL TREATMENT** is easily obtainable. Not only will **METLSKIN** remove old scale, but it also will prevent feed-water solids from adhering to boiler-metal.

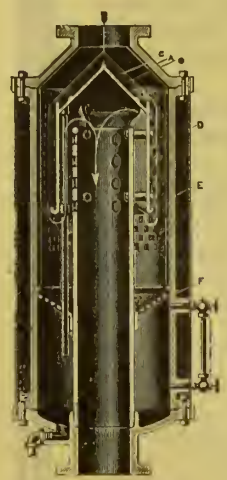
A small daily dose, at low cost, has solved the scale-problem in a host of plants in Canada, the U.S., and abroad.

Why not familiarize yourself with this method of treatment? If your boilers carry as little scale as 1/32 of an inch **METLSKIN** will show you an actual cash saving on fuel-bills. Let us prove it.

CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

St. John Quebec Montreal Ottawa Hamilton Toronto
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents:
Canadian Fairbanks-Morse Company, Limited
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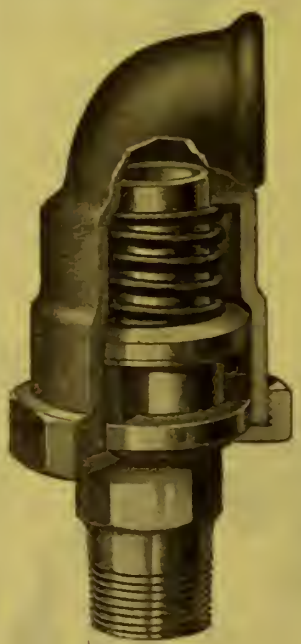


Tuxeda
SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

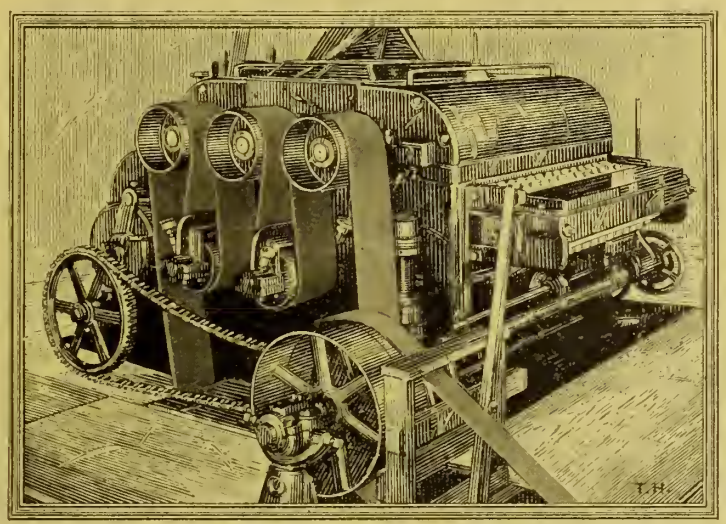
A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
New York City
General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

This illustration shows a Graton & Knight veteran in a Spartan Double Belt, 46 feet long and 8 inches wide. It is running every day in the plant of the Leroi Furniture Company, St. Louis, Mo. It has seen 4½ years of service. This belt-eating sanding machine wore out three 9-inch ordinary belts in eighteen months. Its cost has been 40 cents a week with long service to come.



For all drives designed in our Engineering Department the belts are proportioned so that the stress, due to the horse-power being transmitted, is never more than one-tenth of their ultimate strength. The rules employed are the result of extensive experience, and applied to your problems may show that you are using a belt too good or one not good enough for the work to be done.

The Right Belt in the Right Place

Here is punishment for *any* belt. And as usual SPARTAN is the belt that is game for it. It shows the right belting material in the right place. SPARTAN, greatest of pulley-grippers, flexible and elastic, is solving the problem of the trouble-making drive in thousands of plants. There is one answer and one reason—leather properly tanned and fabricated for a given purpose—a Standardized Series.

You can't think of any belting material that stands hard knocks the way leather does—or one that can be satisfactorily spliced or repaired. Leather has the tightest of frictional grip. It gives and takes as the need arises. It doesn't fray under the side slapping of shifters. After a long and useful life on main drives you can cut it into smaller belts and keep it earning money.

Graton & Knight Standardized Series Belts are made for the work to be done—from the first step in tanning. Very nearly 300,000 steer hides pass through our hands yearly. Think of the broad selection that gives us, the uniformity of quality possible. And installing any G. & K. Standardized Series Belt means the right belt in the right place—not merely a belt, but a belt for a *given* purpose.

Many of the best belted plants ask us to specify the belting for every drive. Try the plan yourself. Then, when buying, call for "Graton & Knight Brand—or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for information about Standardization as applied to Belting

THE GRATON & KNIGHT MFG. COMPANY, Worcester, Mass., U.S.A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packings and Specialties

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GRATON AND KNIGHT

GRATON & KNIGHT

Standardized Series

LEATHER BELTING

Tanned by us for belting use

1851 G&K TRADE MARK

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

DURABLA

DURABLA
TRADE MARK REGISTERED

Sold on a Service Basis

DURABLA COMPRESSED ASBESTOS FIBRE GASKETS are guaranteed to meet every flange condition in your plant, making a permanently tight joint wherever a gasket is required.

One Standard Gasket for all Gasket Work. *Prompt Shipments of All Orders*

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P & C CO

Valves and Asbestos Packed Cocks

Feed Water Heaters
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Power Pumps

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CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Avoid the Constant Repacking of Small Valves

by using "PALMETTO" TRADE MARK TWIST PACKING

The Lubricant in "Palmetto" Twist keeps the stem so well lubricated that the hand wheel turns easily.

Each single strand carries its own lubricant and is a perfect packing in itself.

Heat cannot affect "Palmetto" Twist, and the lubricant keeps it soft and pliable in service.

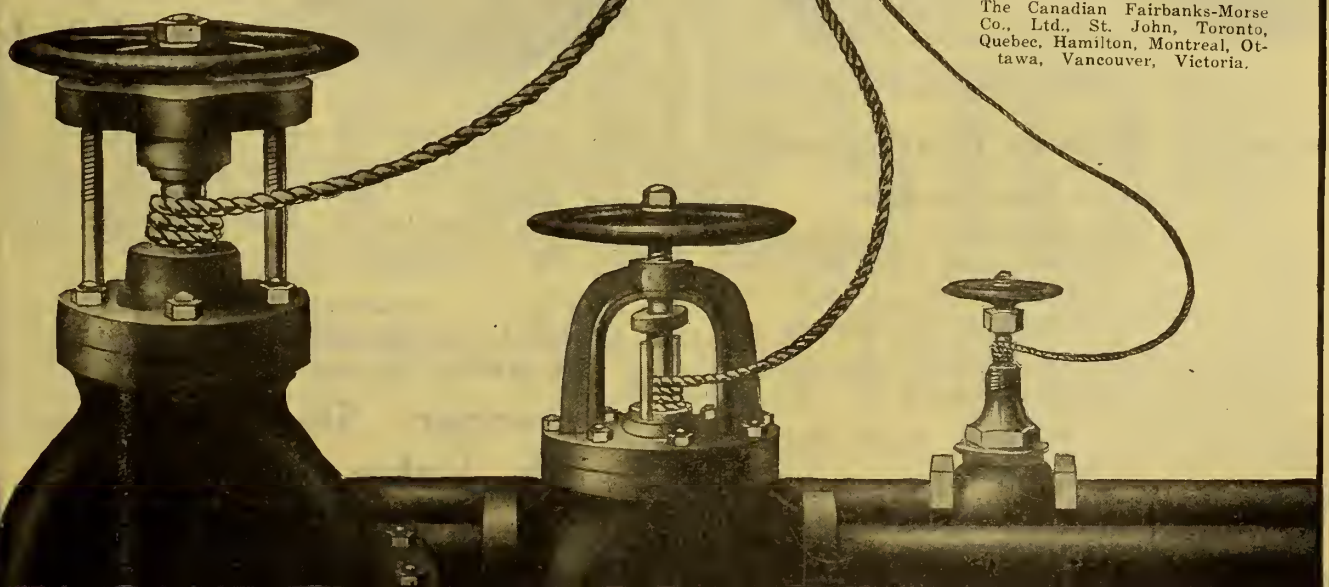
The amount of packing required for a valve is small—if you use the best it means REAL ECONOMY.

Let us send you a sample spool to test—no charge.

ANY SIZE VALVE PACKED FROM ONE SPOOL BY UNSTRANDING.

GREENE, TWEED & CO.
Sole Manufacturers
109 DUANE ST., NEW YORK

Canadian Agents:
The Canadian Fairbanks-Morse Co., Ltd., St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria.



CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Never will this Tube Buckle, Bend or Split

Because of the divided floating head which compensates for the unequalled expansion of the tubes, due to the temperature difference between the water as it enters and leaves the heater, the

ALBERGER HEATER

is proof against troubles such as leaks, split tubes, cracked heads, etc.

On Alberger Heaters there is far less tendency to scale because tube corrugations cause the water to take on a whirling, scouring action.

You will avoid all expense and trouble common to ordinary heaters by giving your plant an Alberger Multi-Head Heater. Both Horizontal and Vertical Types of adequate capacities for every service.

50 % More Heat

Using no more steam, Alberger Heaters are guaranteed to transmit 50% more heat than straight tube heaters of similar size. They furnish hot water as fast as it can be drawn. No storage tank required.

Ask for Bulletin No. 201

Alberger Heater Company
Buffalo, N.Y.

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The Canadian Fairbanks-Morse Co., Limited
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Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Voorhees Rub-Steel Valves

"The Valve with a backbone"

Are without an Equal for

Deane of Holyoke Condensers

or Suctions on Paper Machines

Softest high-grade rubber as seating, supported by an inseparable **steel core.** Spring guides and brass bushed stud-holes as above, if desired, or plain faces.

Not a cheap valve, but positively smoothest in action and longest lasting.

This construction in Four Grades for **every** known pumping service.

The Canadian Fairbanks-Morse Co., Ltd.
Sole Distributors for Canada

High Pressure Gauge Testing Simplified

The constantly increasing use of high pressures in various manufacturing processes has caused us to develop a Dead Weight Gauge Tester for testing Gauges up to a maximum of 5,000 pounds per square inch.

Simple in design—easy of operation. Distinctively AMERICAN.

Write for completely descriptive circular.

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MONTREAL QUEBEC ST. JOHN, ETC.

American Steam Gauge & Valve Mfg. Co.
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THE PACKING FOR *EVERY* PURPOSE

Vulcabeston Red Fibre Sheet Packing is saving power in thousands of Plants—leak-proofing pipe lines of every kind. Vulcabeston is "the universal packing" for superheated and saturated steam, oils, ammonia, hot water, acids and alkaline solutions.

Vulcabeston is capable of complete standardization. *Alone* it takes the place of all "special" packings for "special" services. It is easy to cut and has great resiliency but, unlike rubber, and many compressed asbestos sheet packings, cannot be squeezed out. Vulcabeston exempts power plants from power waste and saves *real* money in operating costs.

If your dealer cannot supply you—
write us direct.

THE JOHNS-PRATT Co.
HARTFORD, CONN.

19-6

VULCABESTON
Red Fibre Sheet Packing

THE FINANCIAL POST
OF APRIL 26TH CONTAINS:

DOMINION STEEL'S SHIP PLATE DEAL

Arrangement Promises to Work Out Well for Company and Shareholders

The continuance of work on the Dominion Steel Corporation's rolling mill at Sydney, N.S., brings to mind that this company has a very favorable agreement with the Dominion Government, and one which should be a good thing for the shareholders.

The company agrees to make plates (basic open hearth) to such thickness or size as required for shipbuilding, the Government to purchase 250,000 gross tons, and have the option of increasing the amount to 375,000 tons. Deliveries are to be made at the rate of 50,000 tons per year, the Government retaining the option of increasing this to 75,000 tons per annum.

The price for such plates is $4.15 per 100 lbs., or $83 per ton, and provision is made that this price may be increased to $4.25 or $85 per ton.

You will find further interesting matter on this subject in THE POST of April 26th.

Farmers, Trusts, and Publicity (Editorial) .....

The Five Best Industrials .....

United Hotel Co.'s Deal for Clifton

Patronage and the National Forest Menace .....

The Steel Trade Items Here Reproduced Also

A Commission Like Ontario's for Nova Scotia .....

Commission of Utilities in B. C. and New Capital .....

Government Failure in Operation of U. S. Railroads .....

Dominion Steel Strikes Hard at Scotia's Claims .....

Rubber Company Has Record Year —49% on Common .....

Price Bros. & Co. Show Nearly $1,500,000 Profits .....

Sawyer-Massey Adopts a House-Cleaning Policy .....

Production of Mining Corporation of Canada Falls Off .....

Bank Clearings Were Affected by Holiday .....

Higher Savings Balanced by Current Loans .....

Says Banks Are a Handicap to Retail Section .....

How is Germany to Pay Billions of Indemnity? .....

Opportunities for Business in Balkan States .....

How to Float Foreign Bonds is a Problem .....

Conditions Are on Quiet Side in Bond Market .....

S. Vancouver to Consolidate its Tax Arrears .....

THE PRICE FOR STEEL SOON TO BE ADJUSTED

Between the United States Railroad and Industrial Boards

NEW YORK.—From a technical market standpoint, according to Hayden, Stone & Co., the most encouraging event of the week was a new high price on this movement for Steel common. The figure reached is the highest since last November. Undoubtedly this anticipates an agreement between the railroads and industrial boards on the price level for steel. This is one of the acts to which the market has been steadily looking forward. It will be important, not only in the material improvement which it should shortly bring about, but even more for its psychological effect. No doubt it will be shortly followed by an agreement on the price for coal.

You will find further interesting matter on this subject in THE POST of April 26th.

Regina's Tax Rate Boosted by Five Mills .....

Beck's Tactics Give N. Toronto a Bad Setback .....

Saskatchewan Dealers in Farm Lands Organize .....

Steel Confusion Now Increased by Naval Board .....

Business Building News Items Appear Each Week in *The Financial Post*

The above are only a few of the many subjects of real profit-making interest to Canadian men of affairs which have been dealt with by expert writers and editors in THE POST of April 26th. THE POST will keep you informed on Canadian business matters in a way unrivalled by any other publication. Send for a subscription to-day. The price is $3.00 per year, and you have only to fill in this form:

The MacLean Publishing Co.,
143-153 University Ave., Toronto.

Send me THE FINANCIAL POST every week till further ordered. I will pay subscription price, $3.00 per year, on receipt of bill, or you may draw on me for this.

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P..H

FOR AIR COMPRESSORS

IRON CAP COPPER COMPANY

Magnolia Metal Co. November 11, 1918.

Gentlemen—

We have used MAGNOLIA METAL for several years, and the best endorsement that we can give it is that one small compressor has run almost *continuously* for TEN YEARS without renewal of babbitt.

Yours very truly,
IRON CAP COPPER COMPANY
F. A. Woodward, Supt.

PRACTICAL ENGINEER POCKET BOOK
Over 600 Pages
A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
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MAGNOLIA METAL CO.
OFFICE AND FACTORY:
225 St. Ambroise Street, MONTREAL

Don't buy that New Electrical Apparatus Just Yet

WE can supply you with high-grade apparatus that has been slightly used and discarded through no fault of its own, at an **immense saving in cost.** For instance, in many cases we take over entire plants simply because of changed conditions such as increased capacity, change of system, etc.

EVERYTHING IS OVERHAULED AND REFINISHED BY US AND **GUARANTEED** AS GOOD AS NEW, BOTH ELECTRICALLY AND MECHANICALLY.

Our catalogs of offerings should be in the hands of every power plant superintendent each time they are gotten out, and it will be worth while for anyone interested in this class of power plant equipment to be on our mailing list to receive all offerings.

Nearly all of the principal power, lighting and street railway plants in the United States are our customers.

WRITE FOR OUR LATEST CATALOG of **Power House Equipment, Street Cars, Motors, Hoists, Compressors, etc.**

MACGOVERN & COMPANY, Inc.

General Office: 114 Liberty Street, New York
Canadian Office: 285 Beaver Hall Hill, Montreal

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

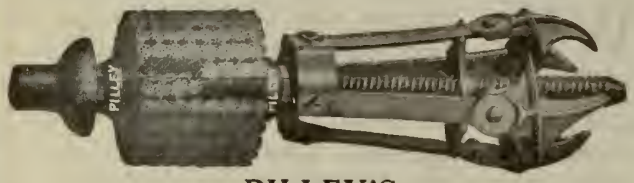
Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.

Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

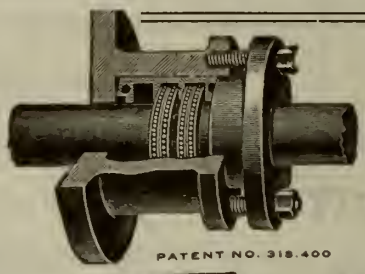
For sale by leading Canadian jobbers.

Manufactured by

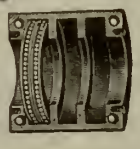
PILLEY PACKING AND FLUE BRUSH MFG. CO.

623 South Third Street - - - St. Louis, Mo.

Eastern Office: 71 Fulton St., New York.



PATENT NO. 318,400



PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775 193	" "	906,103
" "	775,194	" "	934,629
" "	791,300	" "	979,206
" "	805,669	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.

Incorporated 1897

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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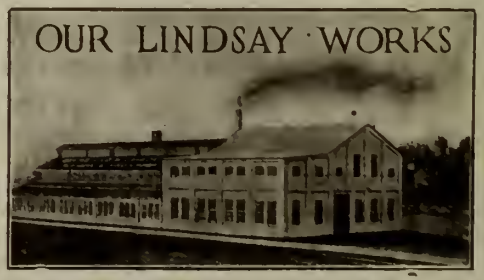
WATSON & McDANIEL CO.

No. 146 N. 7th Street, PHILADELPHIA, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



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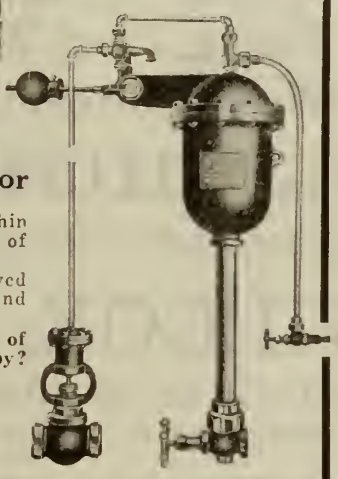
DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

Consult "Power House" Buyers' Guide
If what you want isn't advertised in this issue, consult our Buyers' Directory. If it isn't in our Directory, write us and we will gladly give you the information.

VIGILANT

Automatic Feed Water Regulator



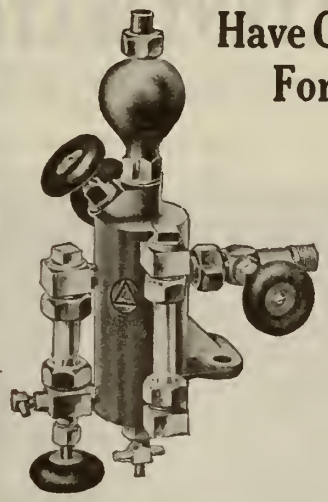
The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.

Years of service test has proved it the utmost in reliability and efficiency.

Catalogue presents many points of interest. May we send you a copy?

The CHAPLIN-FULTON MFG., CO.
28 Penn Ave., Pittsburgh, Pa.

Detroit Lubricators
Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

When the Board of Directors Visits the Boiler Room

One or two or more of them are almost sure to notice and to comment on the presence or absence of Diamond Soot Blowers.

Why?

First: Because it is not uncommon now-a-days to find men with considerable engineering training, as well as business men with much practical experience in power plant matters, on directorates. These men know the value of maintaining clean surfaces for the transmission of heat in the boiler.

Second: Diamond Soot Blowers are widely advertised and the results of many tests have been published in the editorial pages of dozens of technical and trade papers, so that even directors not closely informed on all phases of power plant operation, are familiar in considerable detail with mechanical soot blowers.

Third: Diamond Soot Blowers are installed on over 2,000,000 HP of boilers annually. Other plants with which the directors are associated or are familiar, are increasing their net profits to an appreciable extent by the use of Diamond equipment.

TO MANAGERS AND SUPERINTENDENTS:—

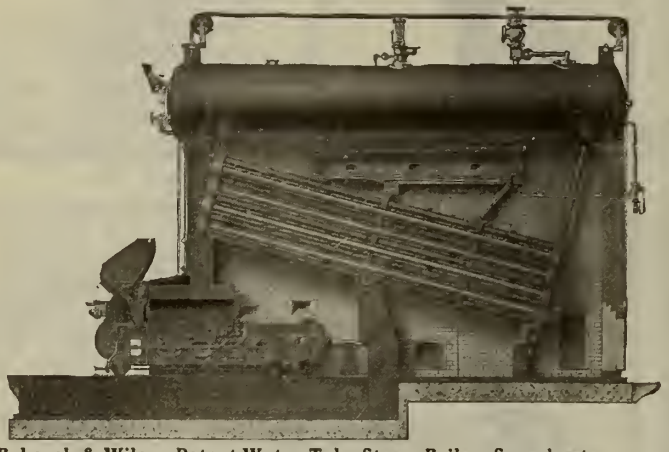
If your boilers are not equipped with Diamond Soot Blowers, what reasonable explanation can you make to your Board of Directors for your failure to utilize a proven method of reducing your fuel consumption 4 to 8 per cent., greatly reducing your labor costs and labor turn-over in the boiler room, and materially reducing your boiler repairs, at an expenditure which will enable you to earn from 100 to 200 per cent. on your investment annually?

For full information ask for Bulletin 162.

Diamond Specialty Company
WINDSOR, ONTARIO
Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



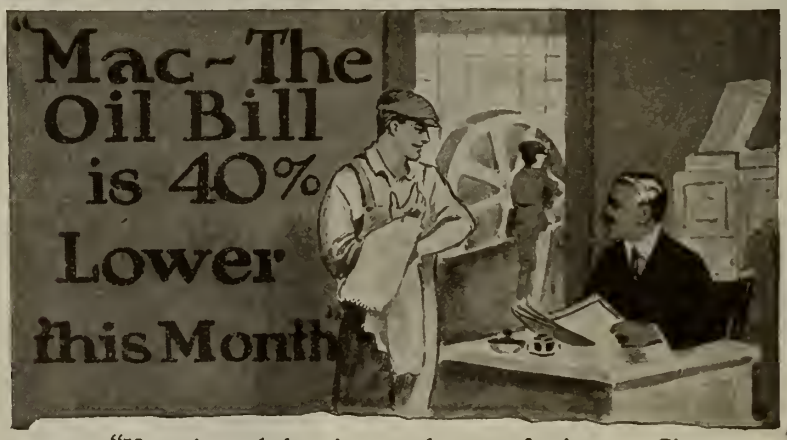
Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

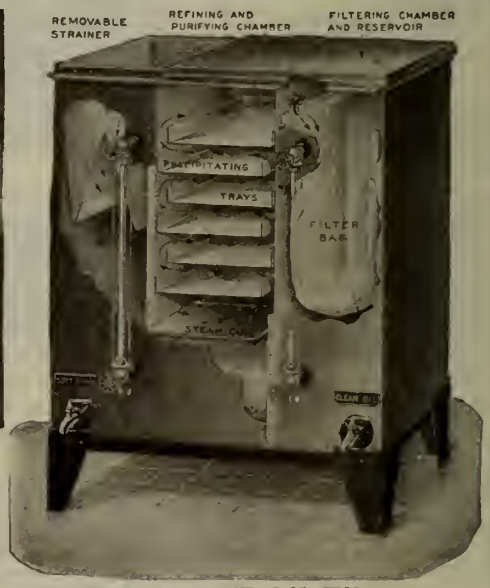
BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING



"Yes, sir, and there's a good reason for it too. Since we installed the BOWSER Oil Filtering Outfit the men in the engine room have been competing to see who could save the most oil. They've cleaned the journal boxes, put pans under them to catch the drips and then put the salvage through the BOWSER Oil Filtering Outfit. We are now using the oil over and over again that was formerly wasted."

The BOWSER Oil Filtering Outfit is simple, compact, economical and reliable.



Bowser 7F Oil Filter

First, means a cleaner engine room.

Second, it cuts your lubricating oil bill considerably.

Third, IT PAYS FOR ITSELF over and over.

WRITE FOR LITERATURE DESCRIBING OIL FILTERING SYSTEMS SUITABLE FOR YOUR POWER PLANT.

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Can. H. W. Johns-Manville Co., Toronto, Ont.

AMMONIA VALVES AND FITTINGS
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa

AMMONIA TANKS
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
Canadian Fairbanks-Morse Co., Ltd. Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd. Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co. Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto, Ont.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Cling Surface Co., Buffalo.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
Waterous Engine Works Co., Brantford, Ont.
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. Consol. Rubber Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Vorhees Rubber Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, WOVEN COTTON
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. I. Philip & Sons, Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Metlskin Mfg. Co., Rochester, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

BOILER SKIMMERS
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mfg. Co., Woodstock.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Coppus Eng. & Equipment Co., Worcester, Mass.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Engineering Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Montreal.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
MacGovern & Co., Inc., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd. Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

BRASS FOUNDERS
McAvity, T., & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BUCKETS, ELEVATOR
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CAR LOADERS AND UNLOADERS
Portable Machinery Co., Inc., Passaic, N.J.

CAST IRON FITTINGS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Waterous Engine Works Co., Brantford, Ont.

CELLAR DRAINERS
Morrison Brass Mfg. Co., James, Toronto, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDNER & WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates, John W., St. James St., Montreal.
Green's Economiser, Ltd., Toronto.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd. Montreal
Canadian Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford, Ont.

CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.

CHAIN DRIVES
Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, England.
Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithaca, N.Y.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto. Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAIN, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto. Ont.
Jeffrey Mfg. Co., Montreal, Canada.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.

CHIMNEYS, STEEL
Babcock & Wilcox, Ltd. Montreal
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

CIRCULATING SYSTEMS (LUBRICATING OIL)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.

CHUTES, COAL
Mackinnou Steel Co., Ltd., Sherbrooke, Que.

CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford, Ont.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox, Ltd. Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Royles, Ltd., Irlam, Manchester, England.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. I. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto, Ont.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Davis Regulator Co, G. M., Chicago.

CONDENSER AND SMOKESTACK PAINTS
Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONTRACTORS' STRUCTURAL STEEL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, PORTABLE
Portable Machinery Co., Inc., Passaic, N.J.

CONVEYORS, BELT
Portable Machinery Co., Inc., Passaic, N.J.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

COPPER TUBE
Empire Mfg. Co., Ltd., London, Ont.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canadian Corkboard Co., Toronto.

CORKBOARD
Canadian Corkboard Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Canadian Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd. Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Can. Link-Belt Co., Toronto, Ont.

CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK AND CROSSHEAD PIN OILERS
Linkenheimer Co., Cincinnati, O.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Canada.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

CURB PUMPS (OIL AND GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

CYLINDER OIL
E. H. Kellogg & Co., New York.

DAMPER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DRAFT APPARATUS SYSTEMS, MECHANICAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

DRAFT RECORDERS
Jas W. Hays Corp., Michigan City, Ind.

DRAFT GAUGES
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon, Holmes & Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Linkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

EJECTORS AND SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENAMELWARE FITTINGS, IRON PIPE
Empire Mfg. Co., Ltd., London, Ont.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Linkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUPTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

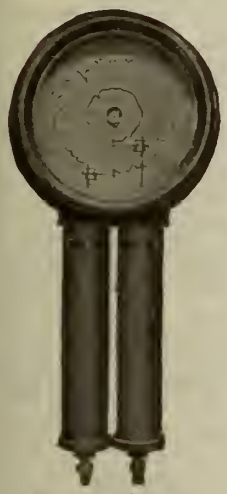
ENGINES, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Hamilton Mfg. Co., Wm., Peterboro, Ont.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Can. Allis-Chalmers, Ltd., Toronto, Ont.

UEHLING WASTE METER

COMBINED

CO_2 AND TEMPERATURE RECORDER



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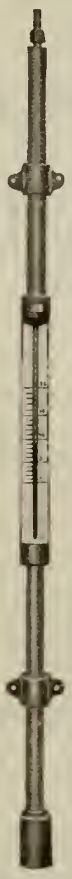
Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO_2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.



CO_2 Indicator for Boiler Front

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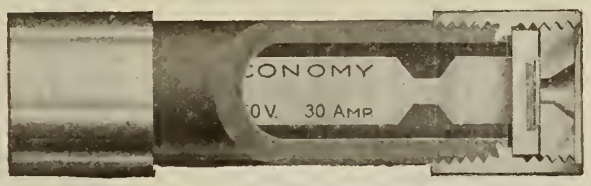

ECONOMY Renewable FUSES

are commended to the practical electrician and engineer because in performance they do all that could be asked of any fuses and, in addition, cut annual fuse maintenance costs 80%. This pioneer renewable fuse, when blown, is instantly restored to its original efficiency by an inexpensive "Drop Out" Renewal Link—the most efficient and economical of all renewal elements. It's the work of a moment for even a novice to replace the link and renew the fuse. ECONOMY renewable FUSES are used by representative houses in all branches of industry throughout North America, and are sold by most leading jobbers and dealers.

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ECONOMY FUSE & MFG. CO.

Of Canada, Ltd.

UNITY BLDG. MONTREAL

Manufacturers in Canada of S. & C. High Potential Fuses—To 150,000 Volts

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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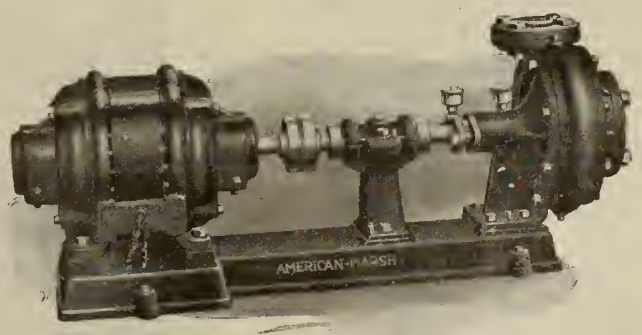
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.



American-Marsh Centrifugal Pump.

ENGINES, MARINE
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Montreal General Tool Co., Montreal, Que.

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Laurie & Lamb, Montreal.
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Waterous Engine Works Co., Brantford.

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Green's Economiser, Ltd., Toronto.

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Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Royles, Ltd., Irlam, Manchester, England.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Darling Brothers, Ltd., Montreal, Que.
Green's Economizer, Ltd., Toronto.
Laurie & Lamb, Montreal.
E. I. Philip & Sons, Toronto.

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Laurie & Lamb, Montreal.

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Mackinnon Steel Co., Ltd., Sherbrooke, Que.
E. I. Philip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

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Bowser & Co., Inc., S. F., Toronto, Ont.

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Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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FLANGES
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Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

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Mackinnon Steel Co., Ltd., Sherbrooke, Que.

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Green's Economiser, Ltd., Toronto.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

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Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

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Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

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Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.
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Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
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Shell Bar Boico Supply Co., Toronto, Ont.
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Laurie & Lamb, Montreal.

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Bowser & Co., Inc., S. F., Toronto, Ont.

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Bowser & Co., Inc., S. F., Toronto, Ont.

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Imperial Oil, Ltd., Toronto.

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McAvity, T., & Sons, Ltd., St. John, N.B.
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Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
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Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

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Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Montreal.
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Mason Regulator & Engineering Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.

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Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston. Mass.
Laurie & Lamb, Montreal.

GREASES
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Can. Economic Lubricant Co., Montreal. Que.
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Jas W. Hays Corp., Michigan City, Ind.

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Penberthy Injector Co., Windsor, Ont.

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Bowser & Co., Inc., S. F., Toronto, Ont

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Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Alberger Heater Co., Buffalo, N.Y
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

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The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

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HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

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Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Thomson-Gordon, Ltd., Hamilton, Ont.
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HYDRANTS
Wood & Co., R. D., Philadelphia, Pa.

HYDRAULIC ACCUMULATORS
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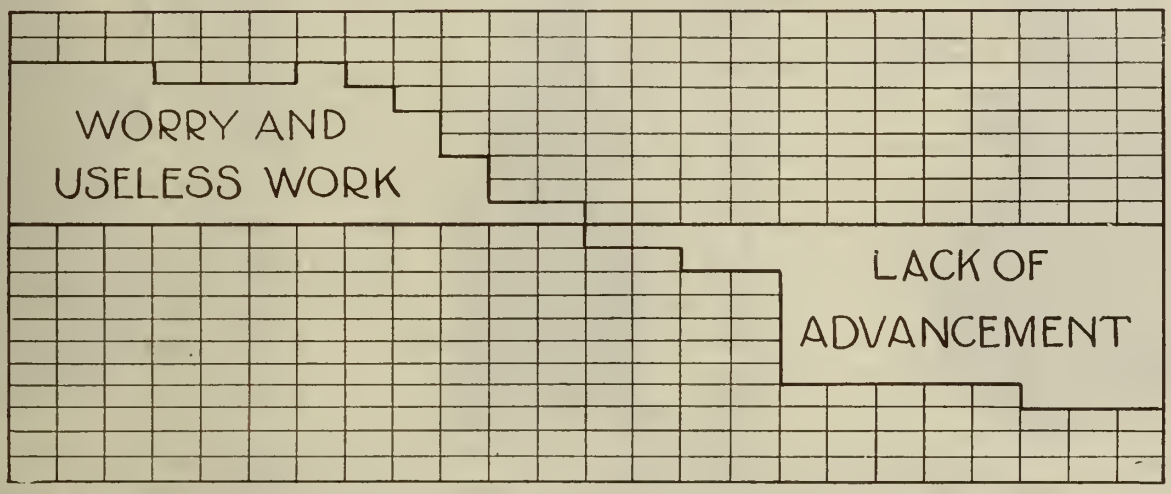
Brick Co., Waynesboro, Franklin Co., Pa.

Let the C.A.S.E. Smooth Out Your Load Curve



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If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

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MacGovern & Co., Inc., Montreal, Que.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Linde Canadian Refrigeration Co., Montreal.
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Uehling Instrument Co., New York, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

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Penberthy Injector Co., Windsor, Ont.

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Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
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Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
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KEROSENE TANKS
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Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont

LAMPS, TUNGSTEN AND NITRO
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LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

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Portable Machinery Co., Inc., Passaic, N.J.

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LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

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Penberthy Injector Co., Windsor, Ont.

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Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

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Beveridge Paper Co., Ltd., Montreal, Que.

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Green's Economiser, Ltd., Toronto.
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Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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E. I. Philip & Sons, Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. I. Philip & Sons, Toronto.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
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METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. I. Philip & Sons, Toronto.
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St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

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Bowser & Co., Inc., S. F., Toronto, Ont.

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Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

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Bowser & Co., Inc., S. F., Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufactnring Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Vorhees Rubber Co., Ltd., Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Crane Packing Co., Chicago, Ill.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE, CAST IRON
Wood & Co., R. D., Philadelphia, Pa.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

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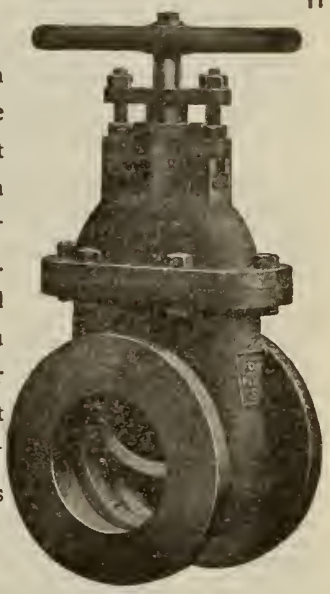
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.



When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

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Boiler Room Efficiency Instruments

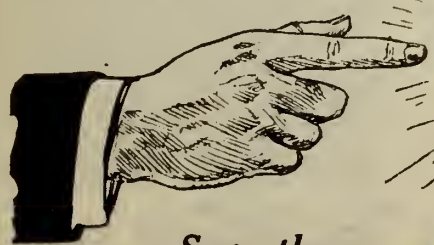
NO MORE GUESSING IN YOUR BOILER ROOM
THE DEFENDER SYSTEM (READS)

Draft, Temperature and CO_2 on each Boiler. Determine the Draft over the fire and at the last pass of the Boiler and the drop in Draft through the Boiler—that gives the highest percentage of CO_2 in the Flue Gas and the lowest Flue Gas Temperature.

This gives the highest Boiler and Furnace Efficiency. The Defender Catalogue No. 10, which is just off the press, shows a very complete line and price list of Combustion Appliances and Damper Regulators for the Boiler Room.

The Defender Automatic Regulator Co., 709 Pine St., St. Louis, Mo., U.S.A.

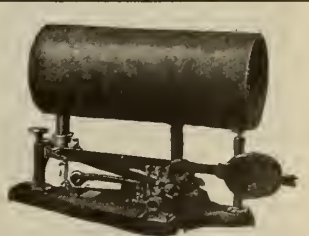
"Black Diamonds" are Precious



Save them

COAL is scarce. The supply is still limited. Scarcity means high prices. You should save every piece of this precious fuel as a measure of business economy.

Morehead Back-to-Boiler System will Save 8 to 20% of Your Fuel.



It keeps condensation out of your steam lines by returning it to the boilers while it is HOT. In a year's time you save many tons of coal. The MOREHEAD SYSTEM gives freedom from steam troubles and maintains a uniform temperature throughout the plant. Requires practically no attention. Let us tell you more about the New Improved Morehead Trap.

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Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.

PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PYROMETERS
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

RECLAIMING SYSTEMS FOR OIL
Bowser & Co., Inc., S. F., Toronto, Ont.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

REGISTERING MEASURES
Bowser & Co., Inc., S. F., Toronto, Ont.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

RUBBER CEMENT TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.

ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.

SELF-MEASURING PUMPS (OIL AND GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.

SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTER LININGS
Beveridge Paper Co., Montreal, Que.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penherthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.

Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Can. Morehead Mfg. Co., Woodstock.
Mason Regulator & Engineering Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Bowser & Co., Inc., S. F., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.,
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont,

TANKS (UNDERGROUND STORAGE)
Bowser & Co., Inc., S. F., Toronto, Ont.

TANKS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
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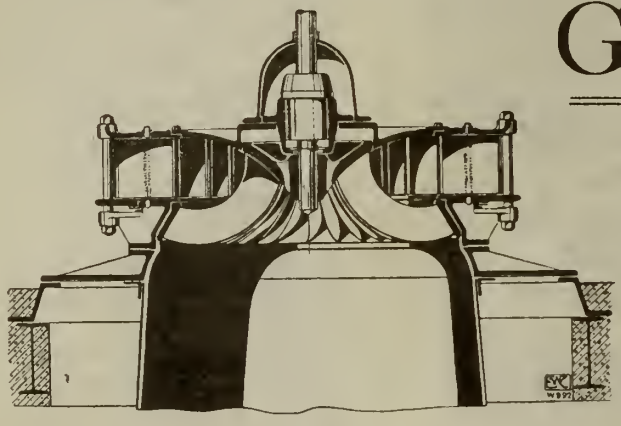

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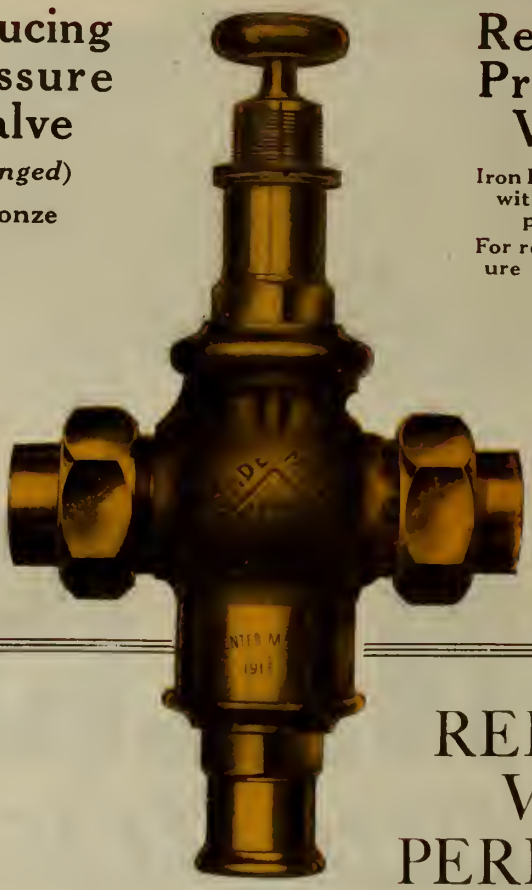

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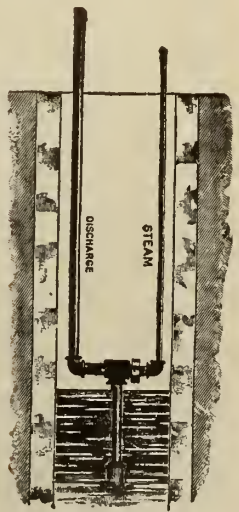

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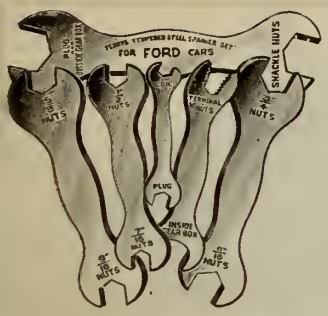

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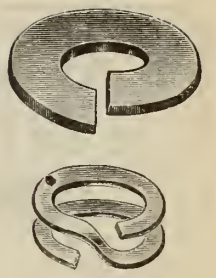

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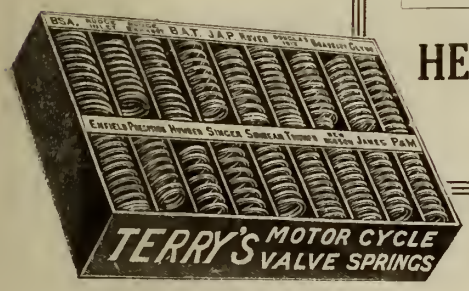

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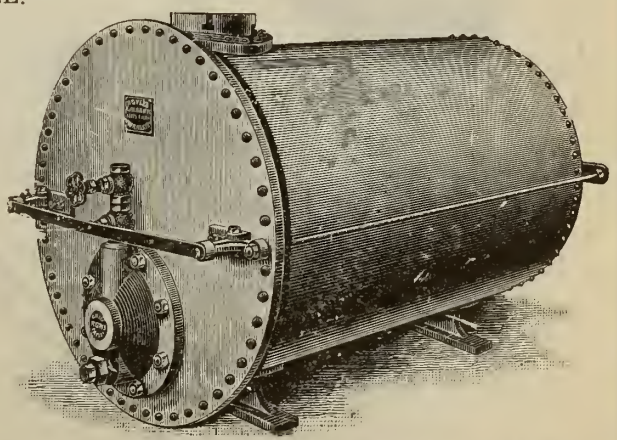

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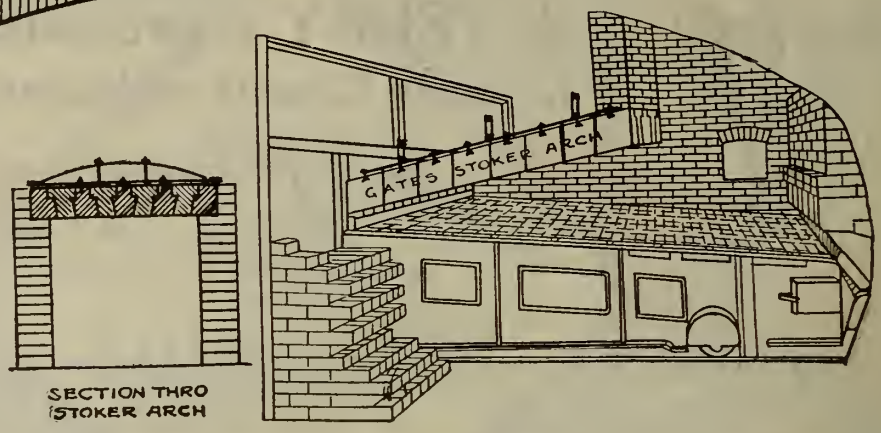

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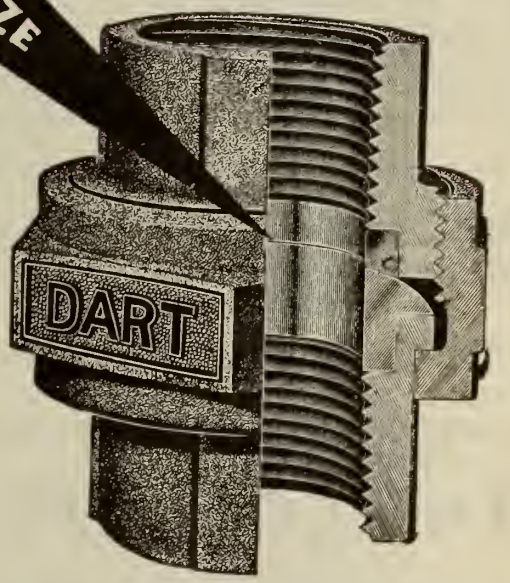

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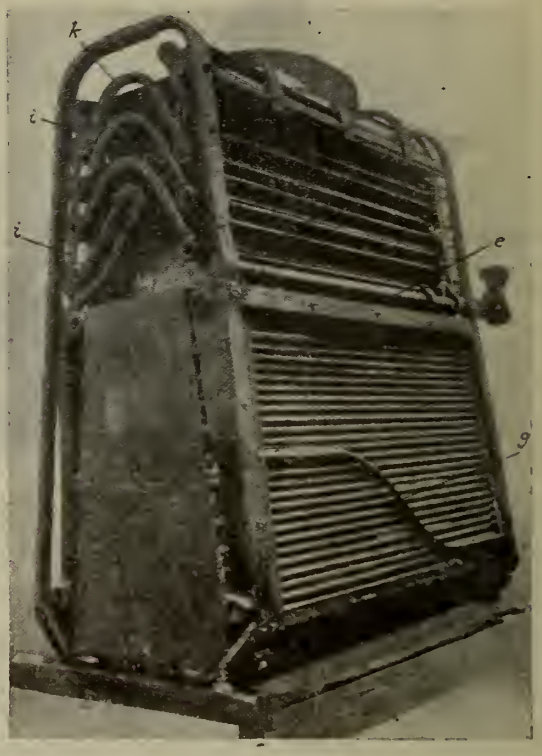
MONTREAL, P.Q.



Responds quickly to sudden demands for steam through automatic control—positive circulation.

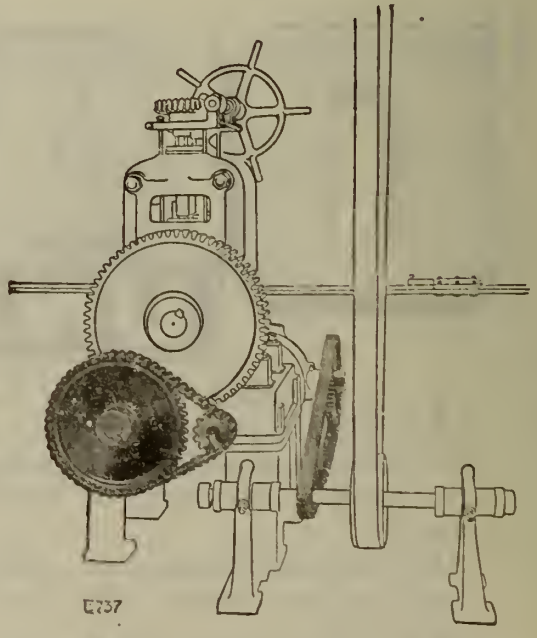
"THE COVENTRY" CHAIN DRIVES

THE ideal drive for all kinds of power transmission. In the case of the rolling mill illustrated, considerable power, large reduction of speed ratio, even flexible torque, silence and short centres are required. Note short distance between centres in front chain drive.

THE
COVENTRY
REGISTERED TRADE MARK

THE "COVENTRY" CHAIN Co., LTD.
COVENTRY, ENGLAND

Cables: Chains, Coventry. Codes A.B.C., 4th and 5th Editions, and Western Union



Rolling Mill for producing stream line wire for aeroplanes. Diameter of rolls 9", rolling speed 20.0 per minute.

The QUALITY of

D. K. McLaren's Genuine British Oak-Tanned Leather Belting

Becomes More Evident As Time Rolls On

When you buy D. K. McLaren's Leather Belting you get a belting that will stand up under many years of severe service. The fact that many of Canada's Largest Power Plants are steady users and that the biggest percentage of our business is repeat orders, speaks well for the popularity of our product.

D. K. McLaren's Belting represents Flawless Backs of the hides of the choicest steers tanned by the genuine British-Oak process; the best known for preparing belts for hard service. Every bit of the hide's natural strength is preserved. Minimum stretch, minimum slippage and fewer breaks are the results you can expect.

D·K·McLAREN LIMITED

Head Office and Factory: 351 St. James St., Montreal, P.Q.

Toronto, Ont.	St. John, N.B.	Vancouver, B.C.
194 King St. W.	90 Germain St.	849 Beatty St.

and satisfy yourself of the many advantageous features embodied in

LUNKENHEIMER "FERRENEWO" VALVES

Note the *seat ring* and *disc*—both of which are made of Lunkenheimer "Valve-nickel," a material having exceptional wearing qualities; the regrindable seating surfaces; the renewability of all parts, including the *seat ring* and *disc*—the full areas through the body; union bonnet; special composition stem, which insures long life to the stem threads; deep stuffing box, etc. These features combined with Lunkenheimer "quality" materials and workmanship make the "FERRENEWO" *the* valve of exceptional merit.

Globe, Angle and Cross, and Horizontal and Angle Check Patterns, for working steam pressures up to 150 pounds.

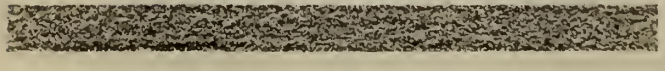
Your local dealer can furnish them; if not, write us. Write for descriptive Booklet No. 567-DC.

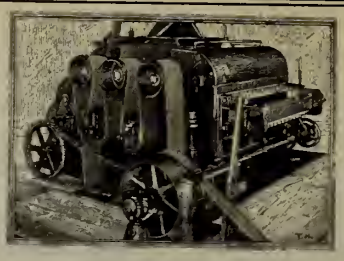
THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World

CINCINNATI, U.S.A.

New York Chicago 2-11-43 Boston London





The Right Belt in the Right Place

This illustration shows a Graton & Knight veteran in a Spartan Double Belt, 46 feet long and 8 inches wide. It is running every day in the plant of the Leroit Furniture Company, St. Louis, Mo. It has seen 4½ years' of service. This belt-eating sanding machine wore out three 9-inch ordinary belts in eighteen months. Its cost has been 40 cents a week with long service to come.

Here is punishment for *any* belt. And as usual Spartan is the belt that is game for it. It shows the right belting material in the right place. Spartan, greatest of pulley-grippers, flexible and elastic, is solving the problem of the trouble-making drive in thousands of plants. There is one answer and one reason—leather properly tanned and fabricated for a given purpose—a Standardized Series.

Write for information about Standardization as applied to Belting.

THE GRATON & KNIGHT MFG. COMPANY,
Worcester, Mass., U. S. A.

Oak Leather Tanners and Belt Makers

Canadian Graton & Knight, Ltd., 84 St. Antoine St., Montreal, P. Q., Canada

GRATON & KNIGHT
Standardized Series
LEATHER BELTING

Eight real advantages

in equipping water tube boilers, oil stills and superheaters with Key Boiler Equipment Company's

KEY SAFETY HAND-HOLE CAPS

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

No gaskets required. Over 1,500,000 now in service. Let us send you our descriptive literature.

Power Plant Equipment Co.

Canadian Selling Agents

310 Dominion Bank Bldg., Toronto, Can.

MASON

QUALITY! RELIABILITY! SERVICE!

Quality, Reliability and Service are the winning factors in business. You are assured of all three when you buy MASON engineering equipment. MASON stands for modern design, high-grade workmanship and long service.

ABOVE EVERYTHING

our Sales Engineers know the **practical application** of our lines to **actual conditions,** and sell from knowledge, not from **catalogs.** We furnish **results,** not merely **machinery.**

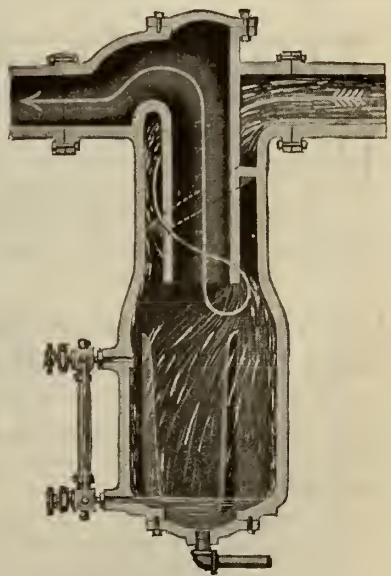
Mason Standard Bronze Reducing Valve

New Bundy Return Trap

THE MASON LINE INCLUDES:—

"Mason" Reducing Valves (genuine).
"Mason" Pump Governors.
"Mason" Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Coppus Turbine-driven Boiler Feed Pumps.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Feed Water Filters.

Full Details on Request



Stratton Separator for Steam and Air

The Mason Regulator & Engineering Co., Limited

Successors to H. L. PEILER & COMPANY

Toronto Representative:
The Arthur S. Leitch Co., 506 Kent Building

Montreal Office and Factory:
135-153 Dagenais Street

Full Information always gladly and quickly Furnished. Use "MASON" Service

STANDARD RETURN TUBULAR BOILER

Horizontal Tubular
Vertical Tubular
Locomotive Types

BOILERS

We have registered designs to conform with various provincial codes.

Our BOILERS Are Installed in the Largest Industrial Plants.

Write Us for Boiler Information and Prices.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Office: Hall Machinery Co., Sherbrooke, Que.

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

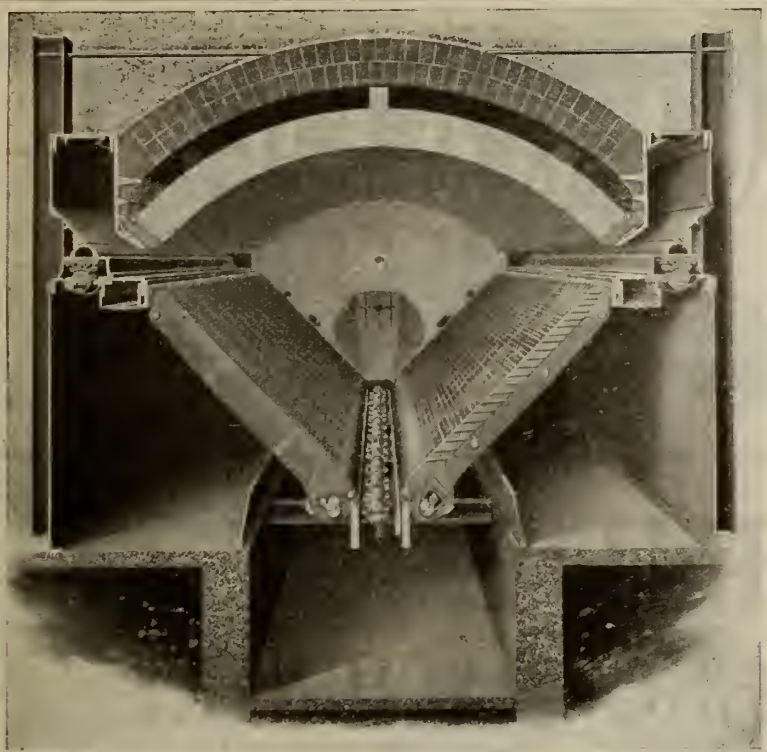
Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Ltd. 376 Dufferin Street Toronto

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec



Cross section showing the construction and operation of the Murphy Automatic Furnace. As the fuel progresses downward the alternate movement of the grates ¾" above and ¾" below the surface of the stationary grates breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder.

A MISER WITH FUEL

That's how one engineer expressed it—when asked about the coal-saving characteristics of

MURPHY AUTOMATIC FURNACES

They are not only misers with fuel but they burn "any kind of fuel that has heat in it," slack, lignite, sawdust, or even refuse.

Our new illustrated catalog, HM-5, explains how the improved Murphy construction makes every heat unit work. Send for copy.

For information on the Riley Underfeed Stoker for large boilers see advertisement in last issue or send for Catalog HR5.

Murphy Iron Works
Detroit, Mich., U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

BOB LONG
UNION MADE
OVERALLS
SHIRTS & GLOVES

My Dad wears 'em

94

Known from Coast to Coast
R.G. LONG & CO. LIMITED
TORONTO CANADA

Starrett Tools

Since 1880

For two generations we have been building fine precision instruments—building them to the Starrett Standard—not to a price.
To-day the name *Starrett* is recognized the world over as standard for accuracy.

Write for Catalog No. 21 CD.

THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hack Saws
Unexcelled 42-901
Athol, Mass.

micrometers

LINDE
REFRIGERATING MACHINERY

Is known and recognized the world over as

The Standard Refrigerating Machine

We have carefully studied Refrigeration under all conditions in Canada for the past 25 years and know what is best for the Canadian Manufacturer.

Our Machinery is "Made in Canada"

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896

Efficiency

In Power Plant Equipment
and Service—that's our Policy.

Study POWER HOUSE advertising and editorial pages—brimful of latest technical and new equipment information. Keep thoroughly up-to-date and you'll profit.

SPECIAL Send in **your** subscription to-day for any number of years at the remarkable rate of **$1.00 Per Year.**

Quality Products Leave No Regrets

York Ice-making and Refrigerating Machinery is not made to fit the price. We have a standard of quality and service which has been maintained ever since the York Organization was started.

It is betraying no secret to say that many owners of ice-making and refrigerating plants have expressed to us, by word and letter, their keen regret at having turned down a York contract because the price seemed too high.

Price is a poor gage to use in buying such important equipment as Ice-Making and Refrigerating Machinery. Confidence is a better one. You know from your own experience that business born of confidence begets new business.

No customer can truthfully say that the York Organization ever tried to take advantage of him. It is on this basis that we have been selling our products, and it is for this reason that we have been successful.

An inquiry from you will be appreciated. You are not obligated to buy York equipment until you are satisfied as to its quality and our good intentions.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 304 Craig St. West | CALGARY 605 Second St

Pure Corkboard

Made in Canada

A New and Important Source of Supply

All buyers know that the sources of supply of pure Compressed Corkboard and Granulated Cork are few—too few—and the output entirely inadequate at times—an unhealthy situation for the buyers.

Therefore, you have special interest in this *new* and *important source of supply*, large in volume, fine in quality and right in price.

It offers you added *security* both as to *cost* and *deliveries*.

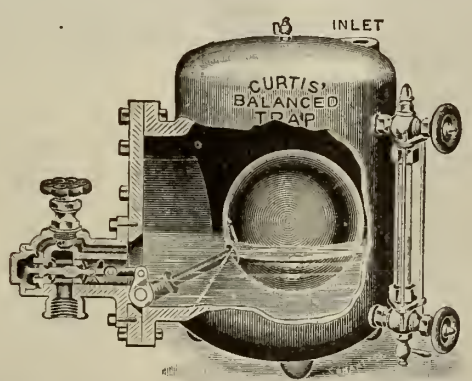
Pure Corkboard is now a necessity to the refrigerating industries, which use many millions of square feet yearly in the insulation of more than eighty per cent, of new construction and repair work.

We are prepared to handle your complete requirements, either for material only or installed in your building. Write us to-day and we will gladly give you full information and quotations.

Canadian Corkboard Company Limited

Head Office: 17 Adelaide St. East, TORONTO

Works at Port Colborne, Ont.



Five Superior Features of the Curtis

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lb.

Write for catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 216 Fulton St., New York City; 174 N. Market St., Chicago, Ill.

TRADE JENKINS MARK

Jenkins Bros

The Valve is the "Key"

You cannot overestimate the importance of the valve. It is the "Key" to your whole system of pipe lines. And you cannot find in your lines another piece of equipment that is subject to such diversity of intense strain. That's why you require **valves of highest quality** if you want efficient, economical service—service that is reliable year in and year out.

Leading Engineers and Superintendents throughout the World (for more than half a century) have learned to recognize JENKINS BROS.' VALVES as the standard of valve efficiency. Scientific construction, extra good quality metal of the **right** kind, accounts for the strength and rigidity of **Jenkins Bros.'** products.

Catalogue No. 8 free on request.

There's a Jenkins Bros.' Valve for every purpose. They are known by the **Diamond Trade Mark,** the sign that gives you assurance of absolute Valve dependability.

TRADE JENKINS MARK
Jenkins Bros

Jenkins Bros. LIMITED

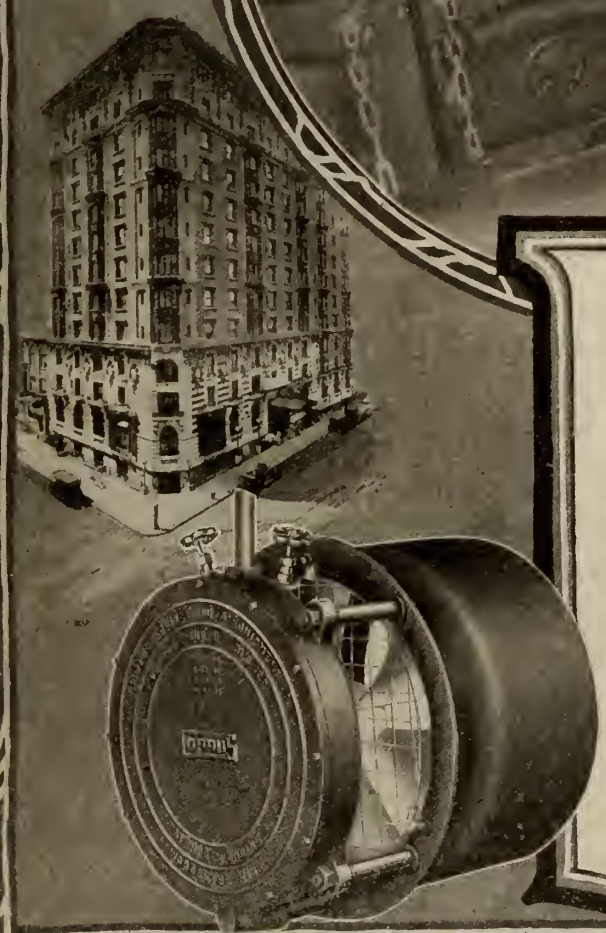
Head Office and Works: 103 St. Remi Street, Montreal, Canada.

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway, London, W.C. 2, England

REGISTERED COPPUS U.S.PAT.OFFICE

In Hotels



This is one of the two 18″ COPPUS Blowers which have been saving money in the power plant of the Hotel Seville, New York City, for more than two years. They cut coal costs, meet peak loads quickly, keep steam pressure constant, save firemen's labor, prevent clinkering, get all the heat out of the fuel, and—an important item, run smoothly and quietly without trouble.

That COPPUS Blowers operate as effectively in hotels as in power plants of mines, mills, factories—in power plants of any sort—is emphatically proved by the fact that numerous other prominent New York hotels use blowers bearing our trade-mark. For example, Broadway, Central, Girard, Latham, Marseilles, Martinique, Shelburn, Langham, Theresa, Waldorf Astoria, etc., have satisfactorily demonstrated the money saving possibilities of COPPUS equipment.

What COPPUS Blowers have done in other plants they can do in yours. Allow our engineers to show you how **"COPPUS equipment can save you money."** Write for Blower Catalog H7.

The Coppus Engineering and Equipment Company

Manufacturers of COPPUS Turbo Feed Pumps and COPPUS Power Turbines

341 PARK AVE. WORCESTER, MASS.

Agents for Montreal: Mason Regulator & Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Building

COPPUS TURBO BLOWER

Jones Underfeed Automatic Stoker

feeds fuel better and more economically than the best of firemen

THE JONES MODERN WAY

The "Jones Stoker" will not only effect a saving of from 15 to 25 per cent. in fuel cost, it saves labor —and it gives a smokeless stack.
The Automatic action of the "Jones" maintains a uniform steam pressure—it responds instantly to varying demands for steam.
There is a great advantage in the Jones Simplicity, no parts move in contact with the fire—this ensures long life. No losses through grates—there are none.

THE OLD FASHIONED WAY

May we mail you full particulars

Jones Underfeed Stoker Co.
Limited
37-41 Britain St. Toronto, Ont.

Dominion Belting Company, Limited
Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

The Publisher's Page

TORONTO MAY 20, 1919

Sells Its Campaign To the Workers

Dodge Mfg. Company Explains to Men in the Plant Reasons for Advertising

By G. D. Crain, Jr., Editor "Class"

THE Dodge Mfg. Company, of Mishawaka, Ind., probably the largest concern in the country making power transmission equipment exclusively, has just started an advertising campaign which will lay great stress on reaching industrial buyers through their trade and technical papers.

Melville W. Mix, president of the company, whose unique methods of securing the cooperation of the 1,500 employes of the company have attracted national attention, held a meeting March 21 to talk to the men about the campaign and to show them why it was a good thing for them.

"Conditions at present are such that advertising is bound to be of great value as a stabilizer," explained Mr. Mix, in telling about the meeting. "Business will be strengthened in many ways by the right kind of advertising at this time. We believe the campaign will put Dodge products over in fine style.

"But these things are not always understood by the men. When they see big advertisements printed in the magazines, they are likely to wonder why the money was not used in a way that would react to their benefit more directly. So we decided to anticipate anything of that sort by telling the whole story in advance of the opening of the campaign."

This was done, and more than 800 employes attended and heard Mr. Mix explain what the advertising is to accomplish. Kenyon Mix, his son, who is in charge of the campaign, showed a lot of stereopticon slides of the copy that is to appear, and the meeting resulted in the factory men being just as completely sold on the advertising idea as the salesmen had been at another meeting.

Advertisers who follow the Mix method, and take their workers as well as their salesforce into their confidence regarding their advertising methods, will get a reaction that will help to make the product as good as the advertising.

Though some national publications will be used in the Dodge campaign, the trade and technical papers have been brought into the schedule in numbers, and a total of 376,336 circulation of this character has been arranged for.

That the company appreciates thoroughly the value of specialized mediums is shown by the stress laid upon the trade publications in announcements going to mill supply dealers, who distribute the Dodge products.

"Every industrial division," it explains, "has one or more strong trade journals.

"These trade publications do not duplicate each other's circulation; they reach the technical man, the superintendent, the executive of one specified industry, because they print the matter that he must know to operate his business at a profit.

"Someone in every industrial plant reads the trade paper of that industry. It is a part of his job to keep informed.

"We found it necessary to advertise in 31 trade papers to reach the thinking men of 20 industries. And we have contracted for full-page space in every one of them."

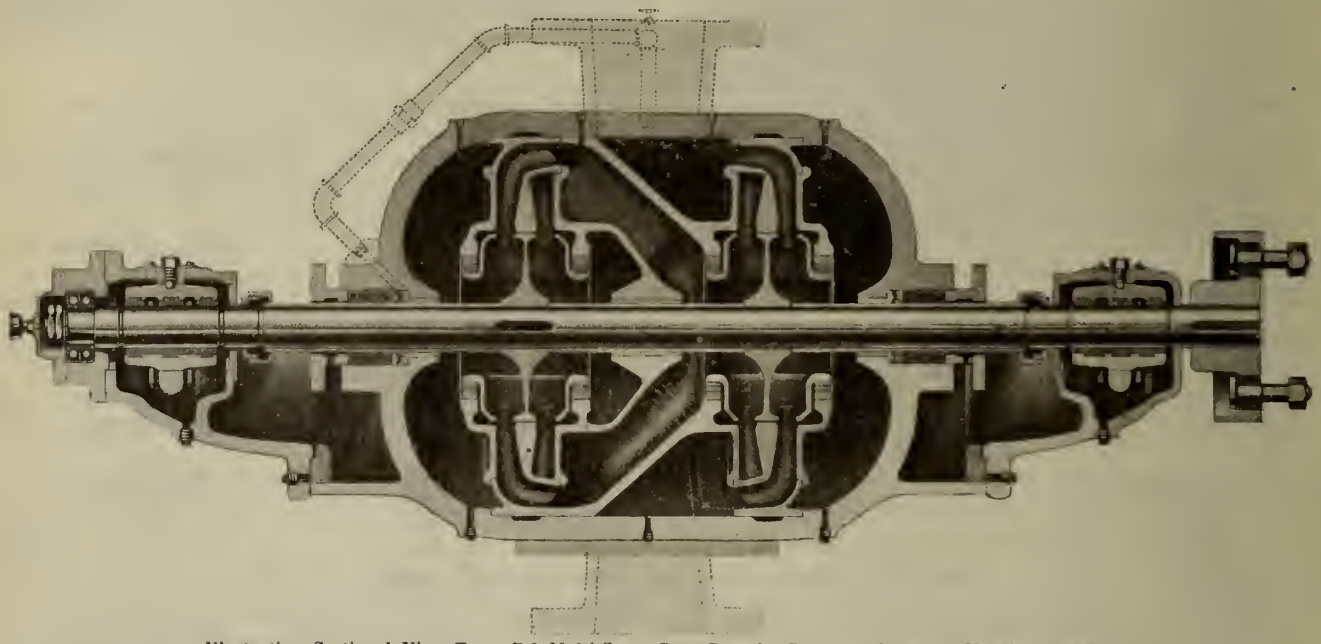
"Read some of these pieces of copy," it is suggested. "Notice particularly that the advertisement to appear in a publication circulated to the rubber industry tells how Dodge products are adapted to rubber mills. Notice how the copy which will be read by a paper mill engineer describes how Dodge products cut the cost of production in a paper mill."

This is, of course, one of the big advantages of trade and technical advertising—the opportunity to talk to the trade buyer in his own language, and to discuss with him the application of product to the special problems of his industry. This is the advantage that is missed entirely by the advertiser who uses merely general circulation, and consequently is compelled to talk in general terms.

REES RoTURBo

Pumping Machinery

Is in use all over the World in Waterworks, Mines, Power Stations, Irrigation Works, Pulp and Paper Mills, Salt, Chemical and General Industrial Plants where highest efficiency, reliability and the best class of Engineering are demanded.



Illustrating Sectional View Type, B.2 Multi-Stage Rees Roturbo Patent Pressure Chamber Pump.

REES RoTURBo Pumps provide a high and sustained efficiency over a wide range of duties. This means a very noticeable saving in power costs.

The Self-Regulating feature of RoTURBo design is responsible for this saving, and this same feature protects your Prime Mover from overloads on a decreased pressure head, eliminating expensive delays and costly repairs.

Our RoTURBo Pump and Condenser Catalogues, full of valuable information, are yours for the asking.

Sole Canadian Manufacturers

The Goldie & McCulloch Co., Ltd.

Head Office and Works, GALT, ONTARIO, CANADA

Toronto Office
Suite 1101-2,
Bank of Hamilton Bld'g

Western Branch:
248 McDermott Ave.,
Winnipeg, Man.

Quebec Agents:
Ross & Greig,
400 St. James St.,
Montreal, Que.

British Columbia Agents:
Robt. Hamilton & Co.
Vancouver, B.C.

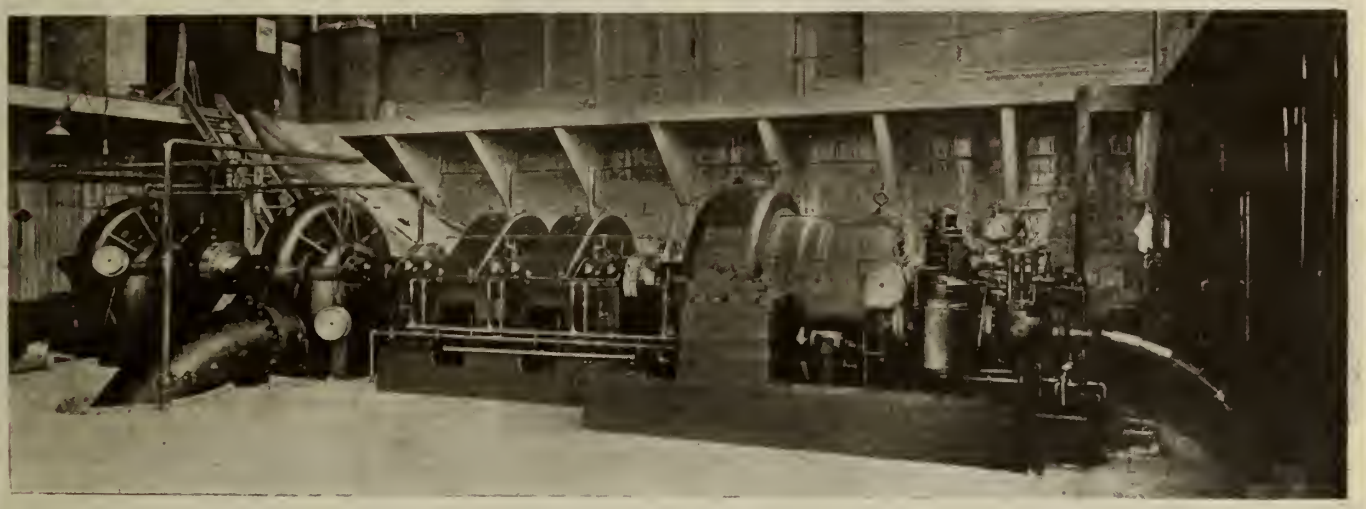
POWER HOUSE

Established 1907 — Published Semi-monthly

Main Pumping Station Toronto Waterworks

Modern Equipment and Recently Completed Extensions Result in Efficient Plant of High Duty

By W. F. SUTHERLAND, Editor Power House



THE rapid growth of municipally owned utilities is indicative of the expansion which has taken place in the size and activities of Canadian cities. From a capacity of 50,000,000 gallons prior to 1913, the Toronto waterworks has grown until a capacity of about 200,000,000 Imperial gallons per twenty-four hours is available when required. This increase has necessitated very extensive alterations throughout the whole system, the installation of new filter units on the island, new mains, and a complete reconstruction of the John Street pumping station.

Present Arrangement of Waterworks System

Water is obtained from Lake Ontario through intake pipes running south from Toronto Island and is pumped on to filter beds. Two systems are now in use, the slow sand filter and later units operating on the drifting sand principle. These latter units are able to filter unusually turbid water without clogging of the filtering material, and without the use of large setting tanks and coagulating basins. The coagulant, sulphate of aluminia, is introduced into the raw water in the suction well. This water is then pumped onto the filters. The sand-bed is composed of fine sand, 9 feet deep, laid on a bed of gravel 9 in. deep, and the action of the incoming water causes the upper part of the sand bed to drift across the water being filtered. The bulk of the impurities, together with a part of the drifting sand, is swept out. The lower portion of the sand-bed which remains stationary, removes the remaining impurities.

NEW BOILER ROOM SHOWING STOKERS AND COAL CHUTES.

From the filter plants the water is conveyed to the city proper under the Bay through a tunnel 8 feet, 6 inches high, and exactly a mile long. This tunnel is about 100 feet below the level of the lake, and the water rises from it through a shaft 10 feet in dia-

VIEW IN ASH TUNNEL. THIS PICTURE WAS TAKEN WHEN THE PLANT WAS UNDER CONSTRUCTION.

meter and of the same depth. From this suction well the pumps draw their supply and provide sufficient head for distribution throughout the city, except to the northern section, where a boosting station, the High Level Pumping Station, is provided.

General Arrangements

As will be seen from the accompanying plan and cross-sections, the main pumping station is divided into several units. Two 15,000,000 gallon high duty pumping engines, built by the John Inglis Co., are installed, and form one of the earlier portions of the plant.

On the advent of Hydro power four Boving centrifugal units, driven by Westinghouse motors, were installed in a separate room. These pumps are rated at 13,000,000 gallons each, and the motors are of the synchronous type, a jaw clutch being provided so that the pumps may be disconnected and the motors run free for power factor correction.

A high pressure pump room houses two Westinghouse Parsons turbine units, driving turbine pumps, made by the Caledonia Iron Works, of Montreal. These two-stage pumps serve to boost the pressure on the high pressure fire mains, laid in the down town district to 300 lbs., on the advent of fire in the down town section of the city, and are only operated when this occurs. The casings of these pumps, it is interesting to note, are of cast steel. Each of these pumps has a capacity of 5,000,000 gallons per 24 hours.

Turbine Pump Room

The portion of the plant immediately to the west of that housing the reciprocating units is of recent construction and contains the De Laval turbine driven pumping units.

The turbines are of standard De Laval construction, and are designed for a steam pressure of 150 lbs. and a vacuum of 29 inches, the normal speed being 3430 r.p.m. Each is direct coupled to a speed reduction gear having a ratio of 33 to 197, so that the pump shaft rotates at a normal speed of 575 r.p.m., and the steam supply pipes to these units are 4½ in. with 36 in. exhaust to standard Wheeler surface condensers, so placed that all the water delivered by the pumps passes through it as cooling water.

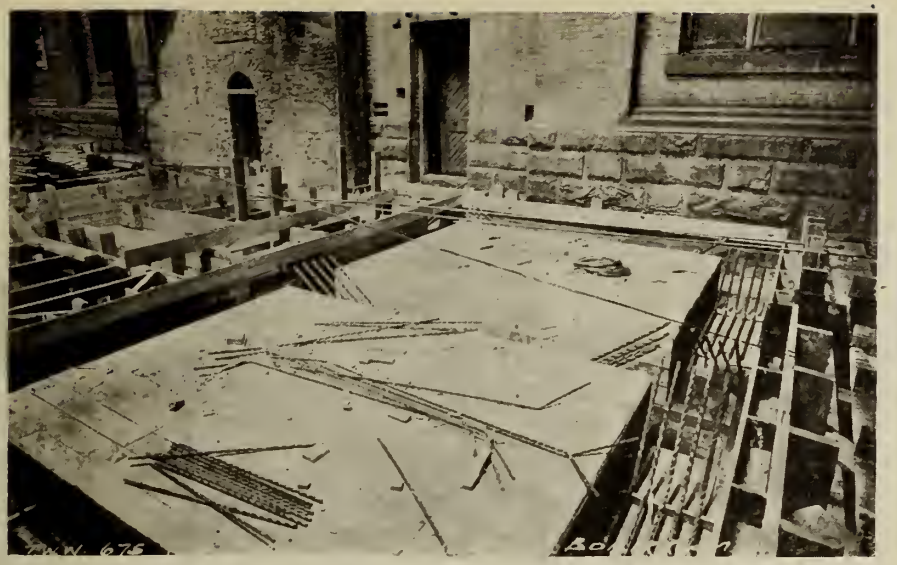
The vacuum pumps are Rotex pumps, built by the C. H. Wheeler Co., and are driven by 7x7 in. engines exhausting into the steam turbines at about the middle stage, doing further work there. Two single stage double suction pumps are connected to each unit, the two pumps being piped together in series. At a speed of 575 r.p.m. each unit delivers 20,000 U.S. gal. per min., equivalent to a pumpage of 24,000,000 Imperial gallons per 24 hours.

The DeLaval Company guaranteed a duty of 141.5 million foot-pounds per thousand pounds of steam, and on test a duty of over 150 million foot pounds was obtained, a remarkably high efficiency.

The two motor driven units are also of 25,000,000 gallon rating, and are two stage pumps built by the John Inglis Co., Toronto. Each pump is driven by a 1,500 h. p. wound rotor induction motor of Westinghouse make.

It may be mentioned that in arranging the suction pipe for these five units it was necessary to dig a trench 20 feet deep and about 8 feet wide in rock. Much trouble was experienced from water seepage, and it was found necessary

TURBINE PUMP ROOM.



THE FOUNDATIONS FOR THE NEW BOILER SETTINGS ARE OF REINFORCED CONCRETE. THIS ILLUSTRATION SHOWS THE REINFORCING BARS AND FORMS.

to instal two 12 inch pumps to control it.

The Boiler Room

The new boiler room presents many features of interest and has a greatly increased capacity over the old one now torn down. Much of the older equipment is incorporated in the new one, nine of the sixteen boilers having come from the old boiler room.

The boilers are all of the water-tube type and are of 300 boiler horsepower nominal rating. Six Heinie boilers are installed, fitted with Chicago & Green chain grate stokers. The Canada Foundry Co. supplied seven Atlas cross-drum boilers, which are fitted with Chicago and Fulton stokers, and the John Inglis Co. supplied three Erie City boilers, these latter being fitted with Bennis chain grate stokers, made by Bennis, of Little Hulton, Bolton, Eng.

The Fulton stokers are part of the new installation and are fitted with water backs, as may be seen from one of the accompanying illustrations, which shows the stoker in the course of erection.

The boilers are all fitted with draft gauges made by L. M. Ellison, Chicago, and soot is blown by compressed air. Operating steam pressure is 160 lb.

Chimneys and Breeching

Two Custodis Radial brick chimneys are installed, one for each bank of boilers. These chimneys are 96 in. by 160 feet high, and are lined with firebrick to a height of 50 feet. The breechings at the chimneys are 8 feet, 6 inches, by 5 feet in size, and throughout their length are lagged with heat insulation, supplied by the Armstrong Cork & Insulation Co.

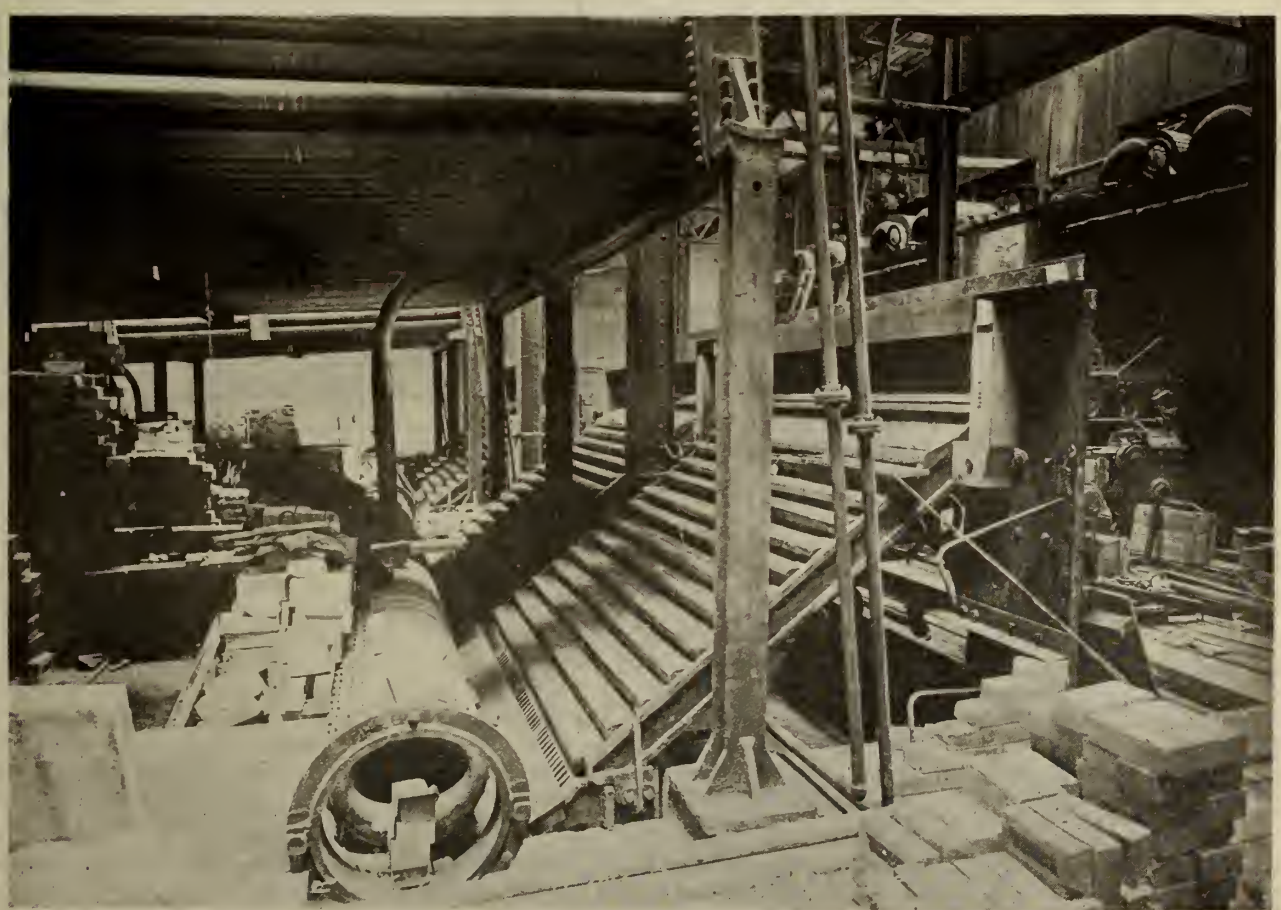
Steam Piping

The steam piping is fitted throughout with Van Stone joints and Crane valves. The main headers are 12 in. diameter, and the steam mains throughout are lagged with insulation supplied by the Armstrong Cork & Insulation Co., Toronto. As an illustration of the excellent design encountered a metal legging is laid on over the heat insulation for mechanical protection.

The bends and pipe work were all supplied by Purdy-Mansell, of Toronto, and it is worth noting that the workmanship in the making of the pipe bends was such that everything came together without any fitting being required on the job.

Feed Water System

The feed water system presents some features of unusual interest and in some



FULTON STOKERS UNDER ATLAS BOILERS. THE ILLUSTRATION GIVES A GOOD VIEW OF THE WATER-BACK.

respects differs from the arrangement usually found in plants for power generation.

Very little exhaust steam is available from station auxiliaries since the major portion of such apparatus is driven by or is a part of the main pumping units. Each of the two large reciprocating units are fitted with feed pumps, barrels and plungers, the plungers being driven from a yoke off the main plunger crosshead. The feed water pumped by these units, and taken from the city water supply, passes through a closed heater fed with exhaust steam from the low pressure cylinder of the unit. The exhaust steam, after passing through the heater, is condensed in a surface condenser, through which all the water pumped by the unit passes. The condensate from these units is not used for boiler feeding, and thus no difficulty is encountered through oil.

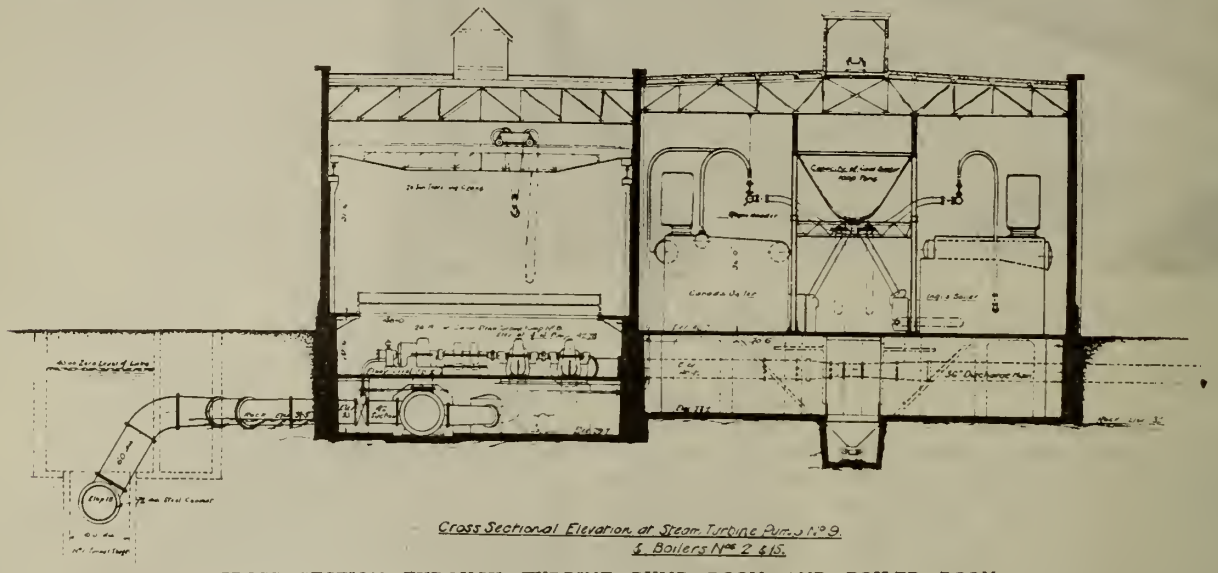
Attached to each of the three 24-million gallon turbine driven units is a Goulds triplex plunger pump, driven off the end of the main turbine shaft by silent chain. These pumps have plungers 3½ inches diameter by 6 inches stroke, and serve to pump the condensers to which they are attached into the feed mains. The surface condensers in this case are also cooled by water on its way to the turbine pumps.

The pumping of the feed water by means of feed pumps attached to the main pumping units effects a considerable economy, as the high efficiency of the large engines and turbines is thus utilized.

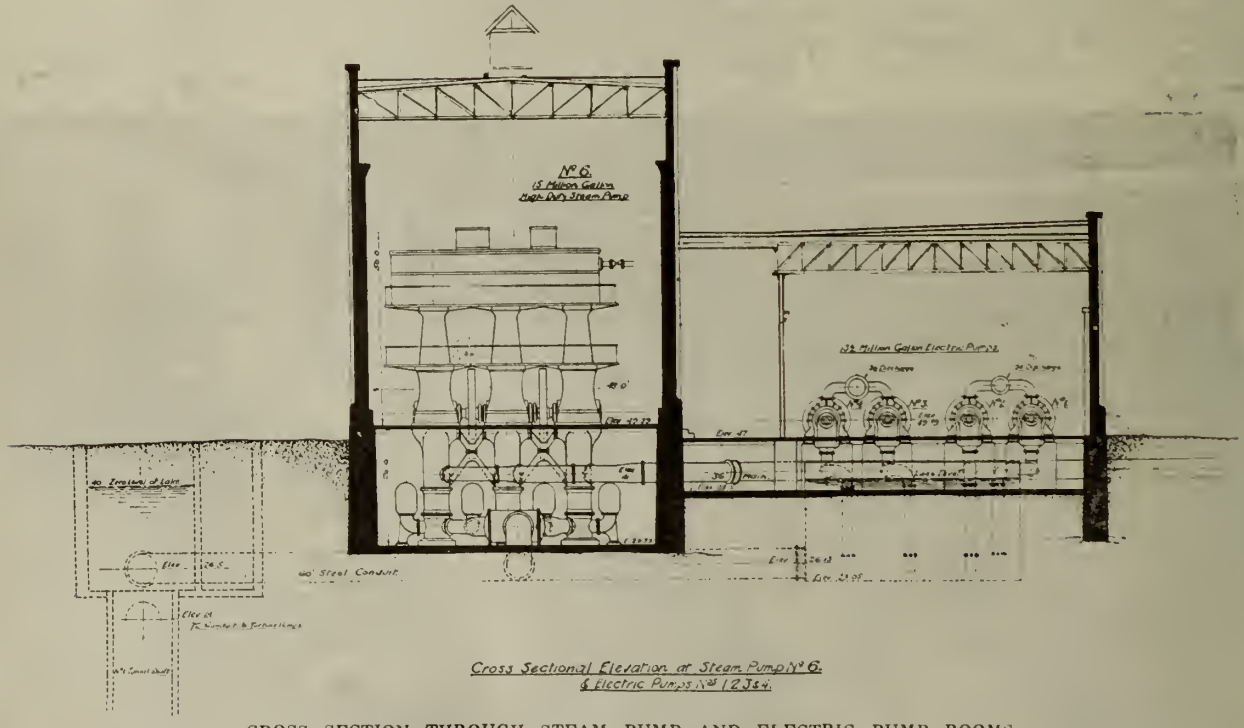
For auxiliary use a 5x12 inch duplex Northey pump is kept in reserve, and in addition to this stand-by pump a Penberthy 2 inch injector is provided on the feed line, so that if no pumps are running sufficient feed may be obtained to keep the plant running.

A standard closed type feed water heater built by F. B. Kelly & Sons, is also provided for use when required.

The main feed line forms a loop on the boiler room floor, at the rear of the boilers, and dropping below this level into the basement at the ends of the two banks of boilers. The main feed line is of 4 inch pipe, and the risers are 2 and 2½ inch.



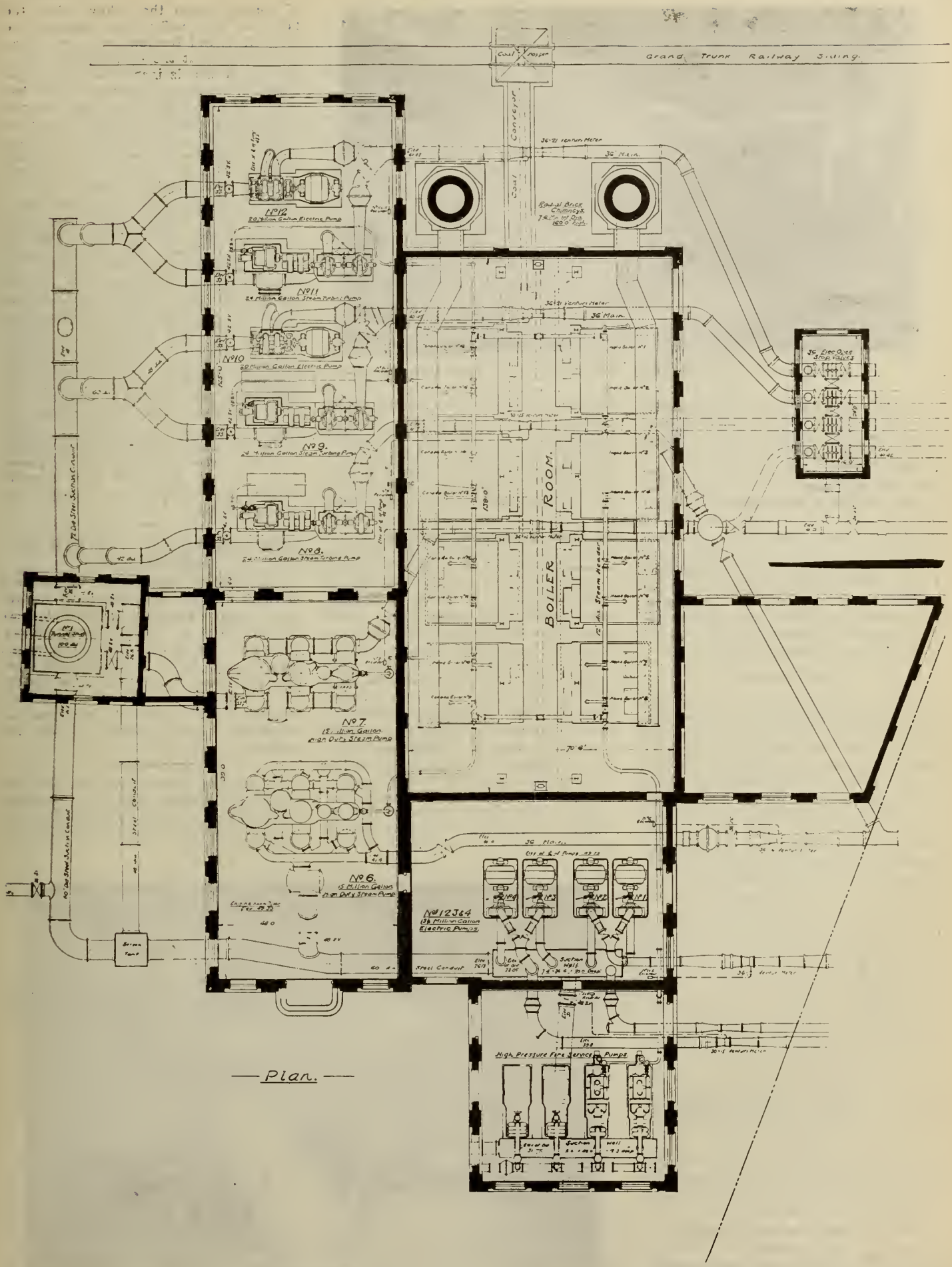
CROSS SECTION THROUGH TURBINE PUMP ROOM AND BOILER ROOM.



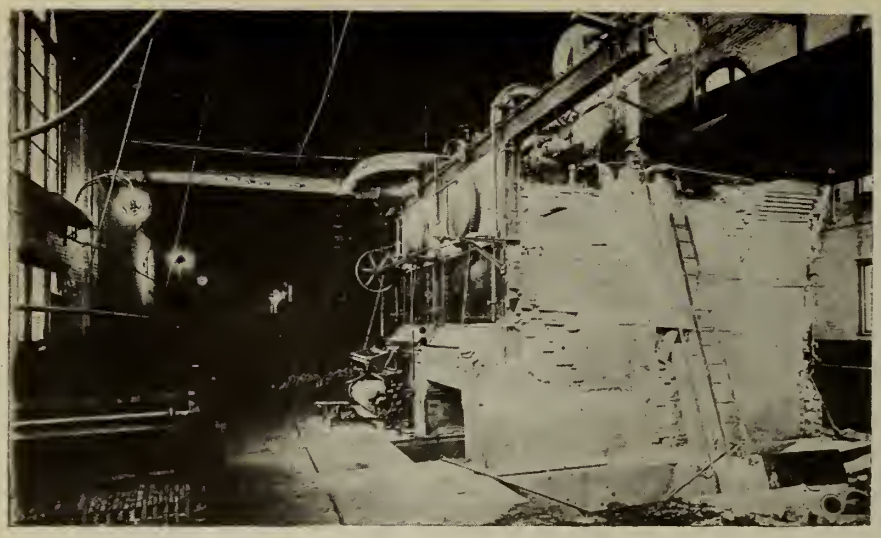
CROSS SECTION THROUGH STEAM PUMP AND ELECTRIC PUMP ROOMS.

Ash and Coal Handling

The coal and ash handling system at this plant well repays considerable study, and the accompanying line drawings give an excellent idea of its arrangement. Coal is dumped from the cars into a hopper, and from the hopper is fed into a sixteen inch belt conveyor, driven off the main bucket conveyor through a clutch by means of transmission chain. At the hopper pro-



PLAN, THE JOHN ST. PUMPING STATION, CITY OF TORONTO WATERWORKS.



VIEW IN OLD BOILER ROOM WHEN BEING DISMANTLED

vision has been made for a coal crusher, not yet installed. From the belt conveyor the coal drops through a chute into the bucket conveyor, and is elevated to the bunkers. The bucket conveyor runs the full length of the boiler room, on top through a monitor, over the coal bunker, and at the bottom through a conveyor tunnel below the ash chute level. The coal is tripped into the bunker by means of trippers located at the proper points, and the upper run of the conveyor has an automatic resetting mechanism for placing the bucket lips in the proper position relative to one another for the descending flight.

Ash Removal

The ash pits under the chain grates have inclined bottoms and are fitted with heavy iron doors for ash removal. Both the pits and ash doors are lined with fire brick and a sprayer is provided in each pit for wetting down the ashes as they are pulled. The ashes are raked out and fall through iron bar gratings of about 2¾ inches mesh into an ash chute, which feeds them directly into the bucket conveyor. The gratings mentioned extend the full width between boiler settings and prevent any large clinkers from getting into the conveyor and causing trouble. Between the gratings checkered steel plate flooring is installed. The ashes are drawn up by the bucket conveyor to the end of the bunker and are tripped into a separate compartment walled off from the coal storage by a concrete bulkhead. The bucket conveyor is driven by means of a twin cylinder steam engine with two 4x6 inch cylinders, and located at one end of the upper horizontal flight. The bunker is of the steel plate suspended type, and is lined with concrete. When full it holds 1,000 tons of coal.

The conveyor system was built by the C. W. Hunt Co., New York, and the bunker by Jeffry Mfg. Co., New York.

EFFICIENCY IN BELT DRIVES

By D. Street

In almost every factory and machine shop a certain amount of power is wasted in transmission through driving belts, the percentage of loss depending on the attention paid to the matter. Slipping, the trouble most frequently encountered, is common to all classes of belting, and generally speaking the remedy applied is to cut and tighten, or "take up" the belt so that it will run free from slackness with a better grip of the pulley; but probably more belts are broken and prematurely destroyed in this way than by actual use, not to speak of the additional load thrown on the engine and the consequent waste of power. To overcome slipping, many engineers incline to the principle of using belts wider than is actually necessary. This permits a heavier load to be carried, but when the practice is generally adopted all over a machine shop with fifty or more belt drives expense is materially increased There is, however, a growing tendency to run belts slack, as not only is friction thus reduced and the life of the belt increased, but no power is wasted and the strain on the prime mover is considerably reduced. Immediately the tension is reduced the friction is proportionately lessened. Further increase of the arc of contact round the pulley (after the belt has been sufficiently slackened to have no initial tension) will not lessen the friction, but the load-carrying capacity of the belt is increased. As an example in many engineering shops it has been found that cuts 50 per cent. heavier can be taken on lathes where the arc of contact has been increased from 180 deg. (with a tight belt) to as high as 220 deg. (with a slack belt) and in one instance with a corn-crushing machine the increase in output was over 50 per cent. To permit of driving belts being run slack a proper belt dressing should be employed. Many belt dressings rely almost entirely on their capacity to "stick," due to the inclusion of rosin or tar in their composition, but others take the form of a non-sticky preservative or belt food free from acid or alkali action, which is absorbed into the belt, rendering it pliable and highly effective, and at the same time protecting it from the effects of moisture, dryness, or chemical fumes. Such a preparation properly applied tends to give belts a velvety cling through the setting up of a vacuum suction between the belt and the pulley face, and will permit of slack running without fear of slip, even under the heaviest loads.

BRITISH LENSES INSTEAD OF GERMAN ONES

The English factory of the famous German firm of Zeiss, which is located near London, has been acquired by two British firms of optical lens makers. The war has proved beyond a doubt that English firms are capable of turning out lenses far surpassing in quality the German ones. Before the war it is estimated that about 95 per cent. of the lenses used in the U. S. were imported.

"I consider POWER HOUSE the best in Canada, because it touches on local power plants as no other paper does for the engineer." — Mr. Greenwood, Hamilton.

OLD BOILER ROOM REMOVED AND EXCAVATION MADE FOR NEW SETTINGS.

Boiler Troubles; Their Origin and Remedy

In This Article the Author Discusses the Many Ills That the Steam Boiler is Heir to and Deals With Preventative Measures and the Proper Remedies for Faults Which May Occur

By T. H. FENNER, Associate Editor

ALTHOUGH a steam boiler is a very solid looking piece of machinery, it is liable to a variety of troubles, most of which are from causes extraneous to its construction.

Different types of boilers exhibit different effects from similar causes, depending on structural features. It is proposed to mention some of the more usual defects, their prevention and remedy. While it is true that these subjects have been treated by many able writers, it is evident that there are many people interested in boilers that these writers have not reached, so that this article may not be superfluous.

Pitting

Very often a brand new boiler is affected by this trouble before it is ever put into service. Boilers that are used intermittently, with varying periods of idleness, are especially susceptible, but pitting is found under all sorts of conditions. In horizontal return tube boilers it usually attacks the tubes and shell above water line. Water tube boilers of the Babcock type will show it in the top drum, while vertical fire box boilers will develop pitting above the water line usually.

Pitting is a local oxidization, and takes the form of small blisters, under which the metal is eaten away, forming a conical hole, very much as a drill would remove it. If not checked it will eat right through the metal. In a new boiler, where the mill scale has perhaps not been thoroughly removed, and the boiler is left standing in the setting for a long while before being used, pitting is very likely to occur. A boiler left standing partially filled with water, is a good subject for pitting, while boilers being fed with very soft water are often found to be well pitted after some time of service. Pitting is one of the most insidious evils we have to combat in boiler maintenance, and is well worth a thorough examination.

Pitting in all cases is an electrolytic action, caused by the presence of metals having different chemical compositions, being immersed in water, which acts as an electrolyte. In other words, the boiler, with its working level of water, is a big cell. The shell of the boiler becomes one pole, the tubes the other, and discharge occurs from one to another, through the medium of water. The same action will take place if the boiler is empty but damp. Temperature and pressure affect the action, and there are various local effects, which are too complicated to enter into here. Iron is soluble in water, and combines with it, forming ferrous hydrate. In the presence of oxygen the ferrous hydrate is oxidized and precipitated in the form of rust. It is here that the pitting takes place.

How to Detect Pitting

It is important for the engineer in charge of a boiler to know when pitting is taking place as soon as it starts, in order to take steps to counteract it. Pitting is one of the easiest things to detect when its characteristics are known, and it is also easy to check if taken in time. In spite of this there are hundreds of boilers yearly going gradually to uselessness through this very cause. The number of boilers met with in the writer's personal experience, which were suffering from more or less advanced cases of pitting, was surprising.

The earliest indication of pitting is a very small discolored spot on the surface of the metal. This may be so small as to pass unnoticed unless the examination is thorough. Scraping with the point of a knife would result in the oxidized metal falling away in a powder. At a little later stage the oxidized metal will form a small blister or bubble, underneath which the action is continuing. The appearance cannot be mistaken, but scraping will prove it beyond a doubt. Once detected preventive methods should be taken at once.

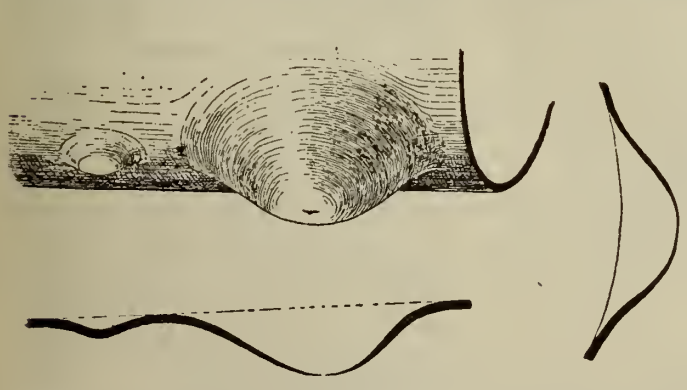
Prevention of Pitting

The time to prevent pitting is before any signs of it appear. This may sound peculiar, but it is just as true as the prevention of disease in the human body. Nowadays, people don't wait until they have to cure typhoid. If there is any likelihood of contracting it they hie themselves to a doctor and get a lot of serum injected, which makes the body taboo to the migratory germ.

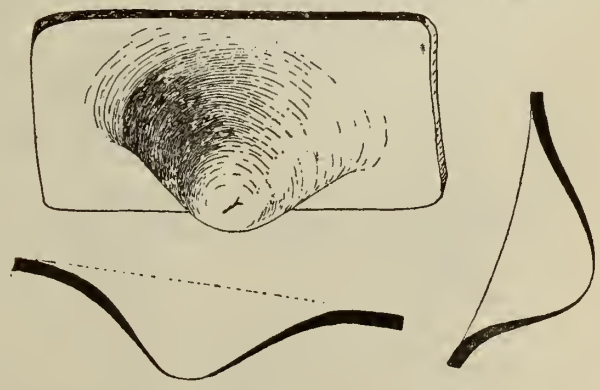
We will take the case of a new H.R.T. boiler, just erected, and the brickwork built up.

The first thing to do is to get a man inside with a good stiff steel wire brush, and get him to brush down all the metal surfaces he can reach till he has got to the metal itself. that is, until all surface scale and dirt has been removed. The surfaces he can reach will be the shell of the boiler above the tubes and, to probably, the second row of tubes down from the top. The stays and both heads can also be treated. If the boiler has a front manhole he can do a good part of the shell on the bottom, which is a good thing, not for the prevention of pitting, but in the interests of clean surfaces. When everything removable in the way of mill scale, steel chips, borings, etc., has been cleaned out, according to the man doing the job, the chief or second should go in the boiler and satisfy himself it is really so. I have seen chippings and boilermakers' washers getting in the blow-down pipes of new boilers, after they had been in service some time, and the man in charge wondering where they could have come from.

The boiler being clean, get the hose on and wash it down from the top until the water running off at the bottom is absolutely clean. The next step is to dry it, and the simplest way to do that is to close up the bottom manhole, take a small quantity of unslacked lime, and suspend it in a pan either on top of the tubes, or down between the centre rows. Then close up the top manhole and leave it for a few hours. The unslacked lime will absorb all the moisture and leave the



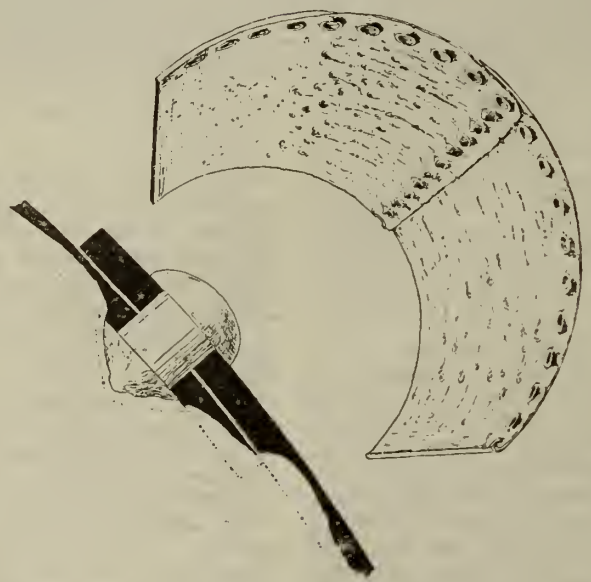
EXAMPLES OF BULGED FIRE PLATE.



SHOWING DRAWING DOWN OF METAL.

tubes and shell quite dry. After opening up again, get some good white zinc, and mix it with coal oil until you have a thin white paint. Don't use boiled oil or any other oil but coal oil.

Get your man inside with the paint brush and instruct him to paint the shell and heads from the level of the top row of tubes, and all the stays. Work your paint well in, so that it covers every particle of surface, but has no lumps. Let your paint have time to dry, and when it is completely dried up put on the top manhole. Slack back a safety valve or any joint you like above the level of the boiler, and fill the boiler slowly until the water runs out of the valve or joint. Your boiler is safe that way until you are ready to light up, and the chances of pitting taking place are remote.



EFFECT OF CORROSION

It is the boiler left standing partially filled that is the most exposed to pitting. Either fill the boiler full up, or have it empty and dry if it has to stand. The British Admiralty follow the plan of cleaning their boilers out thoroughly, and leaving them closed up with the pan of unslacked lime to dry them out.

Suppose your new boiler is in service, and the water begins to show red or rusty looking. Open the drain on the bottom of the water column, and give it a good, long blow. Then blow your glass through, and see if the water comes back rusty. If it does after several blows then you need to treat the boiler to stop it. Mix up some lime and water, until you have a very thin whitewash, about a bucketful, and put it in the boiler through the injector or soda cock on the feed pump. Do this every second day, and in a few days the rust will disappear. The lime will form an almost imperceptible coating over the surfaces, and prevent the rusting.

If pitting commences in a boiler that has been in service for some time, the same methods can be employed. However, in this case, the labor involved will be much heavier. It will be necessary to carefully examine the individual pittings, and clean them out with the point of a three-cornered scraper, or a round file ground to a point, and work at them till the bright metal is plainly seen. Look out particularly for the top row of tubes, for that is where the attack is most developed, and because of the thinness of the tube wall, the easiest to succumb. Use the paint treatment on shells, heads and stays. Use the milk of lime while the boiler is working, and apply it daily until you see the influence of the lime in the gauge glass. Open the boiler up as frequently as practicable, and note the appearance of the pit marks. Care and vigilance will prevent any further spread. I have seen some pretty bad cases stopped in this way, but it is to be noted that pitting should never be given the chance to get bad. Horizontal return tube boilers that are opened up monthly should be examined carefully at each cleaning, and the faintest indication should be noted and steps taken to stop the spread.

Boilers of the internally fired type need to be examined closely on the furnace sheets or tubes, at about the line of firebars, for pitting. Care must be taken when using the white zinc and coal oil paint, not to apply it to a heating surface, as it is not a conductor. However, it can be used on furnaces below the line of firebars with safety. It is a good plan to use it in the steam drums of B.&W. boilers as an additional precaution to the zinc plates used to protect them. These zinc plates are in general use in marine types of boilers, but are practically never employed in the H.R.T boiler.

Grooving

Grooving is another form of local erosion which is hard to prevent and remedy after discovery. This trouble is not very frequently met with in the H.R.T. boiler, but is only too often met with in the locomotive and vertical firebox type. It is a case of ordinary corrosion aggravated by the natural movement of the boiler under working conditions. The place it is usually found is around the O.G. and mud ring of vertical firebox boilers, crown sheets of locomotive boilers, where they join the side sheets, and, occasionally around the circumferential seams of horizontal boilers. Where a dome is pitted on a boiler it is well to look for grooving where the flange of the dome is riveted to the shell.

Grooving is caused by the scoring action of the water, acting on a joint that is to some extent opening and shutting. The most obvious case of this kind is the dome already spoken of. In this case it is the action of the steam instead of water, but the principle is the same. It is especially noticeable in cases where the shell of the boiler has been completely cut away under the dome, and there are no direct stays from the head of the dome. In this case grooving almost surely develops. Where this trouble is very apparent, examine the design of the boiler, and ascertain if it can be stiffened by additional staying, which will relieve the joint to some extent. If a circumferential seam, it may be due to defective caulking in the first place, and if not very much advanced, may be helped by chipping the edge of the plate inside the boiler, till past the groove, and recaulking in a proper way. Fortunately, even in bad cases of grooving, we can call in the aid of electric welding, which will build up the wasted metal to its original and greater strength if required. If all boiler joints were caulked on the inside wherever possible, there would be fewer cases of grooving. Leaky seams will develop grooves by the pure cutting action of the steam or water leaking through. That is why the smallest leak around a boiler shell should be stopped as soon as discovered, or carefully marked and attended to when shut down. Here perhaps a word of warning is not out of place to the man in charge of the boiler. If he does not thoroughly understand the use of a caulking tool, let him get some lessons from someone who does before he starts in, or better still, get a tradesman to do the job. An unskilled hand with a caulking tool can do a lot of harm in a very short time, and start more leaks than he can stop.

External Corrosion

Here is one of the most prolific causes of the depreciation in boilers, and one that is almost entirely due to sheer neglect. It is common enough to see well built and expensive boilers in a state of practical decrepitude after a very short life. It seems strange that this should be so after all that has been written and spoken and sworn on this subject, but that there is still need of preaching was proved to the writer only a few days ago, when he saw a boiler practically corroded away in one spot while the rest was good.

Now this form of corrosion is one to which every type of boiler, marine and stationary, is liable. However, the danger of corrosion is well understood aboard ship and conditions that lead to it are actively combated. It should be the same on shore, but in too many cases is not.

To consider first our old friend, the return tube, horizontal boiler, and the

particular variety of front known as the overhanging front. This is where the smoke box overhangs the brick setting, the breeching to the chimney being set directly on top, and the chimney itself often leading directly overhead. Here we have an ideal spot for corrosion to take place, especially where the boiler is shut down more or less frequently for a few days, or perhaps a season. Take cheese factories, canning factories, sawmills, etc., which are seasonal occupations. The soot and dust is allowed to accumulate round the front head, snow and rain filtering down the chimney, keeping it nice and moist. Perhaps when the boiler is working the hand hole or manhole is leaking also. The process of oxidization goes on merrily, and although perhaps a brush is employed occasionally on the tube plate and smoke box, it only removes the surface dirt. The layers of rust build up hard and solid looking till gradually the rivet heads are almost covered. Then some one comes along who recognizes the symptoms, and taking a hammer, proceeds to chip around the flange. If the owner of the boiler happens to be present he is astonished to see his property disintegrating before his eyes. When the chipping process is finished he will see what was originally perhaps a ⅜ in. or 7-16 in. plate has shrunk to a knife edge, and he is confronted with a nice repair bill. The dog that holds the hand hole in place, on being removed, will often disclose two badly corroded spots where it has rested on the head. The plate itself round the edges of the hand hole is very susceptible to the effects of continued leakage, rapidly becoming thin to the danger point. Around the back head seam is another favorite place for corrosion, due to leakage from the hand hole, or to wet soot lying in the combustion chamber, while the blow-down pipe itself and the pad on the boiler shell is often allowed to become badly corroded.

Right here let a word be said against the practice of building a brick pier around the blow-off pipe to protect it. This is bad in two ways. It is a trap for holding moisture, and encouraging rapid oxidization, and carried to lengths as it sometimes is, forms a breakwater against which the products of combustion impinge and are deflected to each side of the setting. This results in a certain amount of heating surface being lost. Whenever the boiler is washed out some water runs down the shell of the boiler and soaks into the space between bricks and pipe, and if the brick is close to the shell the water lies in between brick and shell.

The only protection a blow-off pipe needs is to be kept clear, and full of water. A paper bag can be filled with water and the water boiled over the gas flame without hurting the bag. A good circulating arrangement on the blow-down pipe is the best protection, but failing that, a short blow once or twice a day will ensure the pipe being clear.

Another place to look for corrosion is at the back head where the back arch rests against the boiler. Here again water is allowed to seep through from above to the ultimate destruction of the plate. As mentioned before, any place where leakage is taking place is a breeding place for corrosion.

Other types of boilers have their more vulnerable spots. In the Babcock and Wilcox type the short nipples connecting the back headers to the mud drums, and the mud drums themselves require careful examination. Very often these drums are close to the ground, and the space between the drum and back headers very small. If soot and dirt are allowed to accumulate in the back pass corrosion is almost certain. When blowing the tubes of Babcock and Wilcox boilers there is usually some leakage on the floor, and some of the water will find its way into the back pass. When the boiler is down for cleaning there is always considerable water splashing about, and if the space between mud drum and back headers has not been well brushed down before washing commences the soot soaks up the water and forms a wet plaster all round.

In vertical fire box boilers the bottom of the fire box under the grate bars is the place to find corrosion, especially under the ring that holds the grates. The ton tube plate also requires careful examination, especially in boilers working in the open where rain and snow can descend the stack. The plate, at the edges of hand holes is also to be watched for corrosion due to leakage. In Scotch marine boilers used for stationary purposes, the lower half of furnace tubes, circumferential seam below the furnaces, combustion chamber bottoms; in locomotive types the fire box below the grates and the smoke box end are the likely places.

Prevention of External Corrosion

The prevention of external corrosion is a question of keeping things clean. A boiler where tube plates and heating surfaces are kept brushed off and the metal visible has no chance to corrode. Clean ashpits in fire-box boilers, clean combustion chambers in bricked-in boilers, scrupulous cleanliness in every part is a sure preventive of this evil. The use of our old friend, white or red lead mixed with coal oil, is of benefit on furnace tubes, below the fire bars, on head flanges of horizontal return tube boilers, in the smoke box of loco type boilers, and any surface liable to corrosion that is not a heating surface.

Do not allow wet soot or ashes to lie against any part of the boiler. Wet ashes are the most violent corrosive agent that can be found. Don't close the boiler up if you have any doubts about manhole or hand-hole gaskets. Furthermore, I would say to chief engineers: "Don't take anybody's word about your boilers. Put on a boiler suit and see for yourself."

The little drop of water leaking from a gasket three or four feet above the shell of a boiler, two, three, or four drops a minute, wears its way through the covering to the shell, and although it apparently evaporates as soon as it strikes the hot metal, it is getting in its work just the same. If you can't stop it, put a piece of galvanized iron under it and lead it away. If you have any pipes in your plant and the asbestos covering is damp, tear it off till you find the cause and leave it off till remedied. Damp asbestos lying in an iron pipe, spells ultimate ruin.

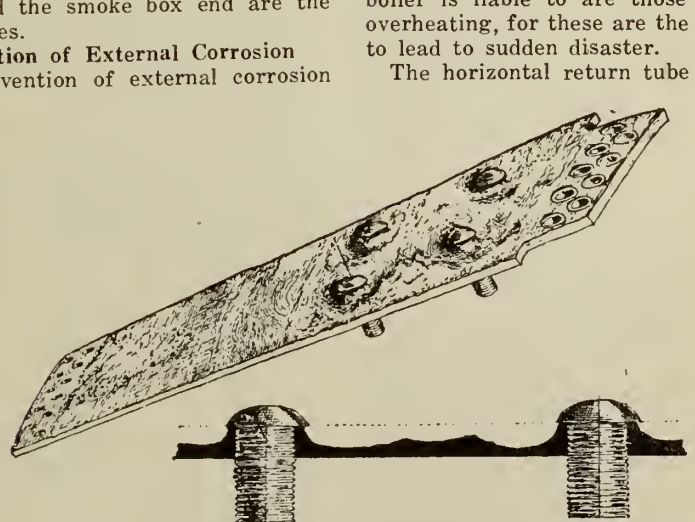
Corrosion is a mean, sneaking enemy that works without rest. It is busy when every other thing in the plant is stopped. It loves the dark. Don't give it a chance. Be as vigilant to detect it as it is to avoid your eye. Corrosion resembles a cancer to some extent, inasmuch as to stop it the affected part must be thoroughly cleansed of growth, and if left too long the part as well as the growth will have to go.

Troubles Due to Overheating

The most serious troubles that a boiler is liable to are those caused by overheating, for these are the ones liable to lead to sudden disaster.

The horizontal return tube boiler, being the one most largely used, will be considered first.

One of the most frequent effects of local overheating is found in the fire-cracks that develop on the plates where they are lapped to form the circumferential seams. While this trouble usually develops on the seam over the bridge wall it is also found both on the front and back seams.



MORE EXAMPLES OF CORROSION.

This is due partly to the way the setting is put in and partly to incrustation on the shell internally. A boiler with a ⅜ in. shell is ¾ in. thick at the lap, and one with a 7-16 in. shell is ⅞ in. thick at the lap. It follows the conductivity is just one half at these joints of the rest of the shell. Therefore, any accumulations of scale at these points are much worse in their effect than the same thickness of scale on a single thickness of plate. This effect is often aggravated by the form of the bridge wall, which directs a hot flame right on to the seam, causing intense local heat. The front seam is less liable to firecracks as if the setting is correctly made it will be out of the influence of the fire entirely. However, it is not so made in many cases, and not only is the seam left exposed to the flame, but a space is left between the fire arch and the boiler shell through which the draught sucks the flame, often burning the hand hole or manhole dogs.

The bridge wall should be made with a gradual slope from the back edge of the firebars, so as to allow the gases to pass over in a fairly straight sweep. With a straight bridge wall the flame and gas are thrown directly upwards, and if the bridge wall coincides with the seam trouble ensues.

Firecracks on the back head seam are nearly always due to scale accumulation, the back head flange being an awkward place to reach when cleaning the boiler. These firecracks usually start at the outside edge of the plate and run towards the rivet hole. They are not serious unless they show signs of starting from the inside edge of the rivet hole. If they do this they should be immediately plugged with a ⅛ in. or 3-16 in. plug and carefully watched. If, on the first sign of firecracks developing, careful attention be paid to the state of the boiler internally and the brickwork externally, their further spread may be checked. As a matter of fact, there are hundreds of boilers that are working with firecracks that first showed up years ago, and are no further advanced than when first apparent. However, firecracks are not to be dismissed with scorn but should be carefully watched at every examination of the boiler to ascertain their progress.

Another trouble due to burning is caused by carelessly-built settings. The back arch of a horizontal return tube boiler should be built immediately above the top row of tubes. Sometimes it is built so high above the tubes that the heads of the rivets securing the stays are exposed to the flame. Further, the plate is likely to be overheated as the water level is often below the height of the arch. This point is often neglected when the arch is being built, and is sure to give trouble sooner or later. The least that happens is the burning off of the rivet heads. Where there is a hand hole in the back head the dog and bolt head that holds the door is almost always burnt off when the time comes to open it up. This is not so serious as it seems, for as long as the boiler is under pressure the door is held up to its place automatically. It is hard to prevent this burning, but sometimes covering the dog and bolt with asbestos will help a lot.

The source of greatest danger is overheating of the shell plate directly over the fire. This is invariably caused by a deposit of scale, or grease that keeps the water from contact with the plate. Transmission of heat is greatly retarded, and instead of the heat of the furnace being absorbed by the water, it is absorbed by the plate, which becomes overheated locally. The result is a bulging of the plate to a greater or less extent, according to the area affected, and the degree of heat attained. If the deformation is sufficient to draw the plate down to extreme thinness a rupture will occur, and a disastrous explosion follow.

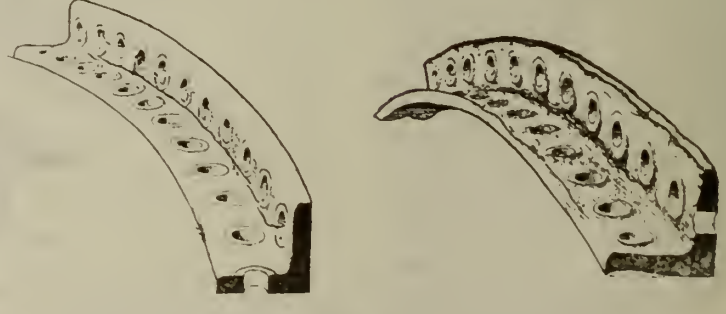
In the firebox boiler of the vertical type, there is danger of the narrow water space between firebox and shell becoming made up with scale and the plate overheating. In boilers with circular furnace tubes there is danger of collapse through overheating, and in the Scotch marine type the combustion chamber crown is a vulnerable spot.

The Effect of Oil

Many men in charge of boilers seem to think that the effect of oil on heating surfaces is exaggerated. The effect of oil on heat transmission cannot well be exaggerated. The following example should serve to convey to the mind of any doubter just what oil can do. These experiments were two of a number carried out by a Professor Durston in England:

A horizontal tube 2½ inches diameter. 10 inches in length, and with walls .135 inch thick, perfectly clean, was tested with an exactly similar tube which had been smeared with oil from a paint brush. The result showed a decrease in heating efficiency of from 8 to 15 per cent., the average of a number of tests being 11 per cent.

The second test was with a 10 inch circular disk 10 in. diameter, 3 in. deep, and ¼ in. thick. The furnace temperature was 1,500 deg. Fahr. With clean surfaces the temperature of the water side of the plate was 212 deg., and the fire side 240 deg. With a coating of grease on the water side of the plate, 1-32 in. thick, the corresponding temperatures were 212 deg. and 330 deg. That is an increase in the temperature of the plate of 31 per cent. These figures should convince the most sceptical.



GROOVING.

Prevention and Repair

If the cause of overheated plates is scale and oil, obviously the way to prevent them is to keep the surfaces clean.

As far as oil is concerned this can be done by passing all exhaust steam used for boiler feeding purposes through efficient oil separators. Give the oil separators a chance, likewise the oil bell, by using the minimum amount of cylinder oil to run the job. Cylinder oil was not meant to be used as a chorus girl uses powder. If your pumps are lifting water from a hot well, put the suction well down so that oil can float on the top if there is any coming in. Watch the gauge glass if you have an open heater, for globules of oil on the water, and watch the boiler gauge glasses for the same thing. Eternal vigilance is the price of safety.

As regards scale formation, this will depend on the quality of the feed water and the amount evaporated.

As a rule the judicious use of ordinary washing soda will solve most scale troubles. Of course, in districts where the water is highly charged with sediments that solidify easily, special care is needed. Each case must be treated on its merits. The following prescriptions are excellent in a general way, being safe and effective, and above all, inexpensive.

When Carbonate of Lime is Present

For each grain per gallon of water found in the boiler use 1½ ounces of pure caustic soda per 1,000 gallons of water evaporated.

When Sulphate of Lime Alone is Present

For every grain of sulphate found in the water, 1¾ ounces of pure carbonate or soda (soda ash) are required per 1,000 gallons evaporated.

When Both Carbonate of Lime and Sulphate are Present

Caustic soda will precipitate both these salts in the following proportion: If water contains 6 grains of carbonate per gallon it would require 6 by 1½ equals 9 ounces of caustic soda per 1.000 gallons, and this would also eliminate 8.16 grains of sulphate. This is water containing 14.16 grains of solid matter per gallon, of which 6 were carbonate and 8.16 sulphate, could be treated by adding sufficient caustic soda to remove the carbonate.

Take a boiler evaporating 1,000 gallons of water per day. The water contains 26.32 grains of solid matter per gallon. Of this 6 grains are carbonate, 16.32

Continued on page 47

Fuel-Burning Equipment of Modern Power Stations

The Following Article Treats of One Form of Stoker, the Inclined Multiple Retort, and Gives Some Interesting Data Relative to Large Installations Which Have Been Completed in the United States

By JOSEPH G. WORKER

Manager Stoker Section Westinghouse Electric & Mfg. Co.

WAR necessities brought about, to a certain degree, "conventional" steam power plants. The activities of the different Government administrations, however, have exacted requirements, in detail, conducive to the highest economic operating results. Production, on the one hand, has made the different public service corporations face the necessity of increased power facilities, and the requirements of fuel conservation, on the other hand, have demanded a careful study of detail problems, not only in the selection of equipment, but in providing means for its economical operation. The co-operative activity of the power plant management, with all these problems, cannot be better exemplified than in the character of the steam equipment designed for recent installations of new steam plants.

A study of the fuel burning equipment of the most modern plants will show that every consideration is being given to those details which provide for a balancing of the economic results that come from a careful selection of equipment, good supervision and correct operation. It will be found that elaborate means are being provided so that the boiler room organization can do things easily. It is no longer necessary for firemen to climb ladders and crawl over the boiler tops to change the position of dampers, although such methods are still common in many old plants. Mechanisms are being placed at the hands of the operators so that it is not necessary for them to go to inconvenient places in order to control operating conditions.

The most generally used fuel-burning equipment for large boilers in the modern stations, is the "inclined multiple retort" underfeed stoker, designed for large boiler units, ranging from 1,200 to 1,500 h.p. A number of boilers containing 12,600 square feet of heating surface have been used, and are furnishing steam for 7,000 to 8,000 kw. in the prime mover. It is not at all improbable that this unit will be further developed to furnish steam for at least 10,000 kw., in the prime mover for continuous operation. These units are set singly, with large alleyways between each setting, so that the boiler and fuel-burning equipment are accessible on all sides. The stokers are designed for a flexible operation of 50 to 300 per cent. rating. Clinker grinders are used in a number of cases for discharging the ash and refuse automatically.

FIG. 2—INTERIOR VIEW OF BOSTON EDISON FURNACE.

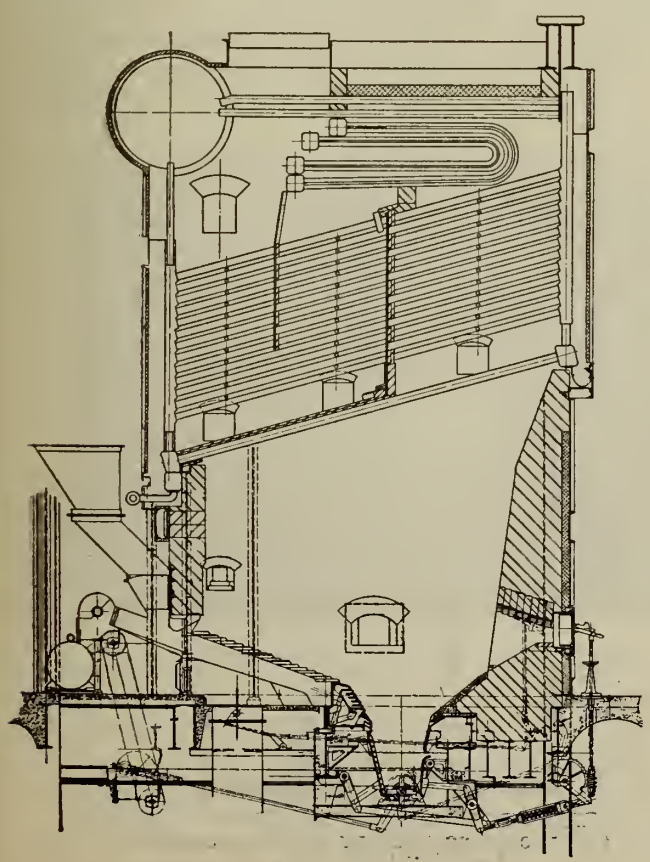


FIG. 1—CROSO DRUM BOILER SETTING USED BY THE BOSTON EDISON CO.

The following brief description of the fuel-burning equipment recently installed in a number of modern power stations covers a wide range in the character of load and fuel used. Some of these plants are completely new stations, while others are extensions to old stations, and still others are old stations in which inadequate fuel-burning equipment has been replaced by more modern equipment.

Edison Electric Illuminating Company of Boston

This company has replaced the old fuel burning equipment under eight 512 h.p. boilers with inclined underfeed stokers. One of these stokers was equipped with a clinker grinder, the idea being to try this out under regular operating conditions and with the fuel available, this being a part of a study for the new extension to the station. Although the stoker was of small size (five retorts), the clinker grinder operated satisfactorily, and it was decided to use this design in connection with the equipment for the new extension, consisting of four cross-drum boilers, 42 sections wide, 14 tubes high, and 18 ft. long, rated at 1,232 h.p., at 300 lb. gauge pressure, equipped with a superheater designed to give 150 degrees superheat.

These stokers, as shown in Fig. 1, are of the underfeed type, having 13 retorts installed under the back end of the boiler, under the mud drums, and equipped with rotary clinker grinders, Fig. 2, for removing the ash and clinker continuously. The stoker drives, Fig. 3, are divided with not over four retorts to a

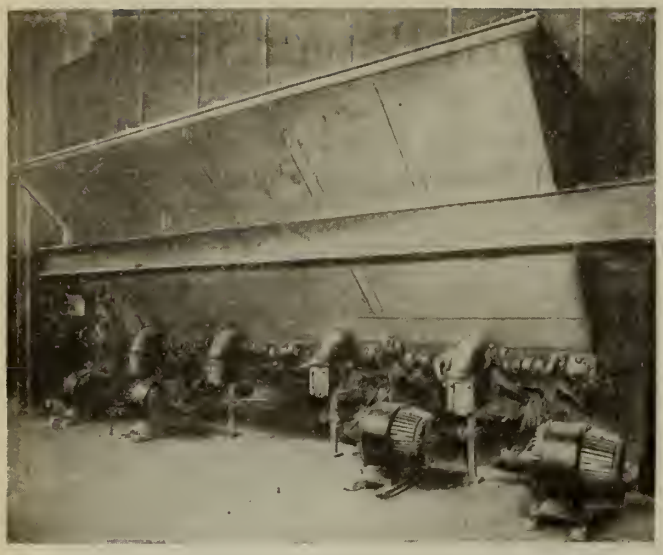


FIG. 4—REAR VIEW OF BOSTON EDISON BOILERS SHOWING INDICATING INSTRUMENTS, VALVE PEDESTALS, ETC.

motor; also the wind boxes and dampers are so arranged that they can be controlled on the same basis, this provision being made so as to give a complete control of coal and air across the entire furnace width.

The coal usually used is New River, of approximately the following analysis:

Fixed carbon	73.50
Volatile	20.75
Ash	5.75
Moisture	3.25
Sulphur	1.05
B. t. u.	14700

The average per cent. of combustible in the ash and refuse is not to exceed 15 per cent. The stoker equipment, when supplied with the above fuel. is designed to develop 30 per cent. of normal rating of the boilers for periods of short duration.

The Boston Edison engineers worked out a design in which doors are placed on the bridge wall, and all controlling mechanism placed at the end opposite the stokers, Fig. 4, so that when the operator views the furnace fires through the bridge wall doors he will have at hand the controlling mechanism.

Buffalo General Electric Co.

The fuel-burning equipment for a recent extension of this company's boiler plant consists of 24-retort underfeed stokers, applied to 1,140 h.p. cross-drum boilers, Fig. 3. The stoker equipment is designed for burning high volatile Pittsburgh coal, of about 13,500 b.t.u. as fired, 10 per cent. ash, 3 per cent. moisture, and two per cent. sulphur. Air-admitting dump grates are furnished with the stoker equipment, these being power-operated. To eliminate, as much as possible, the formation of clinkers, air boxes were designed for installation in the side wall.

The combined efficiency for the plant's operating conditions will range from 75 per cent. at 200 per cent. of boiler rating, to 65 per cent. at 500 per cent. of boiler rating. The coal burning equipment is designed for continuous capacity of 480 per cent. of boiler rating, and 600 per cent. for short durations. In comparison, this boiler has 24 retorts installed under an 1,140 h.p. boiler, while at the Delray station of the Detroit Edison Co., there are 26 retorts installed under a 2,365 h.p. boiler.

Union Gas & Electric Co., Cincinnati

The new $8,000,000 plant of this company contemplated the installation of eight cross-drum type boilers containing approximately 12,625 sq. ft. of water heating surface, with superheaters to produce 250 degrees of superheat. Each boiler was made up of 42 sections each, 13 tubes high and 20 feet long, the furnace width being 24 feet inside the setting walls. Each boiler is equipped with economizers over the boiler and each boiler, with economizer, is designed for evaporating 100,000 pounds of water per hour continuously from 100 degrees to steam at 250 pounds pressure, and superheated 250 degrees, Fig. 6. The entire equipment is capable of evaporating 120,000 lbs. of water under the same conditions for short periods. The fuel burning equipment is designed for burning West Virginia coal, from the Kanawa district, containing approximately 12,500 b.t.u. per pound as fired.

The stoker equipment is of the underfeed type, each stoker containing 14 retorts placed under the rear of the boiler under the mud drum. The stokers consist of double dumping grates with arrangements for admitting air to them. The fuel burning equipment is designed for combined efficiency ranging from 75 per cent., with a boiler capacity of 35,000 pounds of water, to 65 per cent., with a capacity of 100,000 pounds of water. Each stoker is driven independently by direct current motors, connected by Morse silent chain drives to the line shaft of the stokers. Instrument boards are installed to indicate to the operators the exact furnace conditions.

American Gas & Electric Company, Windsor, W. Va.

The $10,000,000 plant of this company,

FIG. 3—FRONT VIEW OF STOKERS

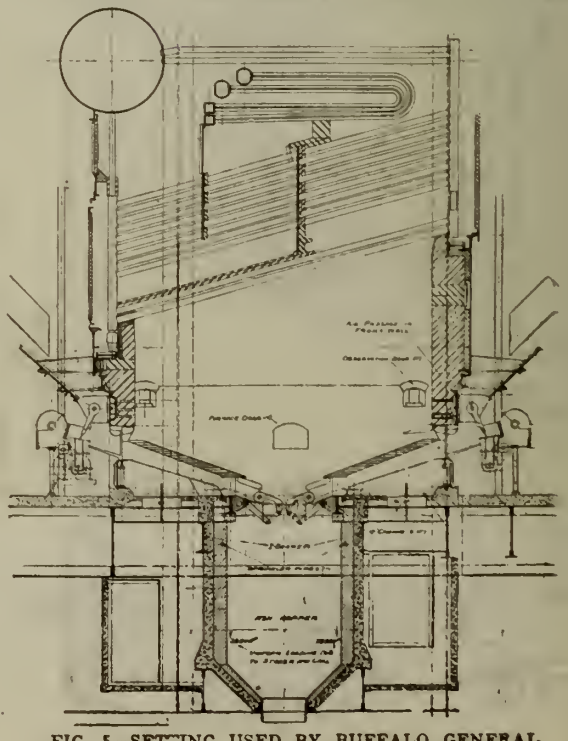


FIG. 5—SETTING USED BY BUFFALO GENERAL ELECTRIC COMPANY.

located in the coal fields of Pittsburgh, is one of our largest power plant developments of recent years. The present boiler-room equipment, Fig. 7, either installed or provided for, consists of 14 boilers with underfeed stokers similar to the equipment mentioned for the Union Gas & Electric Co. The setting of the stokers is shown in Fig. 8, and the instrument boards, as shown in Fig. 9, are placed between each boiler in the aisles.

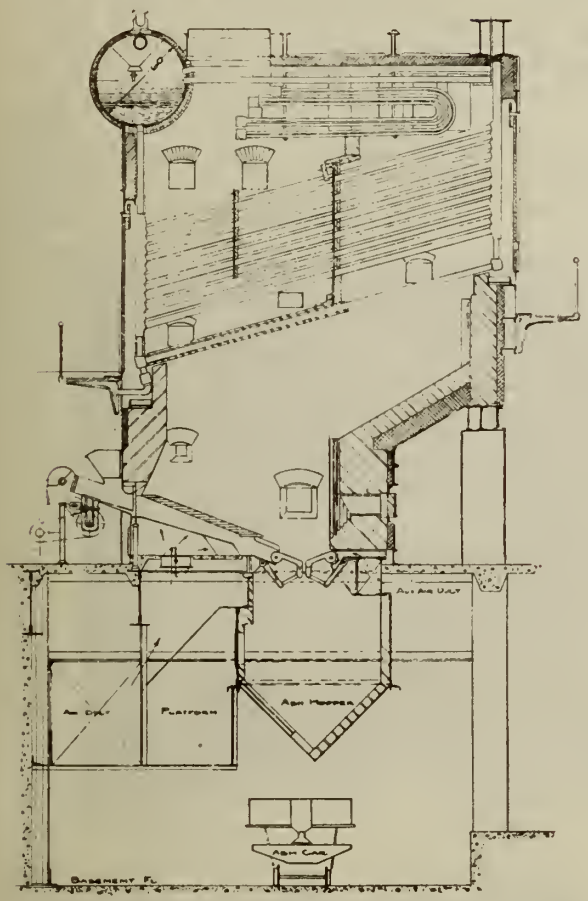


FIG. 6—STOKER AND BOILER ARRANGEMENT AT THE PLANT OF THE UNION GAS AND ELECTRIC CO., CINCINNATI.

FIG. 7—MOTOR AND CONTROL MECHANISM OF THE STOKER.

Detroit Edison Co.

The front view of the boiler and stoker equipment installed at the Delray plant of the Detroit Edison Co., is shown in Fig. 10. This consists of 2,365 h.p. boilers equipped with 26-retort underfeed stokers, with clinker grinders. The Detroit Edison Co. engineers have done considerable work in the development of these clinker grinders. Difficulty was at first experienced on account of the fuel bed breaking, where the fuel left the underfeed part of the stoker, and going into the ash well. It will be noted from Fig. 10 that the grate surface has been curved, this being done in order to eliminate the breaks in the fire. This equipment is run ordinarily at about 150 per cent. of boiler rating, but higher capacities can be obtained when necesary. The coal used contains about 13,200 b.t.u. as fired, and 10 per cent, ash. Under the above operating conditions, the combustible in the ash runs from 14 to 18 per cent.

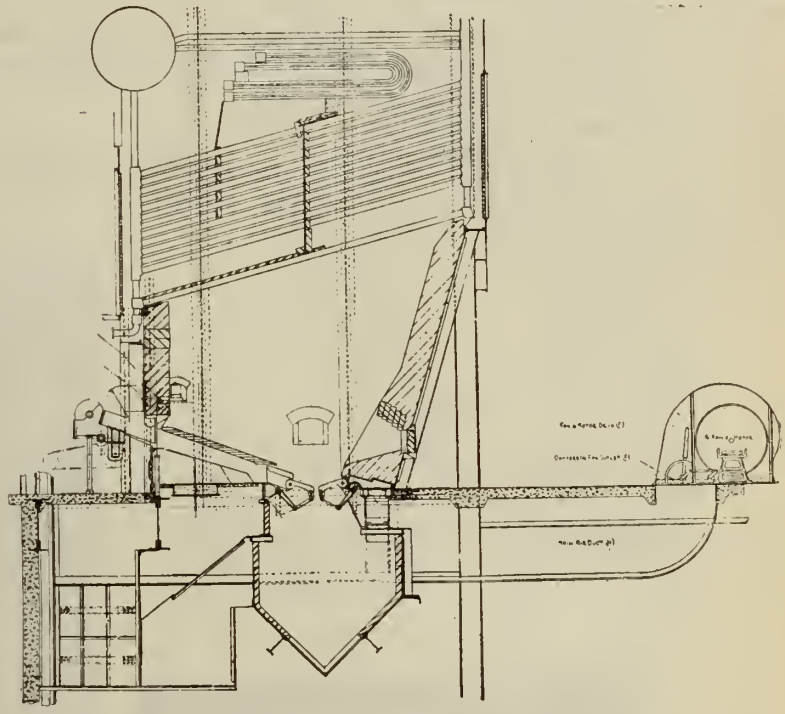


FIG. 8 STOKER AND BOILER EQUIPMENT AT THE AMERICAN GAS ELECTRIC CO. PLANT.

FIG. 9—INSTRUMENT BOARD USED IN CONNECTION WITH THE STOKERS AND BOILERS SHOWN IN FIGS. 7 AND 8.

The instrument board used for indicat-

ing to the operators the condition of the furnace is shown in Fig. 11. It will be noted that everything possible is provided to facilitate ease in handling the controlling equipment.

West Penn Power Co., Pittsburgh, Pa.

The new plant of the West Penn Power Co., on the Allegheny River, above Pittsburgh, contemplates some decidedly novel features in the boiler and stokeroom equipment. The initial installation is designed for six boilers of the cross-drum vertical-header type, 42 sections wide, 16 tubes high, 20 ft. long, set with the front header 16 ft. above the floor, each boiler being rated at 1,529 h. p., and equipped with superheaters designed to give 200 degrees superheat. Underfeed stokers are to be installed at the front and rear ends of the boilers, Fig. 12, 14 retorts under the mud drum, and 14 retorts under the front of the boiler. The operating conditions are to be a maximum of 300 pounds gauge pressure, 200 degrees superheat.

The boilers will be set in two rows, with aisles about 15 ft. between, thus giving plenty of room around each boiler for proper operating facilities. The stoker drives are so divided that there will be 7 or 14 retorts driven by one prime mover, and the wind box dampers are arranged to control separately the air for units of 3 or 4 retorts. The stokers are to be equipped with clinker grinders for continuously removing the ash and clinker. Pittsburgh coals will be used, with approximately the following analysis:

Analysis:

	Coal "A"	Coal "B"	Coal "C"
Fixed carbon	57.38	49.96	56.55
Volatile	34.81	32.84	32.80
Ash	7.81	13.26	10.10
Moisture	5.52	0.94	0.55
Sulphur	1.50	1.20	0.79
B. t. u. (as fired)	13500	11748	12713

The boiler equipment is designed so that the flue gas temperature will range from 500 degrees at 150 per cent. rating to 700 degrees at 300 per cent. ratin, the combined efficiency ranging from 75 per cent. at 150 per cent. rating, to 65 per cent. at 350 per cent. rating. Each stoker, when burning fuel as mentioned above, is designed to develop 350 per cent. of boiler rating continuous with the clinker grinder in operation, and 400 per cent. of boiler rating, for peaks of short duration. Under these operating conditions, the combustible in ash is not to exceed 14 per cent., and the ash is to be discharged into water-sealed ash pits.

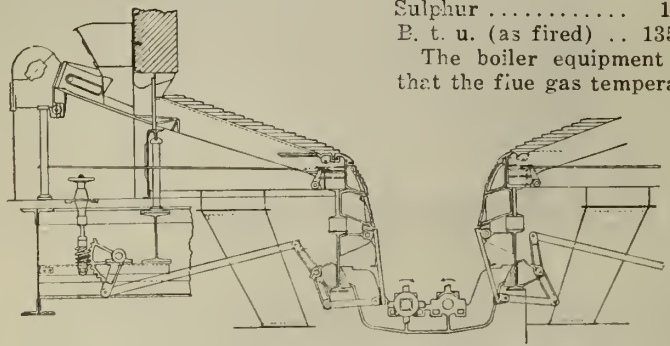


FIG. 10—SECTIONAL VIEW OF STOKERS AT THE DELRAY STATION, DETROIT EDISON CO.

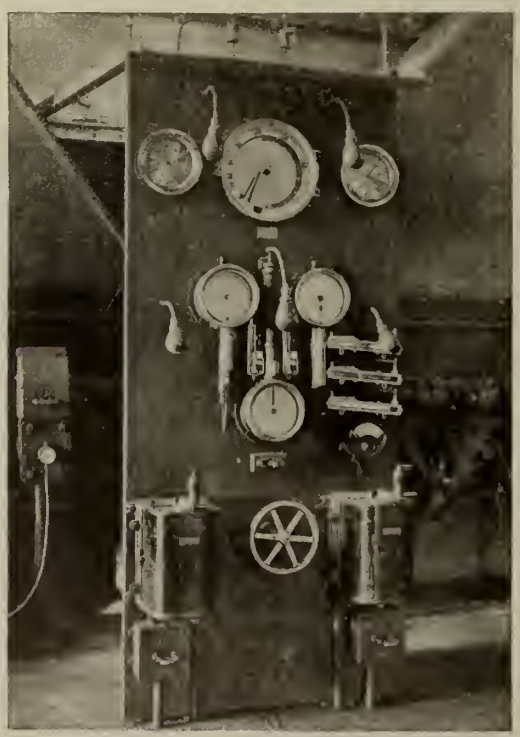


FIG. 11—INSTRUMENT BOARD AT THE DELRAY STATION.

Minneapolis General Electric Co.

The engineers for H. M. Byllesby Co. have been very active in redesigning the fuel burning equipment of plants under their management. For example, at the Minneapolis General Electric Company's plant, Fig. 13, there were installed 12 underfeed stokers, under twelve 600 h.p. boilers. A recent extension to this plant contemplates the installation of five 14-retort underfeed stokers under five 1,300 h. p. boilers. On account of the coal conditions prevailing at this plant, it was necessary to design equipments for two grades of coal of the following approximate analyses:

	"Coal" A	Coal "B"
Fixed carbon	56.48	43.49
Volatile	30.81	32.59
Ash	11.03	20.40
Moisture	7.00	10.00
Sulphur	1.70	3.48
B. t. u.	13400 dry	11200 dry

Under the above conditions, the operating performance of fuel "A" ranged from 1,800 to 3,000 h.p. continuous, and 4,500 h.p. for short durations. With the poorer grade of coal, the maximum capacity was reduced to 3,000 h.p. for short durations.

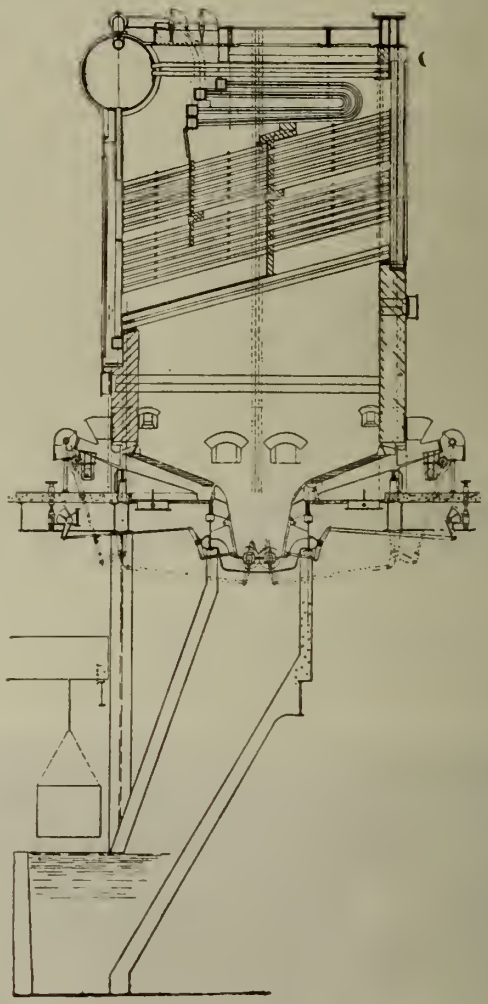


FIG. 12—SECTIONAL VIEW OF STOKER AND BOILER APPLICATION FOR THE WEST PENN POWER COMPANY'S NEW STATION, PITTSBURGH, PA.

Union Electric Light & Power Co., St. Louis

In the past year or so, the boiler plant

of the above company has been entirely revamped, and a change made in the type of fuel burning equipment formerly used. Careful study was made in regard to the installation of stokers, and it was finally decided to install underfeed stokers for use with good Illinois coal, of the following analysis:

Fixed carbon	48.9
Volatile	27.3
Ash	14.9
Moisture	8.9
B. t. u. (as fired)	11112

The main problem at the start was that of designing the equipment to eliminate, as much as possible, trouble due to clinker formation on the side walls. After the equipment was in operation, and when using the coal that was originally contemplated, very little difficulty was encountered with clinkers. Performance results are shown in Fig. 14, when a grade of coal with the following analysis is used:

Fixed carbon	41.0
Volatile	29.0
Moisture	9.0
Ash	21.7
B. t. u. (dry)	12000

Considerably more attention was required to keep the fires uniform and cleaned properly in order to decrease clinker trouble to a minimum.

FIG. 13—STOKER EQUIPMENT OF THE MINNEAPOLIS GENERAL ELECTRIC CO.

Denver Gas & Electric Co.

Recent developments in the West have brought about the installation of underfeed stokers for burning coals found in the Denver markets. The above company's new extension contemplates the installation of four 750 h.p. boilers and four 9-retort underfeed stokers. The application setting worked out as shown in Fig. 15 was made to give sufficient combustion space for any high volatile coals that were liable to be used at this plant, including lignite. The fuel burning equipment has been designed for the following coals:

Fixed carbon	39.00
Volatile	35.85
Moisture	19.70
Ash	5.37
Sulphur	0.42
B. t. u. (dry)	12000

When using the above fuel, the operating performance ranges from 140 per cent. boiler rating to 200 per cent. boiler rating for short duration, with approximately 70 per cent. combined boiler and furnace efficiency.

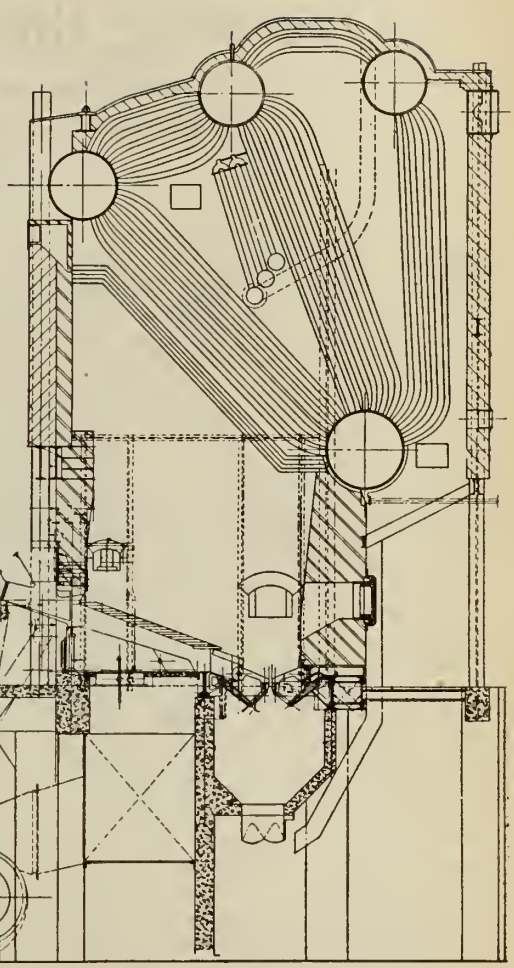


FIG. 15—SETTING USED BY THE DENVER GAS AND ELECTRIC COMPANY.

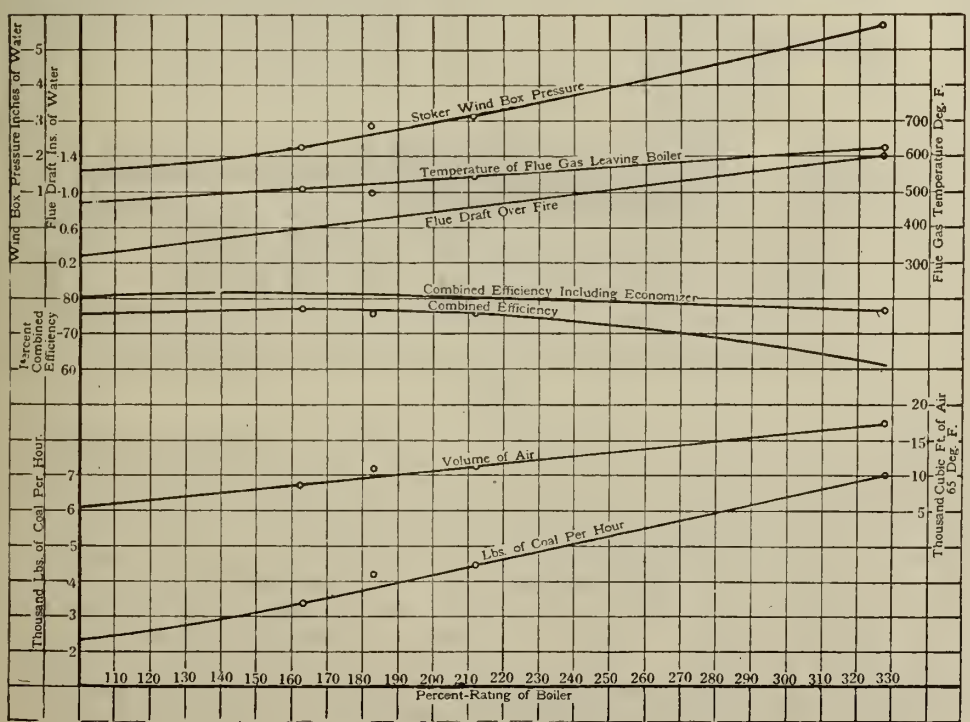

Wind Box Pressure Inches of Water
Flue Draft Ins. of Water
Percent Combined Efficiency
Thousand Lbs. of Coal Per Hour
Thousand Cubic Ft. of Air 65 Deg. F.
Flue Gas Temperature Deg. F.
Stoker Wind Box Pressure
Temperature of Flue Gas Leaving Boiler
Flue Draft Over Fire
Combined Efficiency Including Economizer
Combined Efficiency
Volume of Air
Lbs. of Coal Per Hour
Percent-Rating of Boiler

FIG. 14—PERFORMANCE CURVES OF A SIX RETORT STOKER AND A 558 H.P. BOILER.

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Operating the Babcock Chain Grate Stoker

The Author in the Following Article Gives the Result of Operating Experience and Gives Valuable Hints for the Operation of Chain Grate Stokers in General

By S. BALMFIRTH

THE writer having had charge of B. & W. boilers and chain grate stokers for some five years or so, has during that time engaged quite a number of engineers and firemen, but has not, during the entire period, found one man who knew anything of stokers, or who had handled them in any way. Consequently, the writer has been obliged to instruct every one of them. Experience teaches, but the cost of the course is often high.

It generally costs anything from $50 to $100 to break a new man on boiler firing, if the engineer on the watch is at all busy. So to help cut down the H. C. of L. (which being interpreted, is the high cost of learning,) the writer offers the following suggestions, the value of which has been proved by experience, the hope that they will prove of benefit to some fellow craftsman.

The Babcock chain grate stoker is a splendidly made machine for its purpose, but like all other machines requiring intelligent care, otherwise it is bound to give trouble.

A study of the illustrations will show that it is made up of three main parts: The grate proper, the feed mechanism, and the driving gear. The grate is made up of two kinds of links, the common, and the driving links. These last mesh with the sprockets in front and receive their motion from them.

At the rear half of the grate will be noticed flat plates F F, placed in an oblique direction: these are shutters or vanes, to be used to increase or decrease the rate of combustion according as the load on the boiler is heavy or light. When the grate is running it is supported by rollers, A A, these giving the grate a slight rocking motion, helping to break up any coke that may form, and also shaking down ashes.

During operation of the stoker the grate should be tightened sufficiently to be flat on top, and without any sag.

As will be seen in the illustration, the feed arrangement consists of door B, together with gearing to raise and lower the same. The door is made up of cast iron top, bottom and sides and is filled with firebrick.

One source of trouble with chain grate stokers is the feed door. Some coals will coke and burn close up to the door, and so get it too hot. But one of the most frequent causes of trouble, is the lack of knowledge on the part of the fireman on how to handle the boiler on light load or on how to bank the fire.

The driving gear consists of a train of spur and worm gears. These are driven by a roller chain from a sprocket on the countershaft to a sprocket on the driving shaft of the transmission gears.

There are four changes of speed obtainable through the transmission device, by means of a rack and pinion. Thus it is possible to change the speed of one stoker without altering the speed of another though both are being driven from the same countershaft.

The motion is transmitted to a worm, driving a worm wheel on the front sprocket shaft of the stoker. One point to be remembered is that the clutch nut should only be tight enough to drive grate. It is best to tighten this nut with the driving chain running, then it is only necessary to keep on tightening until the clutch picks up its load.

It should be possible to hold the grate with the ratchet wrench supplied with it, with the clutch in. In fact this clutch is a safety device, if it is not made inoperative through being set up too tightly.

One of the main features of the Babcock stoker is the ignition arch. This is of course of firebrick and is about four feet long, extending back, directly behind the feed door.

Until this arch is thoroughly heated, the stoker will make smoke, and also it is not possible to operate this stoker if for any reason this arch cools, which is quite possible, as will be shown later.

Whether the installation is a new one, or the boiler is being put into commission after cleaning, it is always best to work the stoker entirely round by hand. This may save considerable trouble later. To illustrate, some little time ago, the writer had a stoker overhauled, during which process it was found necessary to renew a good many links both common and driving.

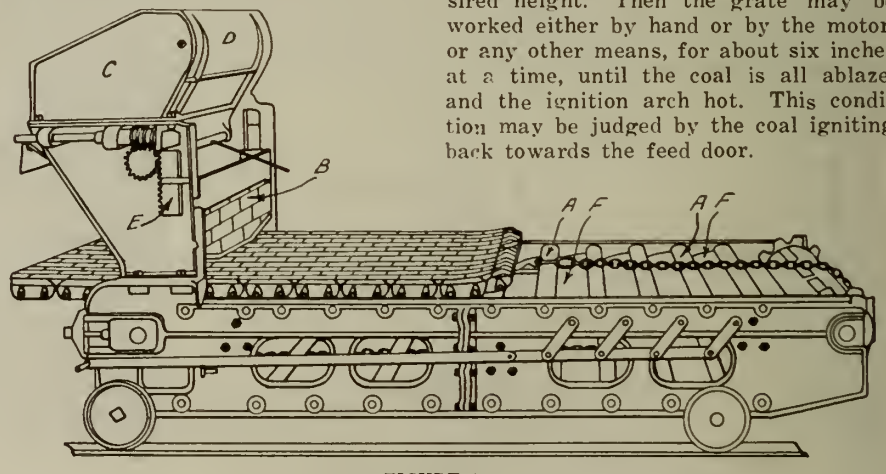

FIGURE 1

As there is always a right and a wrong way of doing things, and as, further, too many cooks are apt to spoil the dinner, it so happened that some of the driving links were placed in wrong. The stoker had been pulled out from under the boiler, for overhauling, and as the time was short, it was pushed back into place, and the fire lighted. By the time the fire had been worked to the back, there was about 20 lbs. pressure, and then it was discovered that the grate would not run. It had gone quite freely up to a certain spot then it stuck. So there was nothing for it but to let the fire out and draw out the stoker again. It was found that the driving links in two places, of course, in the middle of the width of the grate, had been placed back to back, instead of face to face.

Having turned the grate round (this is done of course with the clutch nut loose.) it may be covered with coal about three or four feet in, but not further. If ashes are available for covering the rear of the grate all the better. The feed door must be lifted out of the way, for at best there is only about eight inches of an opening at the front. The fire is then lighted in the usual way, keeping it well forward, the idea being to get the ignition arch as hot as possible.

When the fire is well under way, the front of the hopper may be closed and the hopper filled. Open the coal shutter and lower the feed apron to the desired height. Then the grate may be worked either by hand or by the motor, or any other means, for about six inches at a time, until the coal is all ablaze, and the ignition arch hot. This condition may be judged by the coal igniting back towards the feed door.

One point to be observed in starting a stoker is, that the draft should be checked by keeping the damper partly closed until the fire is well alight back to the feed door.

Possibly some reader is wondering why the grates should only be covered with coal for three or four feet, and the back of the grate with ashes. If all the grate be covered with coal it will not all ignite whilst the fire is gathering strength, and as soon as the grate begins to move, much of the coal will be dumped over the back, so it is better to

cover the back of the grate with ashes.

The chain grate stoker is adapted to burning bituminous slack, under natural draft, without smoke. In fact the writer always goes hunting for trouble if any smoke appears at the stack, and generally finds it. The appearance of smoke generally indicates that the fire is carried too far back, that is, when the boiler has been in operation for any time. Smoke is always formed at starting up, but when the ignition arch is properly heated there is practically no smoke formed whatever. There is another condition, however, which will tend to the formation of smoke, and that is, insufficient draft, but generally speaking. smoke is the result of too much fire. The carrying of the fire too far may be due to the fire bed being too thick, the grate speed too high, or the draft too low, or a combination of all three; but, whatever the cause, the result is always the same, burned-out ash plates. These plates can be seen in the illustration.

No set rules can be given for the proper thickness of fire, or the speed of the grate. However, given a draft, at the breeching of .6 of an inch, and fairly fine slack, a fire of from 3½ in. to 5 in. thick will give good results. When the load on the boiler is light, the vanes shown at the back of the grates may be closed; this reduces the draft through the back end of the grates and prevents holes forming at the back of the fire.

The proper condition in which to have the fire is just to get the coal consumed by the time it reaches the noses of the ash plates. If it does not reach the ash plates, but is burned out before, cold air is drawn through the ashes, resulting in a loss of efficiency; if carried too far there is a great danger of burning out the plates.

One fireman that the writer had, had a trick of running the fire over the back, then dumping the fire into the pit, and leaving it there, with the result that one day there was a nice large hole in the dump door.

With some coals, especially coking coals, it is necessary to rake over the fire frequently through the middle sight door, otherwise there is a considerable loss by excess air being drawn through the fire. Some coals require more raking than others. The writer is quite aware that this procedure is not according to Hoyle, but sometimes it has made all the difference between having sufficient steam and not having it, on the writer's plant.

In the earlier part of this article it was mentioned that it was possible for the ignition arch to get cooled off. At first sight, the writer knows that this seems impossible, but it has happened quite frequently that the boiler fires have gone out, in, fact, one morning it happened twice within the space of two hours.

This trouble was caused by the coal changing from fine to almost nut coal, so that the feed was not deep enough for the nut coal; cold air passed through the coal bed and the fire ran away from the coal. This is one of the most annoying things that can happen.

About the quickest thing to do if the fire has not got far away from the feed apron, is: Close the feed shutter, run the apron right up, and opening the front of the hopper, pull the fire forward again.

In case the fire has got too far away, about the only thing to do is to feed wood in through the sight door, and push it forward under the arch again, always partly closing the damper, as, naturally, whilst this is in progress, steam is going down. This never happens except on a heavy load, when there is not an ounce of steam to spare.

To prevent this happening when the coal changes in texture, it is necessary to alter the thickness of the fire and the speed of the grate to suit the coal.

One thing to be avoided as a plague, is to get the fire so thick or the speed of the grate so high, or both, as to make it necessary to stop the grate. There is nothing worse for the grate, or that will shorten its life more than to stop it with a heavy fire on. What generally happens is that the corners of the links burn off and the links themselves get hot, and there is a great danger of the grate sticking fast. The writer has had all these things happen to him.

Lastly, the back of the grate must be watched to prevent the ash plates being thrown back by clinkers. With some coals it is almost a continuous process keeping the back of the grate clear. A coal that is high in ash and sulphur should not be used; about 2 per cent. sulphur being the safe limit. Two boilers are somewhat difficult to manage on light load, so one fireman tried carrying practically all the load on one boiler and banking the other, so he just nearly closed the damper and stopped the stoker. It worked beautifully, only next day the fireman relieving him had his own troubles. The coal in the hopper had all coked, and hopper sides were hot and coked more coal so it would hardly feed, and before the day was out the bricks dropped out of the door, because the fire had burned back up into the hopper, and in doing so, had also burned the door bottom in two. So that the following night it was necessary to put in a new door. This was done by taking off the hopper top, Nos. C and D, taking off the apron racks, E, and lifting out the remnants of the apron and putting in the new one. This takes about three hours from start to finish, and is not a pleasant task at best.

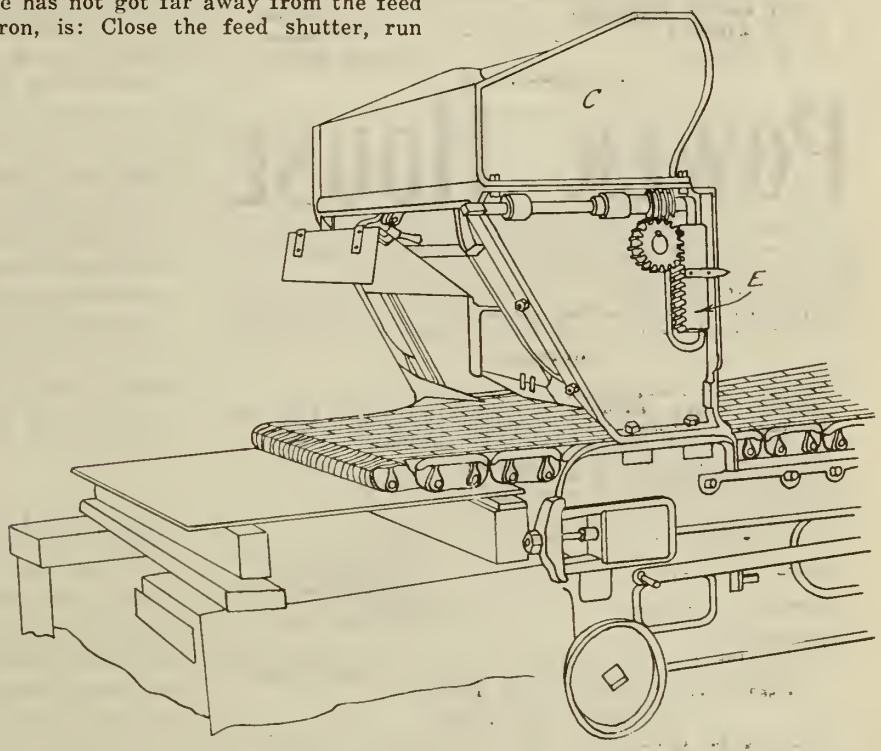

FIGURE 2.

To properly bank a chain grate stoker fire, the following is the method of procedure. Stop the grate until about half the fire is burned out. Then, with the door up to the top, run the grate at high speed. This will bring a thick bed of green coal under the ignition arch too fast for it to be burned. When it is judged that sufficient coal is on the grate to carry over the time needed, close the feed shutter, which is inside the hopper and is not shown in the illustration, and allow the coal below the shutter to be carried on the grate. When the last of the coal is from six to twelve inches away from the door, stop the stoker, lower the feed door to the bottom, nearly close the damper, leaving open just sufficiently to take away the smoke.

The fire will keep alight and will keep the arch hot for hours, without damage to the hopper or shutter or apron. When breaking up the fire again, instead of pushing it back, as under a hand-fired boiler, pull it forward.

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Power Plant Efficiency

IT is interesting to note the growing importance attached to combustion and the boiler room in general, evidenced in the many articles which have appeared of late in the technical press. Power plant efficiency is of more than academic interest to both engineer and plant owner, and anything tending to the cheaper production of steam is eagerly welcomed.

With the progress which has taken place in the turbine little more can be hoped for in the more efficient utilization of steam in the generation of power and it is to the boiler room that efforts will have to be directed in the main for the securing of further economies.

This, after all, is to be expected, for the coal pile is the greatest source of trouble and expense, and the saving of a pound of coal by proper combustion practice is of more value than the securing of an equal economy in the prime mover at a greater capital expense.

It may be safely stated that the average boiler room is operated at much less than its possible efficiency even if no extra equipment is purchased and with proper attention to the various factors entering into the combustion of coal much can be done to decrease the cost of steam power or heating.

In securing proper combustion it is self-evident that the engineer must know how his coal is being burned and more attention will have to be paid to the equipping of the boiler room with instruments for the checking up of the various steps from the coal pile to the stop valve. The average boiler room makes but a poor showing when compared with the turbine or engine room with its meters and recording apparatus for every conceivable purpose.

Together with the control of combustion goes the proper handling of coal and ashes, and a little thought and the expenditure of a little money in this portion of the plant will not only make the fireman's lot easier but will show returns on the balance sheet.

Hitching Big Ben to the Central Station

AN interesting development in A.C. transmission has rather interesting possibilities for the future. An electrical clock has been developed, driven by a small synchronous motor which utilizes the frequency of an alternating current circuit for its functioning. The principle involved is very simple but in its carrying out very accurate control of the generator frequency will be necessary. This has been accomplished by the use of a similar clock mechanism together with a very accurate clock movement of the ordinary kind, although wound up by electrical means. When this device comes into general use it will render the accurate keeping of time a very simple matter, an accuracy of a few seconds a month being a comparatively simple achievement.

No doubt somebody will ask, "What are you going to do if power goes off?" This contingency will be taken care of by an auxiliary clockwork mechanism which will come into play when the power supply is interrupted and will cease functioning when it is restored.

Turbine Locomotives

THE one field in which the reciprocating engine has held its own is to be invaded at last by its deadly competitor, the turbine. A turbine driven locomotive has been designed in Europe which gives promise of at least being quite useful. The use of an impulse type, non-condensing turbine has been suggested which will be reversible and which must work economically at various speeds.

One suggestion is to the effect that a single steam turbine be placed in front of the boiler on a specially low frame with two axles. The axis of the turbine follows the direction of the rails, and drives through worm gearing, an auxiliary shaft lying in the direction of the wheel axles and supported on the front frame structure. At each end of this shaft is a crank from which the motion of the turbine is transmitted to the driving wheels by coupling rods. The axial thrust of this turbine is taken up by a special thrust bearing and the most suitable type of turbine to use in this case is a pressure turbine with a rotor for forward and one for reverse motion.

Well, This Sounds Like Real Easy Money

Written by One Who Had It Tossed at Him

LOOKING over CANADIAN MACHINERY a couple of weeks ago, I saw an article headed "Is There Such a Thing As Easy Money?" That is, in the nature of things, a highly controversial subject, and complicated by the fact that the ones who get their money in the easiest manner, think it is obtained only with difficulty.

Personally, the pursuit of the elusive dollar has always been fraught with hard labor and indifferent success. Only one occasion comes to my mind wherein I was the hunted, and the prettily engraved paper, the pursuer, Even at that, the manner of its coming was attended with so much mystery and anxiety of mind, that I doubt if it could be strictly labelled as "easy money."

The means by which I was, at that time, endeavoring to lay the foundations of a fortune, was by taking charge of the steam plant of a manufacturing concern. The salary was in inverse proportions to the duties. This particular plant had started in a modest way some years before, the motive power at the beginning consisting of a vertical firebox boiler, and a 15 h.p. horizontal engine. The original engineer had been a bricklayer, who having developed a partiality for hanging around the boiler, during the construction period, in order to warm himself, was struck by the comparatively easy and sheltered life the fireman seemed to lead. It looked so much more comfortable than laying bricks in the invigorating winter climate, that he determined to change his profession. Fortune favored him, inasmuch as the incumbent of the position developed an attack of the demon rum, and was summarily discharged. The erstwhile follower of the ancient rites applied for the position, and obtained it.

The product of the factory was a household need. With the growing population of the country the demand for the company's goods increased. The plant grew, more power was necessary, and a horizontal boiler took the place of the vertical, a new boiler room being built to house it. More buildings came along, more pipings, more boilers, more power. With the help of the handy man who had become the chief steamfitter, pipes were run here and there and everywhere. With the introduction of motors instead of the old line shaft drive, an electrician became necessary. Old Bill, the one-time bricklayer, kept strictly aloof from this phase of the proceedings. He was already in the position of the Irish Fusilier crossing the Tugela River in the Boer War. The commanding officer, during the fording of the stream, gave the order "Fall in two deep." One of his followers replied in anguished tones, "Begorra, I'm in two deep already."

Things were getting so complicated for Bill, that he decided to find an easier job. Before long he got in touch with a nice little factory that used one boiler for heating only, and transferred his patiently won engineering abilities to this haven of rest. This was where I stepped in.

I was at that time in a big plant out in the country, but yearned for a city life. Some friends of mine in the supply business were looking out for a job for me, and one day I got a letter from them, advising me that some clients of theirs had a nice little plant they wanted a man for, who could do a little re-organizing. After a little correspondence. I accepted the position, and moved in to the city.

I found a plant, consisting of four 150 h.p. horizontal return tube boilers, a pair of compound engines, horizontal, air compressor, belt-driven generators, hydraulic pump, and the old original engine, which was used occasionally at nights.

In the boiler room was the most astounding collection of pipes it has ever been my misfortune to run up against. They ran overhead, under the floor, were mounted row upon row on the walls. The main steam pipe was a fearful and wonderful layout, and a graceful wreath of steam surrounded every joint. While I was standing on the boiler top, trying to visualize this Chinese puzzle, a wildly excited old fellow rushed up the ladder, and started shutting down the main stop valves on all four boilers. Naturally all the safety valves started to blow, and the boiler tops become a most uncomfortable location. The boilers were in the basement, and there was a door leading from the tops to the yard, so I strolled gracefully out to wait for the excitement to stop. I hadn't yet taken charge, and my enthusiasm was beginning to cool a little.

While I was trying to decide on whether I should go home or not, the superintendent came along. He had left me just a few minutes before, to allow me to look around a little. He looked worried. "I thought you were in the boiler room," he barked when he saw me. "Well, I was," I replied, "but there seems to be a holiday proclaimed, and I didn't want to interfere. Does this sort of thing occur very frequently, or is it just emergency practice?"

"Well, this is what we want to stop. All this trouble is over a burst pipe in the galvanizing department. There's so many pipes and valves leading there that no one knows what to shut off, and the quickest way is to shut everything off, plug the pipe, and trace it after."

That was my introduction. However, I liked the super, and was promised very many inducements if I would stay and straighten things out. I stayed, and in a few months had things improved a lot. Incidentally, I had a lot of trouble with some of the oldtimers, especially a night fireman, an Italian. It ended up with my firing him, and he departed, vowing vengeance.

Christmas was approaching, and I was getting over the worst of my troubles. I didn't have to work more than an average of fourteen hours a day, and sometimes even got a Sunday at home. I had been married a short time, and was getting quite well acquainted with my wife, in the intervals between supper and bed.

One day, I was called to the 'phone. A strange voice came over the wire. "Is that Mr.——?" it demanded. I pleaded guilty. "You are chief engineer there?" Again I admitted the soft impeachment. "That's alright. Now what is your private address?"

I immediately became dignified. "I don't know you, sir, and I don't give my address to strangers. Who are you, and what do you want." Mystery pervaded the voice. "You'll find out who I am in good time. I can't tell you over the 'phone." "Very well then," I replied, "it's no use prolonging the conversation."

I hung up the receiver, and tried to forget all about it, but I kept on wondering. It seemed peculiar.

Foolishly, I told my wife about it after supper that night. To my surprise, she immediately dissolved into tears. "Oh dear, oh dear, I knew something awful would happen. Why did you do it?" Not knowing what I had done, I couldn't explain, so said nothing. "Don't you see," she went on, "it's that dreadful Italian. The papers are full of dynamite outrages. We'll be blown up in our sleep, I know we will."

This angle hadn't occurred to me. It seemed funny to me, and I was foolish enough to laugh. I got the blowing up right there, and incidentally, determined to keep business affairs to myself in future. However, peace settled down after a while, and nothing more was said, though she was plainly worried.

Two days after came the call again. This time I had a new idea. "Look here, old chap," I said to the unknown, "I have all the life insurance I can carry, so it's no use your bothering." The owner of the voice laughed. "I am

not selling life insurance, but I'm glad to know you carry it." There was something about this I didn't like. I tried a new tack. "Why don't you come down here and see me?" I demanded. "Oh, that wouldn't do. It's better for my own sake to see you at your house." "Well, you can jolly well find out," I yelled. "I'll never tell you." He laughed again. "I just called you up to let you know I've found out. You'll see me on Christmas Eve," and the receiver was hung up at his end.

Christmas Eve was only two days off. I did a lot of powerful thinking during that time, though I didn't say any more to my wife. I could think of no solution. I didn't owe any money to anyone, and had no enemies, with the possible exception of my late fireman. There seemed nothing to do but wait.

We were going out that night, and though I was not to be scared, I was sort of hurrying my wife up while she dressed. She seemed to be longer than usual, but the last time I looked in she had said she couldn't be any quicker, and I was making her nervous. I thought to myself, that was quite fair, as I was nervous myself.

A short, sharp ring at the door bell. I jumped about a foot, and then, pulling myself together, boldly opened the door. A mild looking stranger stood there. "You are Mr. ——" he asked, and immediately I recognized the mysterious voice of the telephone. I nodded without answering.

"You have given me a lot of trouble to find you," he went on. "Can I speak to you a minute." I sized him up, and concluded I could handle him alright. "Very well, come in," I answered, and led him in to my modest sitting room.

"My name is Brown," he said as he took a chair. "I represent the —— Oil Co. I have been months trying to sell your firm, and shortly after you took charge, I got an order. Here is a little Christmas present," and he laid a ten dollar bill on the table.

I tried to protest. "Not a word," he broke in. "This is entirely between you and me. I wish you a very merry Christmas." Before I could frame the words I wanted to speak to him, he had reached the door, and was half way down the steps. I concluded to let him go, and returned to the room, to enjoy the heartiest laugh I had enjoyed for some days.

My wife came out to enquire into the cause of my mirth. I told her I was laughing at a man for giving me ten dollars. "Of course," she said, "ten dollars is only a joke to you. What was it for?" "Well, my dear, it was supposed to be for value received." I explained what my visitor had said to me. "The whole point is this. I had no more to do with purchasing oil or any other supplies than you have. Our firm divides its orders among the people who buy from them, and no matter what the quality, they each get a turn. Anything I say for or against carries no weight. As a matter of fact, this chap has the worst brand of oil on the market, and he knows it. That's why he feels so grateful to me, for what he thinks is my good influence. It would be a shame to undeceive him. The reason he got an order is because his people bought some stuff from our firm, and as long as they continue to buy from us, he will get more orders, and we will get a visit from Santa Claus."

Well, the following Christmas, I received two ten dollar bills, and the one after that, on the last occasion I showed my friend a case of cutlery the boys had given me that day on the occasion of my leaving the firm.

"Well," he said, "I am sorry you are leaving. I hope you will put in a good word for me with your successor."

I promised.

The Joys of Camping Out

HE thought he'd take some holidays and so he got a tent, to camp beside the babbling brook and save a month of rent. He got some pickles and some ham, some salmon and some tea, and every kind of fodder that his cooking eye could see.

And then he got a tiny bed, a blanket and a sheet, to keep the spiders and the bugs from rompin' on his feet.

He also bought a fryin' pan and took a spoon and knife, and told his friends that he was off to lead the simple life. The boarding house he would forget and all his troubles there, and just commune with nature and devour the clover air.

The day had been so beastly hot, it added to his zest to reach the shady wooded spot and chuck his coat and vest.

The camper ate his humble meal and lined up his interior, and swore, by gum, that campin' was a system most superior. He lit his pipe and in the dusk he puffed great clouds of smoke, and dreamed he wuz an Injun brave 'way down at Shogyhoke.

And then he tumbled into bed to dream of joys in store, and the woods re-echoed for a mile with a most gigantic snore.

And the sun came peepin' in at him and he chuckled out with glee, "By all the jumpin' hottenots, this is the life for me." He made a rush to get a meal just like a hungry horse, for this tentin' in the woods had roused his appetite, of course.

But the ants were in the butter dish, and flies camped on the ham, and fourteen different crawlin' things were in the fryin' pan.

The bugs were swimmin' in the milk, though some of them were dead, and the worms had set up keepin' house inside his loaf of bread. He said a lot of sizzlin' words, they just ran out like strings—he's boardin' by the week again on hash and prunes and things.—Ark.

ONCE the Allies finish up the peace terms the next thing is to polish off the man who started the whole thing. At present he's hiding behind a Dutch bedstead.

* * *

WE are now approaching that peculiar season of the year which is punctuated at painfully regular intervals by rhubarb sauce, rhubarb pie, rhubarb pudding, rhubarb, etc., etc., etc.

* * *

CITIES shove up taxes on vacant land to make the holders sell. Very good. But in so doing they simply put the price of vacant land where the real honest-to-goodness builder can't touch it.

* * *

ON May 7, 1915, the Germans sank the Lusitania, and on May 7, 1919, the peace terms were handed to them. It took four years, but the wind was sown and the whirlwind was the harvest.

* * *

THE box car is the greatest industrial loafer that we have heard of for some time. In fact, some railroad man with a mania for figures has it figured out that if the box car came to work at 10 in the morning the whistle would blow at 12 minutes past 11 for it to quit work. The rest of its time it is hanging around on sidings and waiting to be loaded or unloaded. As there are some 2,500,000 freight cars in United States alone, the amount of loafing this collection does must be staggering in the aggregate.

* * *

OUR idea of a steady job is being janitor of that airdrome in Newfoundland where those trans-Atlantic flyers are going to start from.

Progress in New Equipment

THE BLONCK EFFICIENCY METER

THE illustration shows two Blonck boiler efficiency meters installed on a double boiler setting at the High Level Pumping Station, Toronto waterworks. The use of these meters effects considerable economy wherever installed, and at the same time they are as nearly foolproof as possible. This efficiency meter, if carefully watched, will be sure to bring about an average increase in CO_2. It indicates constantly the condition of the fire and baffles, and in general the clinkers and soot, and is a good guide to damper regulation. All this is accomplished without having to teach the fireman anything more scientific than the relative positions of two different colored oils in a draft gauge. The position of these two columns of oil shows the fireman when his fires are too heavy or too light, or whether he has holes in his fire, etc. More than this, they show how the furnace is operating and if there should be an accumulation of soot on the tubes, or if a baffle falls these things will be indicated in an unmistakable manner.

The meter is always calibrated with the boiler, to which it is fitted, and CO_2 analyses taken to determine the best operating condition of the boiler on normal rating. When this is determined the two different colored liquids will be found to be in alignment and at the proper point on the scale for normal load. Should a lighter fire than normal be carried for light load conditions, the liquid columns still in alignment if the proper conditions are maintained will be to the left of the normal operating position, and if a heavier load than usual is carried, to the right.

The meter is applicable to both forced draft and natural draft conditions, and the pipe connections are easily arranged for either condition. In addition to the running of pipe connections the boiler damper should be arranged in such a manner that it can easily be adjusted from a position near the meter.

The meter is easily checked up for accuracy by removing two plugs and letting the two liquid columns return to zero. Should they not return to zero the meter is easily readjusted by placing more of the proper colored oil in until they do.

A Fuel Saving of Almost 10%

The figures given below are from four ten-hour shift tests, made with 4 Sterling boilers, identical in every respect, two equipped with Blonck boiler efficiency meters, and the other two running without them.

All four boilers were running at the same time, thus eliminating all atmospheric changes, and all four were fed from the same bunker.

These tests were made in May, 1918, by the engineers of one of the largest and best equipped plants in the United States, the plant being furnished with all known devices for efficiency and saving:

	Without Blonck Meter	With Blonck Meter
Aggregate duration of test hours	40	40
Feed water, pounds.	1,539,451	1,677,455
Feed water temperature, deg. fahr. .	91	91
Coal as fired, pounds .	274,815	287,100
Steam pressure, average	137	137
Evaporation per lb. of coal from and at 212 deg. fahr. .	6.15	6.82
Percentage of saving		9.83%

The meter representative had no connection with these tests except to set the narrow plates of the Blonck meters for best firing conditions.

After that was done, the running of the tests was left entirely to the firemen and engineers of the plant, and the data as above quoted represent the results obtained as shown by their own figures.

E. J. Philips and Sons, Hamilton, Trust Bldg., Toronto, have been appointed sole Ontario representatives for this meter.

BLONCK BOILER METERS.

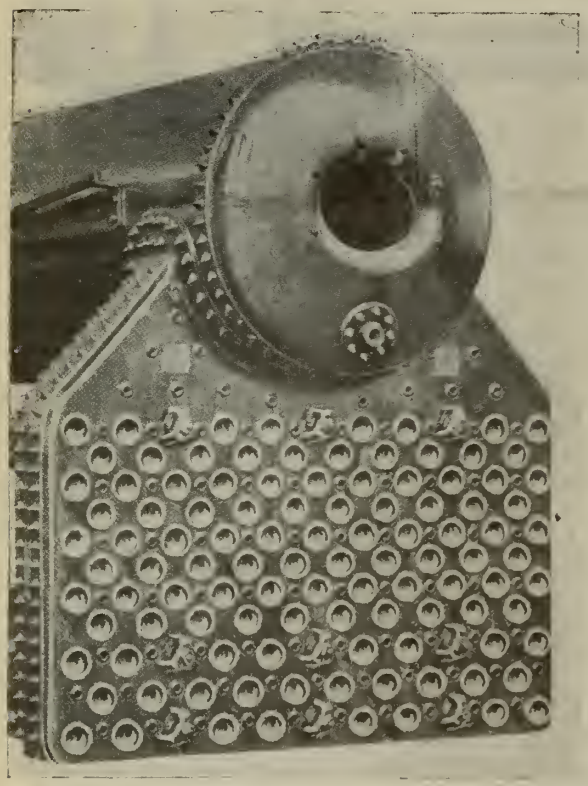
HANDHOLE CAPS

The accompanying illustration shows a new device which has met with considerable success for the capping of tube holes in water tube boilers, superheaters, down draft furnaces and other special apparatus. The Key Safety handhole cap is a pressed steel cup with tapering sides, and is placed in position from the inside of the boiler. In applying it all of the handhole openings are first converted to a standard size by revolving in the hole a special roller tool. As the rollers revolve they remove any roughness from the interior diameter of the holes, and impart to it a taper corresponding to the taper of the cap.

The handhole caps, after being coated with graphite cement, are lifted into the holes by a special pickup, attached to a chain from inside the water leg. When the rollers of a setting tool are revolved inside the open cup face of the cap, thereby pulling the cap tightly into the hole, and making a metal to metal contact which will stand more than 3,000 lbs. to the sq. in. on hydrostatic test.

In operation the steam pressure on the cap holds it on its seat like a check valve, and when necessary to remove it a blow with the hammer readily unseats it.

This device is applicable to many other uses besides the one illustrated. Old fire tube boilers may easily and cheaply be converted into serviceable tanks through the medium of closing up the tube holes with the handhole caps.



HANDHOLE CAPS.

This handhole cap is sold in Canada by the Power Plant Equipment Company, Ltd., Toronto.

THE NEW ONE-UNIT TURBO CENTRIFUGAL BOILER FEED PUMP

Ever since specially designed centrifugal boiler feed pumps have demonstrated their efficiency and economy in power plants of modern construction, the owners and operators of smaller power plants have been waiting for a centrifugal boiler feed pump which would meet their requirements.

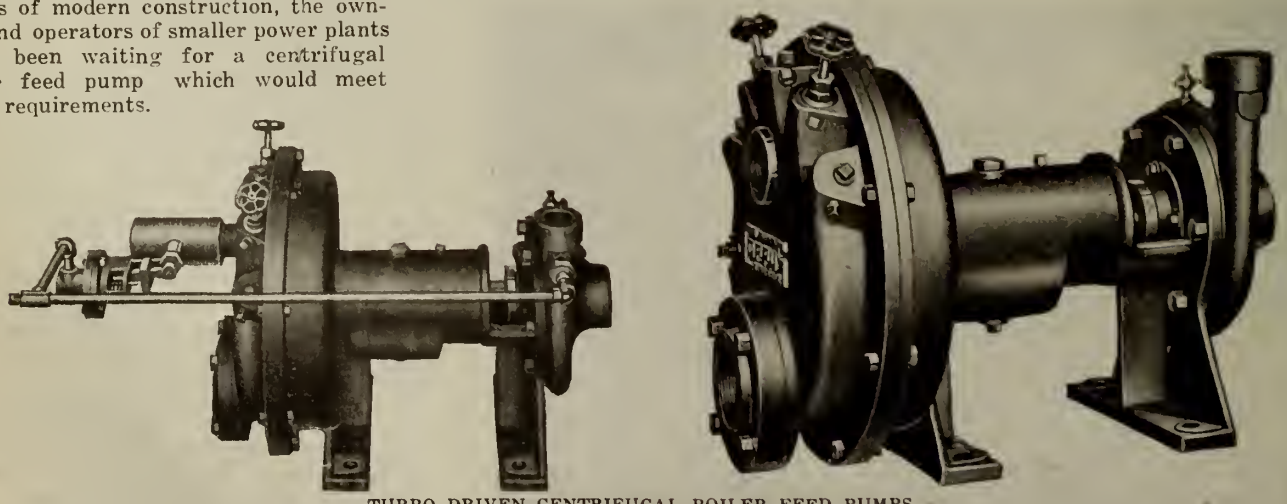
The only reason that such a pump has not been constructed up to the present time is the fact that practically all pump manufacturers specialize in pumps alone. Since they do not build either steam turbines or electromotors, the driving end of a centrifugal feed pump could not be constructed in the same plant as the pump. This necessitated the two-unit type of construction, involving a more expensive product than most small power plants are willing to invest in.

A manufacturer of small power turbines has just placed on the market a new steam turbine driven centrifugal boiler feed pump, especially designed for boiler feeding, in plants of 100 to 3,500 b.h.p. Every care has been taken to see that all the advantages of centrifugal feed pumps which have proved so successful in larger plants, have been retained in this smaller, more compact unit.

Both the pump and the steam turbine are combined in a single unit, and thus the pump occupies but very little floor space. Simply designed, compactly constructed of the best materials, in a plant newly equipped for the purpose, the new pump promises to come into general favor in a very short time.

As with larger centrifugal boiler feed pumps, the exhaust steam is free from oil, there is no water hammer so injurious to pipe lines and valves, and the steam consumption is unusually low. The feed water capacity is controlled by regulating the hand valves at the boilers, a saving of time that will be much appreciated by any power plant engineer.

The pump is built in four standard sizes, in capacities ranging from 100 to 3,500 b.h.p. Full details and an interesting catalog will be sent upon request by the Coppus Engineering and Equipment Co., 344 Park Ave., Worcester, Mass.



TURBO DRIVEN CENTRIFUGAL BOILER FEED PUMPS.

"POWER HOUSE is instructive and contains good information." — Mr. F. Roseburgh, Toronto.

DURABLA PACKING

Flange joints in piping installations are factors in engineering that demand particular attention, especially where the system is operated under varying conditions of heat and cold, and the consequent expansion and contraction of the metal, and the condensation of the steam and vapors. Economy should never displace efficiency unless this efficiency means economy.

Durabla packing is made of a combination of asbestos and the best binding materials, which will not pulp around the joint. It is unaffected by temperature change, or the action of oils, chemicals, hot water and liquids, and gives exceptional service for steam and gas engine operation. It has a peculiar ability to withstand shock or vibration, which makes it very effective for steamship service. It is made in sheet or gasket form and will withstand temperature of 1,000 degrees and pressure of 300 lbs. without signs of destruction, and will not deteriorate when kept in stock for a lengthy period.

DURABLA PACKING

"Your ads. are read as much as the other matter."—Mr. G. Newton, Winnipeg.

"I look over the advertisements the first thing for new machines or new advertisers. I thereby learn something about machines."—Mr. Lamb, Goderich.

"I can say that POWER HOUSE is a helpful paper for me, and that I never will be without it so long as I am an engineer."—Mr. J. D. Barkman, Steinbach, Man.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before The House

13. If your safety valve has been blowing off at 100 lbs. and now commences to blow at 80 lbs., what would you do to remedy the same, in the event of the steam gauge indicating 120 lbs. before the safety began to blow? What would you consider the possible cause, and what would you do to remedy the same? What action would you take?

14. If you were taking charge of a boiler where the safety valve steam gauge and water column had been taken off to prevent damage to same, and you were in doubt as to the correctness of the steam gauge, how would you set the safety valve when it was replaced on the boiler in order that it might blow off steam at 100 lbs. pressure, and in replacing the water column how would you set it at the correct height on the boiler?

15 .Explain the construction and action of an expansion joint as used on a main steam pipe. What omission in the construction of expansion joints would lead to serious accidents when steam is first applied?

16. Explain fully the construction and action of a safety valve spring-loaded pop. In what does it differ from the other ordinary spring-loaded valve? What is the advantage of the pop over the ordinary? How does the connecting of a long discharge pipe affect its working.

17. What is the meaning of factor of safety as applied to steam boilers? What is the real limit of the strength of a boiler? Explain the manners in which frequent variations of steam pressure affects the strength of boiler, and why?

18. Show by sketches and explain different ways of staying the segments of boiler heads above the tubes, stating the advantages and disadvantages of each method?

19. What is the difference between a direct current dynamo and an alternating current dynamo? In what way does a dynamo differ from an electric motor? Can a dynamo be run as a motor, or the motor as a dynamo?

20. If you were in charge of a steam plant where there was boiler power to spare, but the engine in its present condition was fully loaded, what would you do to increase the power of the engine in order to run extra machinery, assuming that the boiler pressure can not be raised, and that all parts of the engine are strong enough to carry the extra load?

21. Explain some type of ammoniac compressor, giving details of operation. How would you naturalize ammoniac fumes escaping from a leaky pipe in an enclosed room, and after this is done how would you locate the leak?

22. What is the safety head of an ammoniac compressor? What purpose does it serve, and how is it constructed? What precautions are necessary in taking compressor cylinder apart in order to prevent injury from inhaling ammoniac gas, if this gas should be inhaled to such an extent that a person becomes unconscious, what action would you take to save him?

23. What is the position of the eccentric related to that of the crank for engine running, either over or under (a) with direct motion; (b) with indirect motion; (c) with indirect valve and direct motion; (e) with expansion valve (righting cut off) direct motion, with indirect motion for same?

E. V. M., Lardo, B.C.

Answers to Questions In Last Issue

Question 9.—What is the probable h.p. of the following engine, also the water consumption per h,p, hour, the boiler h.p. and the size of the feed pump required to supply this outfit with water. The engine is non-condensing and compound, having cyls. 11 in.×19 in.×12 in. stroke, running 260 r.p.m. cut-off H. pressure ⅝ stroke, and cutoff L. pressure ¾ stroke.

Answer.—First we will have to assume some definite pressure, say 100 lbs. gauge. Now to find the mean forward pressure in the high pressure cyl. use the following formula:

$$Pm = P\frac{(1 + \text{Hyp. log } R.)}{R} - \text{in this case}$$

$$115 + \frac{(1 + .4700)}{1.6} = 105.8 \text{ lbs., the mean}$$

forward pressure.

(The ratio of expansion in high pressure cylinder = 1.6, hyperbolic logarithm of 1.6 is .47000.)

Next we must find the back pressure against the high pressure piston on the receiver pressure. This may be found as follows:

115 lbs. ÷ 15=7.6, the ratio of expansion throughout the both cyls. and the square root of 7.6=2.7 approx., and 115 ÷2.7=42.6 lbs. pressure approx. Now 105.8—42.6 = 63.2 lbs. × .8 as a factor equals 50.5 lbs. as the mean effective pressure in the high pressure cyl.

It is good practice to have the range of temperature drop in each cylinder about the same. So we will see how this works out. Steam at 115 lbs. =338° F. approx. and at 15 lbs. 213° F. Now 338 − 213 = 125°÷2 = 275.5° F., and as 275.5° F.=16 lbs. pressure, this receiver pressure should be O.K.

Now the M.E.P. in the low pressure cyl. is found in the same way.

$$Pm = P\frac{(1 + \text{Hyp. log. } R)}{R} \text{ or}$$

$$42.6 \frac{(1 + .2626)}{1.33} - 15 = 25.5 \text{ lbs.} \times .75 \text{ as}$$

a factor = 19 lbs. approx., as the mean effective pressure in the low pressure cyl.

$$\text{The horsepower} = \frac{\text{PLAN}}{33{,}000}$$

For the high pressure cylinder this equals:

$$\frac{50.5 \times 1 \times 95.3 \times 260 \times 2}{33000} = 76 \text{ h.p. approx.}$$

and for the low pressure cyl. this equals

$$\frac{19 \times 1 \times 283.5 \times 260 \times 2}{33000} = 83 + \text{h.p. approx.}$$

Now the total equals 78+83 = 161 h.p.

The steam consumption of engine, with say, 2 % clearance in high pressure cyl. and neglecting the piston rod and condensation in pipe lines and ports, equals:

$$\frac{95.3 \text{ sq. in.} \times 12 \times ⅝ \text{ of stroke} - .02\%}{1728} \times$$

$$.2617 \times 2 \times 260$$

or 55.8 lbs. of steam per minute, and 55.8×60=3448. lbs. of steam per hr., and 3448÷161. h.p.=21.4 lbs. of steam per h.p. hour.

(Quite an economical engine if it really develops the 161. horse power.)

Now taking 30 lbs. of steam to equal 1 b.h.p. this engine would require 115 h.p. boiler, or better, 125 h.p., this boiler would require a pump, if it is to handle hot water. A steam cyl. 4½ in. dia., water cyl. 3 in. dia., length to stroke 4 inches, this pump to be of the duplex ram pattern.

NOTE.—This problem has been solved throughout by the use of a slide rule, therefore is only approximately correct.

F. F. McNEIL.

Question 11.—A cyl. 24 in. bore, carrying an initial pressure of 100 lbs. gauge, the studs to hold the cyl. head in place have an allowable pressure of 5,000 lbs. per sq. in. section. How many studs and at what pitch would they be placed?

First the thickness of cyl. walls should be approx.

$$t = 0.0004\ D\ p + .03 \text{ in.}$$

When t = thickness of wall in inches

D = dia. of cyl.

p = maximum pressure lbs. per sq. in. allowing 12,500 lbs. tensile strength of cast iron and 10 as a factor of safety, with .03 in. for reboxing.

This would make the diameter of the circle for bolts equal to about 27½ in. and $.24 \times .7854 \times 100 = 45{,}240$ lbs.

Now if we would take the area of one bolt as equal to 1 sq. in., this would only require 9 bolts, which is not sufficient. Better to make bolts smaller, say 1 in. in dia., area of 1 in. = .7854 × 5000=3927 lbs., that can be carried by one stud.

Now 54240÷3927=12 studs required approximately.

Now as 27½ in. is the dia. of the stud circle, the pitch of studs will be $27.5 \times 3.1416 = 84.8 \div 12 = 7.06 + 1$n., circular pitch, not chordal pitch.

F. F. M.

Question 12.—The stays in a horizontal tubular boiler have an allowance of 6,000 lbs. per sq. in. If the segment to be stayed is 24 in. × 72 in. what is the dia. and the number of stays required?

Answer.—Now, 24 in.—2′=20 in. and 72—2′=68 in.

$$\text{Area of segment} = \frac{20,^3}{68 \times 2} = 58.8$$

and

$$\frac{68 \times 2 \times 20}{3} = 906.6$$

Total area 965.4 ins.

Area of segment to be supported is, therefore, 965.4 sq. inches.

Again we will have to assume some definite working pressure, this pressure will be governed by the weakest part of the boiler. Say 125 lbs. working pressure.

Now 965.4×125=110,675 lbs. to be supported. The number of stays at this 6,000 lbs. would be 110.675÷6000=18.3 stays of 1 sq. in. area, or say 18 stays. The diameter of the stay if made of round steel would be 1⅛ in. approx.

If stay is made of flat bar it must have the same sectional area and the "crow feet" to have the same sectional area as the body of stay after the rivet holes are drilled.

NOTE.—All of the above questions have been solved by the use of a "slide rule," so are only approximately correct.

F. F. McNEIL.

Readers' Queries

Question.—What horsepower should a Woolf reverse compound engine develop? High pressure cylinder, 7¼ in., low pressure 11 in. diameter, 10 in. stroke, 230 kw. per minute; 150 pounds boiler pressure. What would be the mean pressure in the high and low pressure cylinders? What back pressure would there be on the high pressure piston? How much more power would the same engine develop with 175 pounds boiler pressure?—S.A.P., Hillseby, Sask.

Answer.—You do not give the particular which is the most needed to answer this question, namely, the cut-off in the high pressure cylinder. You should also state whether the engine is tandem or cross. However, assuming your engine cuts off at ¼ stroke in the high pressure cylinder, and that there is a receiver between high and low, the answer would be: Initial pressure, say 140 lbs. at high pressure steam chest. If cut-off takes place at ¼ stroke, ratio of expansion is 1 to 4. Final pressure at release in high would be

$$140 \div 4 = 35 \text{ lbs.}$$

When the exhaust opens the pressure will drop to say 25 lbs. on entering receiver. This will be initial pressure on low pressure piston. As steam is admitted to low pressure cylinder this pressure will drop till admission is cut off, the amount of drop depending on the point of cut-off in the low pressure cylinder.

The amount of power developed in the engine depends entirely on the amount of steam admitted to the high pressure cylinder. The point of cut-off in the low merely alters the distribution of work in the two cylinders, for at whatever point admission to the low pressure ceases, the total weight of steam acting on the engine is the weight admitted to the high pressure at cut-off in that cylinder. If the cut-off in the low is early, more work will be done in the low, and less in the high, and vice versa. The ratio of the cylinders is in the proportion of $7\frac{1}{4}^2 : 11^2 = 1 : 2.3$. The cut-off in the high is at ¼ stroke. The total expansions are therefore $4 \times 2.3 = 9.2$. This would give a final pressure of about 15 lbs. at release in the low pressure cylinder.

These pressures will be lower in actual practice due to losses. So we have for the high pressure an initial pressure of 140 lbs., and a final pressure of 35, with a back pressure of say 25 lbs. This will give a mean pressure in the high of approximately 62 lbs. The initial pressure in the low will be the receiver pressure, 25 lbs. Final pressure, say 12 lbs., and back pressure about 2 lbs. Mean pressure, say 16 lbs. The M.E.P. referred to the low will be

$$\text{MEP of High} + \text{MEP of Low} = 62 + 16 =$$

$$\frac{\text{M.E.P. of High}}{\text{Ratio of H to L}} + \text{M.E.P. of low} =$$

$$\frac{62}{2.3} + 16 = 43 \text{ lbs.}$$

$$\text{H.P.} = \frac{43 \times 11 \times 11 \times .7854 \times 10 \times 2 \times 230}{12 \times 33{,}000} = 47.46$$

Your engine would be about 50 h.p.

Increasing the pressure to 175 lbs., keeping cut-off the same, would increase the power about as follows. The initial pressure at high becomes 165 lbs. Final pressure 41.25 lbs. Back pressure about 30 lbs.

In low initial pressure 30 lbs., final pressure 18 lbs., back pressure 3 lbs.

M.E.P. of High=73 lbs. M.E.P. of low 20 lbs.

$$\frac{73}{2.3} + 20 = 51 \text{ M.E.P. referred to low.}$$

$$\frac{51 \times 11 \times 11 \times .7854 \times 2 \times 10 \times 230}{33{,}000 \times 12} = 56.3$$

These calculations are necessarily approximate, but illustrate the methods employed. The only real determination is by the indicator.

WASTED FUEL IN FACTORIES

In most factories the ashes and waste from boiler and other furnaces, carrying a variable amount of usable fuel, is either taken to a common dump or is carted away without any attempt at recovering the useful parts, sifting even not often being done. In this way loss of fuel occurs, and it would seem that there is room for treatment of both factory and domestic fuel wastes. Probably a combination of dry and wet separation would give the best results, the material being graded and to some extent separated dry by means of revolving screws as in a coal washery, and afterwards separated in wet jigging or other machines so far as the heavy waste is concerned, the light stuff, metals and other material over, perhaps, rejections from a 2 inch mesh screen, being hand sorted. Fine stuff below that passing a ¼ inch mesh screen could also be left untreated, and the result of treating the grades between the ½ inch and 2 inch would be fuel and waste.—M. M.

J. Patterson, superintendent of works for the Shell-Bar Boico Supply Co., Ltd., Toronto, died on the 23rd of April. Mr. Patterson was extremely well known in engineering circles, and for the past four years had been works manager for the above firm.

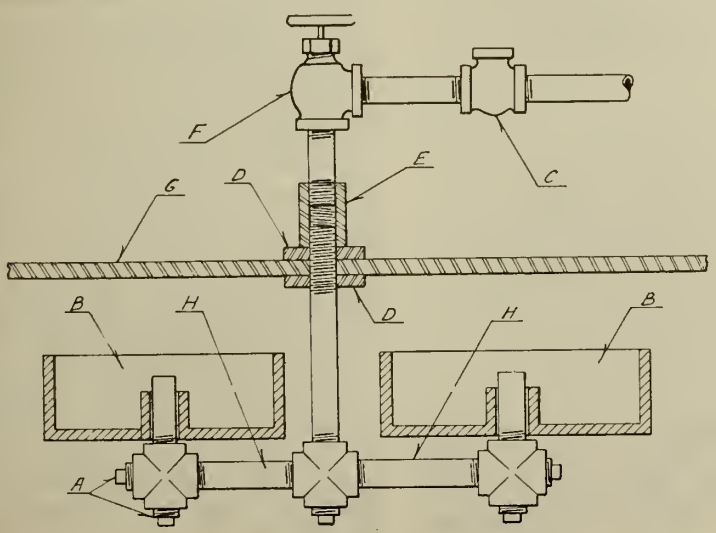
The American Steam Conveyor Corporation, Chicago, announce the appointment of N. B. Stewart as district representative in charge of their St. Louis territory. Offices have been opened at 708 Merchants LaClede Building, St. Louis, Missouri.

The Operators' Point of View

TOP FEED PIPE FOR DIRTY WATER

THE feed arrangement shown is an improvement over the scale box usually placed on top row of boiler tubes. Three cross ties are connected as shown with cleanout plugs, A, screwed in just tight enough to prevent them unscrewing by any slight vibration that may occur. Two short upright pieces of pipe are turned into the upper outlet of the end ties. The centre upright is connected to the top of the boiler shell with two locknuts, D D E. is a pipe coupling. F an angle valve and C a check valve. B B are two shallow cast iron boxes, with an opening in the centre as shown. These boxes can be made about 20 inches long, by 12 inches wide, by 5 inches high, for a boiler 60 in. x 16 in., or smaller. The pipe arrangement must be placed just low enough to allow the boxes to be lifted from the centre pieces. The pieces H H must be screwed in very tight, so that the weight of the boxes will not cause them to unscrew and allow the boxes to fall off.

The feed through the double pipes will be so slow that much of the dirt will settle in the boxes, which can be taken out and emptied at cleanout time. All the pipes should be full size. Boilers from 42 to 54 in. in diameter should have a feed pipe of 1½ inches; boilers 60 in. in diameter should be 2 inch. Of course pipes a size smaller than this will supply the water required so long as they are free of scale, but it sometimes proves a paying investment to use pipes a size larger than actually necessary. One objection which has been held against the scale box was placing it on top of the tubes. The scheme shown gets away from this.—J. E. NOBLE.



TOP FEED FOR DIRTY WATER.

SOME INTERESTING BELL CONNECTIONS

By R. S. WRIGHT

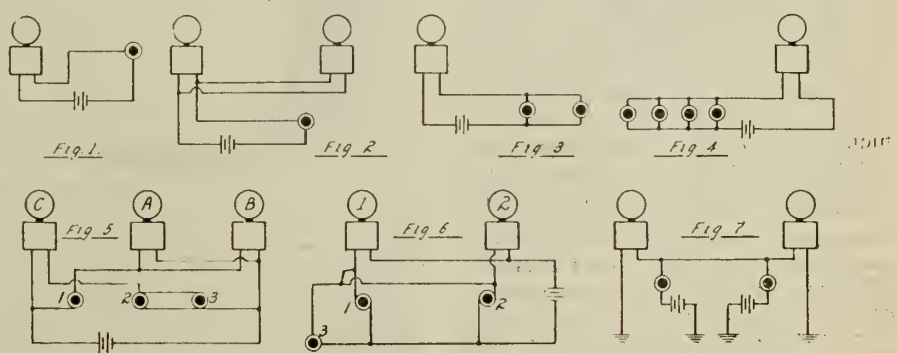
The method adopted for running the wires of bell circuits will depend upon the character of the installation, involving the complexity of the system. Fig. 1 shows a very simple bell circuit, composed of bell, single contact push button, and a battery. The circuit is closed by pressing the button, then the current will flow from the battery through the bell and push button, and back to the battery, causing the bell to ring as long as the button is pressed. This system is suitable for a front door bell.

Fig. 2 shows how an additional bell can be connected in parallel with the bell in Fig. 1. In this circuit both bells will ring when the button is pressed, the current dividing at the point where the bells are connected together.

In Fig. 3 two buttons are connected in parallel, and either will ring the bell. This circuit shows how the bell may be rung from either front or back door.

Fig. 4 shows four buttons connected in parallel either of which will ring the bell. The circuit is used when it is desired to ring the bell from four different points.

Fig. 5 is a combination of Figs. 2 and 3. Push-button No. 1 will ring bells A and B, which are connected in parallel. Buttons Nos. 2 and 3 are in parallel and either will ring bell C.



BELL CONNECTIONS.

Fig. 6 shows a circuit where one single contact and two double contact push buttons are used in connection with two bells in parallel. Double-contact push buttons are used for the purpose of saving wire. Without them, in a circuit, more wire would have to be used to get the same result. No. 1 button will ring No. 1 bell; No. 2 button will ring No. 2 bell, and No. 3 button will ring both bells in parallel.

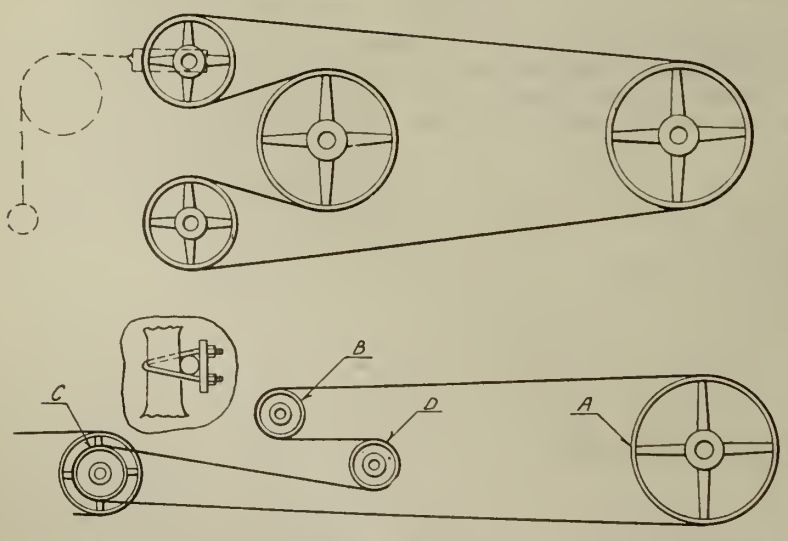
Fig. 7. This circuit shows a ground return. Any bell-circuit using a wire for the return is called a metallic circuit. Any circuit where the ground is used as a return is called a ground circuit. In general it makes no difference whether the positive or the negative pole of the battery connects with the bell or the push button, except where a ground return is used. In the latter case the negative pole should connect with the earth. Ground wires are usually connected to ground-plates, but it is very common to use a gas or water pipe where convenient as a ground return. It should always be remembered that the positive pole of the batery is at the top of the negative plate and the negative pole is at the top of the positive plate. For in-

stance, in the case of a Leclanche cell, or dry cell, the positive pole is at the top of the carbon (negative) element, and the negative pole is the top of the zinc (positive) element. In the case of a gravity Daniel cell the positive pole is at the top of the copper (negative) plate, and the negative pole is at the top of the zinc (positive) plate. Within the cell the electric current always flows from the positive plate to the negative plate, while in the external circuit the current always flows from the positive pole to the negative pole of the cell or battery.

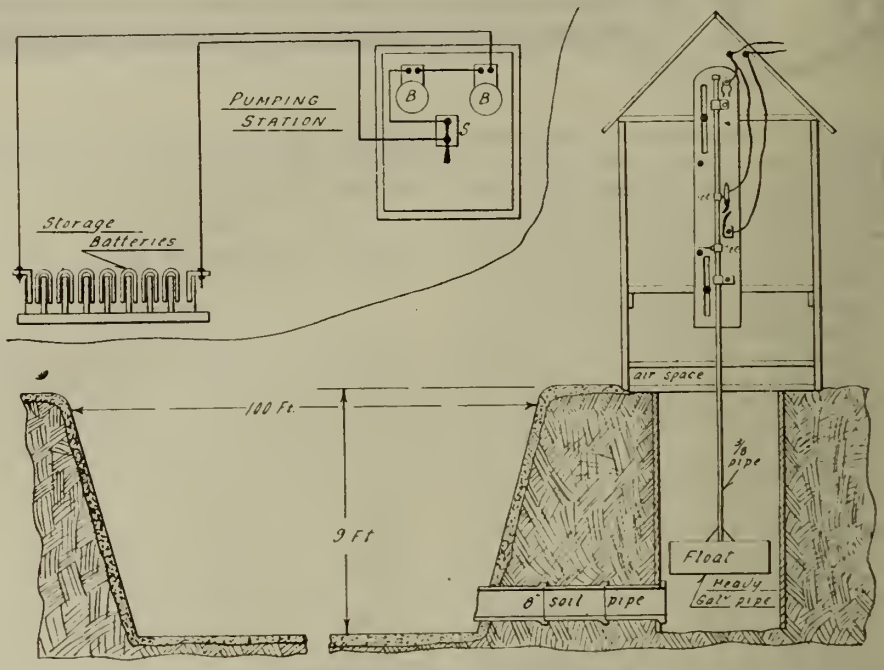
REVERSED BELT DRIVE

Some months ago a contributor to POWER HOUSE described a rather out of the ordinary type of belt drive, like that shown in Fig. 1. The advantages inherent in this type are (a) where reversal of rotation is desired this does not wear, chafe, or burn the belt as does a crossed belt drive, especially where there is a wide ratio between the diameters of the two pulleys used, and (b) when the shaft centres are not far apart and the load is considerable, in which case a short cross belt depreciates rapidly and is also hard on the bearings. The dotted lines in Fig. 1 indicate the possibility of using one of the idlers as a unique application of this drive as I once saw it used in a portable sawmill, and which is perhaps equally applicable to some other lines of work. By way of explanation I will mention that these plants are essentially ground floor installations, and that when an edger is used it is customarily driven from a pulley on arbor of the lumber saw. This arbor is some feet longer than that used in two story mills, or, when not itself longer, it is provided with an extension which gives the same result. The slab saw is customarily driven from an overhead line shaft, which in turn is driven from a second pulley on the engine crankshaft. By this method the slab saw table lies cross-wise of the mill. Sometimes a quarter-turn belt or a bevel gear or a bevel friction is inserted so as to enable the millwright to place the slab saw table lengthwise of the mill, thus making easier work for the slab saw man. In many instances no trimmers are installed. In this particular plant there was only one pulley on the engine crankshaft, and not enough remaining for a second one. Then, too, the overhead line shaft was too short for the customary drive unless a quarter-turn belt were used, which, however, would normally have required the second pulley on the crankshaft. Fig. 2 indicates the layout they finally adopted. A is the pulley normally used for driving the edger. B is the edger pulley. C is the slab saw line shaft pulley (this is the shaft which is normally placed overhead and driven from the crankshaft.) This was, in this instance, placed low down and the slab saw driven from it by a horizontal instead of a vertical belt. The slab table ran cross-wise of the mill. By means of twisted U clamps (see insert Fig. 2) the millwright clamped across the edger frame a piece of 1 15-16 shaft, about the length of the edger arbor, and on this he placed the loose pulley, D, held securely in place by a reliable collar on each side of it. By belting the pulleys as indicated (Fig. 2) he thus drove both B and C with the same belt, and avoided the necessity of crowding a second pulley onto the short crankshaft or substituting from the main saw arbor. The plan seemed to give entire satisfaction, though I thought that had the heaviest work been on C instead of on B there would have been some loss of power through D. Others did not all agree on that with me, yet in making similar drives in other types of plant this feature might be worth some consideration, and, if a dynameter or if electric drive were available for use, possibly some experiment could be made.

J. E. McCormack.



REVERSED BELT DRIVE.



ELECTRIC SIGNAL FOR RESERVOIR.

ELECTRIC SIGNAL FOR RESERVOIR

By G. D. Mills

About seven years ago I installed an electric signal for the town of Sussex, to tell the height of water in the reservoir. The pumping station is situated in the town and the reservoir is about a mile away on a side hill.

Before the installation of this signal it was necessary for me to walk up to the reservoir every other day. Sometimes I would find the water very low, which was bad for fire fighting, as may be imagined, and at other times it was running over, causing a waste of fuel.

The accompanying illustration shows a signal which I installed at the pumping station and reservoir. Before installing the signal I knew it would have to be of such a nature as would work in both winter and summer, as the committee would not sanction one for summer use only, the cost of the pole line being quite an item. It was neces-

sary then to figure out how one might be arranged to work with four or five feet of ice in the reservoir. At last the idea struck me, and telling the committee that it could be arranged to work all the year round, I readily obtained permission.

The accompanying sketch shows how the signal system was finally worked out. An eight-inch tile soil pipe lead into an upright shaft in which the float was placed. The float will carry 60 pounds without sinking. The contacts are made of brass and are quite long, so that there is splenty of spring to them. They have also a cutting edge for removing frost if any gathers. The plank carrying the fixtures is provided with slots so that it can be adjusted up and down. The contacts are arranged the same way. We generally keep the low-water mark about 26 inches below high-water level.

The tank which the building sets over is frost-proof so there is no ice to interfere with the operation of the float. First there is a plank floor and then a 10-inch air space, then second floor, then a layer of straw over that, and the building is well banked outside in winter.

Now you notice in the sketch that two vibrating bells are placed on the panel in the pumping station. The second one was installed in case the first should get out of commission.

The line running from the pumping station to the reservoir is a metallic circuit and having eight cells in the battery, which is charged up when charging the fire-alarm system.

This signal has been working for the last seven years and never gives any trouble. I have seen different electric signals for tanks and reservoirs, but none that would work where there is ice.

HARDNESS AND WEAR

Hardness is a metallic quality which practically defies definition; anyhow, recent attempts to define it are, to say the least of it, disappointing. Unusual cases of wear always provide interest to the engineer, and have a bearing on the subject; most often alteration in the material of one member provides a remedy.

In a milling machine of good U. S. A. type there was a worm and wheel meshing. A few days in service found trouble; examination showed that both worm and wheel had the tried and worn appearance as if abrasive had been used for lubricant, the teeth of the wheel were over one-third worn away and the worm itself scored.

The cause—steel worm and steel worm wheel both unhardened; the wheel was replaced by one of cast iron, and gave no subsequent trouble.

In another instance a hand-actuated toggle press of simple type to stretch pieces of solid drawn tube to a shape unobtainable commercially was designed; at all events, although quotations were invited in several likely quarters, none were received, the quantity was moderate, and probably would not pay for special tools and usual drawing methods. Whatever the reason, it was decided to have the job home-made, and a simple toggle drawing press was made up from available material. The screw was fixed at 1¾ in. diameter, for the reason that the shop possessed a pair of R. and L. square thread taps of that size, which were dug out from obscurity; and were a veritable find. The smith was commissioned to make two nuts and blank for threading, and no one gave a thought to material. The smith made screw blank nuts from the same steel bar. It took exactly twelve hours' work to produce fine steel powder, visible on screw and exterior of nut, and lubrication had no effect whatever, while turning the handle became a matter of horsepower. The job was dissembled, the screw cleaned up, and two gun-metal nuts obtained from a local foundry to a hastily made rough pattern. The job never gave trouble after, and the press used for occasional jobs has screw and nut threads in perfect condition after a lapse of years. The question of wear is not altogether one of hardness, M. steel and cast iron work perfectly together as a wearing surface, so also do the usual babbitt and bronze; but a mild steel shaft will not work with a mild steel bearing—try it and see. The shaft will cut and score, while if the pressure is considerable, as in a worm or pressure screw, the freezing qualities of the similar material in contact merely emphasizes the matter. Lubricant has literally no effect whatever; it is merely a vehicle to float away the disintegrated particles of steel as they are produced. Two pieces of steel glass, hard and perfectly polished, might slide for years, but such an instance is, to say the least of it, unusual in mechanical matter. Cast iron, as a wearing surface, is a puzzle. In engine cylinders, worn to a glassy surface, there are minute pin-holes, and a close examination shows that the harder points in the structure stand in relief. The essential beauty of cast iron as a wearing surface is the glaze or surface it acquires after running in under proper treatment. If from any cause the glazed surface, becomes abraded the cast iron wears with great rapidity, scores and cuts up in a remarkable manner. Whether the material actually has a surface flow and gets an increased skin tension analogous to that produced in a fluid when solvent substances are introduced it is impossible to say, although theories to explain the facts are numerous enough.

The glazing property of cast iron is not without drawbacks. Possibly the largest single surfaces exposed to running wear in cast iron are those in the reciprocating marine engine. Guides, slide valves and cylinder surfaces are all of considerable size, and the glazing is very marked. Cast iron is by no means the hardest of known substances, but its resistance to abrasive wear places it in the forefront of substances used by the engineer for wear resisting. This lends interest to the subject of hardness versus abrasion.

The glaze on cast iron after prolonged wear is extremely hard; in fact, on a large slide valve it can hardly be touched by a file under all the pressure a man can exert to make the implement bite.

When a large slide valve on a marine engine gets into this condition, efficient lubrication becomes difficult; at all events, there is a decided tendency for the valve to squeak, and the trembling of the eccentric rods show that it is difficult to propel. Usually high flash cylinder oil in quantity fed by a mechanical lubricator will not effect a cure. The only remedy is to break up the surface of the valve at the earliest opportunity, and every marine engineer is aware of the necessity and deplores the hard work involved. The breaking of the skin on the valve with coarse block files does the trick, while the seating is very rarely touched, except that at long intervals it becomes necessary to remachine both valve and coat. It appears, therefore, that under conditions of large area and considerable pressure with the temperature usual to steam practice, that the skin of machined cast iron undergoes a molecular change, beneficial up to a certain point and then detrimental to running. The same remarks apply to the large guide surfaces and crosshead slippers.

STATE CONTROL OF U. K. ELECTRIC SUPPLY RECOMMENDED

The Advisory Council to the British Ministry of Reconstruction have made a most important and far-reaching recommendation in regard to the nationalization of electrical supply and plant. The report of the chairman recommends:

1. That the electrical power should be generated on a national system.

2. That the operation of large generation stations be taken in hand at once.

3. That generating plant should be nationalized.

4. That distribution should be left in the hands of such of the present agencies as are efficient and progressive.

5. That an Electricity Board be formed, with six members of proved business experience.

The report states that while fully sensible of the necessity of limiting to the utmost extent any further capital commitments of the State, stress is laid upon the vital importance of a full development of electric power for productive purposes. It is pointed out that the development of such power in the United Kingdom is at the present in its infancy, and that high authorities have estimated the loss incurred by the nation through failure to take full advantage of electrical progress at not less than £100,000,000 a year. On the other hand, the capital invested in electrical generation (as distinct from distributing) plant in the United Kingdom does not apparently exceed £45,000,000.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$28 00	$.....
1¼ in.	32 00	.....
1½ in.	35 00	28 00
1¾ in.	35 00	28 00
2 in.	40 00	28 00
2¼ in.	43 00	30 00
2½ in.	45 00	35 00
3 in.	52 00	40 00
3¼ in.	.....	47 00
3½ in.	62 00	48 00
4 in.	70 00	60 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$5 50	$4 50
Tank plates, 3-16 in..	5 75	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard	**Lapweld**	
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill	list plus 5%
At warehouse	list plus 25%

Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$4 75
Steel bars, base, Toronto	5 00
Steel bars, 2" to 4" base	**6 00**
Iron bars, base, Montreal	4 55
Steel bars, base, Montreal	5 05
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 25	$ 6 25
Sheets, Black, No. 10.	5 25	5 25
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 85
Premier, 10¾ oz.	....	8 50

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	0 35
Solder, guaranteed	0 40
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	5 20
White lead, pure, cwt.	16 20
Red dry lead, 100-lb kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A.....list plus	20
Emery Cloth.....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 08
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon	1 80
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ¼ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless	0 55
Tubing, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add 40,	10
Cold pressed nuts to 1½ in.	add $4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper	17 25	19 00
Tin	60 00	58 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 50
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided	$0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

FAIRBANKS DIAL SCALES

No Loose Weights

No Calculations

The Dial indicates the gross or net weight directly.

This is but one of our many types. We can furnish a scale for any purpose.

WRITE FOR FULL PARTICULARS.

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POWER ALCOHOL

By M. M.

The subject of power alcohol is of great importance for two reasons: First, because the world is using the existing limited supply of mineral oils faster than their rate of production, and secondly, because the production of denatured alcohol is an important and profitable industry. The problem naturally falls into two parts: that of production and denaturation, and that of utilization. In Germany the potato is the chief source of the supply, and in 1913 some 70,000,000 gallons of alcohol (90 per cent. absolute) were distilled from potatoes 3,000,000 tons being used for the purpose out of a total crop of 50,000,000 tons grown on over 8,000,000 acres of land. The industry in that country owes its success in part to a bonus on alcohol used for other than beverage purposes (which is provided by a tax levied on the latter) and in part to efficient co-operation between the farm, distillery, and market. In France the chief raw material is beet. In 1912, 18,000,000 gallons of denatured spirit were produced, but the industry was handicapped by the onerous regulations governing the denaturation. These regulations made the spirit expensive and unsuitable for the lighting and internal-combustion engines. Apparently they have been withdrawn since the war began, and it is the intention of the French Government to make alcohol a cheap national motor fuel. Even in the U.S.A. steps are being taken to develop the alcohol industry; in the United Kingdom it hardly exists. In 1914 only 7.7 million gallons of denatured spirit were manufactured, and there is no record that any of it was used for light, heat, or power. In 1915 Great Britain imported 120,000,000 gallons of petrol, and the equivalent quantity of alcohol might easily have been produced in Great Britain. Five million tons of potatoes only would be necessary, and 600,000 acres properly cultivated to yield 12 tons per acre would have provided the crop for food and for alcohol. Beet could be grown instead if it were desirable. The Australian committee has gone very completely into all the possible sources of alcohol in that continent and concludes that while potatoes would be too expensive, large crops of Sorghum (S. saccharatum) could probably be grown yielding 100 to 180 gallons per acre, while Cassava, which gives a higher yield, might be equally suitable. Synthetic alcohol is possible, and one process is being worked successfully by a Swiss hydro-electric company, which is able to sell pure spirit at 1s. 8d. per imperial gallon.

On the Continent the price of the spirit compares favorably with coal, gas and oil, so that it is used for domestic purposes in addition to its use in various industrial operations. For power purposes a special engine is required if the best results are to be obtained, though petrol engines can be adopted on alcohol as was demonstrated in Germany early in the war, when the Russians had overrun Galicia and a shortage of petrol was threatening disaster to the German transport service. With petrol at 40.5d. per gallon and alcohol at 30d., the cost per horse power hour is the same using the same engine, and assuming that with petrol it has a thermal efficiency of 20 per cent., while when altered for alcohol it has an efficiency of 22.5 per cent. Specially-designed alcohol engines will give 30 per cent. or more with a corresponding decrease in fuel cost. The increased thermal efficiency is due to the increased compressions (as high as 180 to 200 pounds per square inch) which can be employed without danger of pre-ignition. With petrol, 80 pounds per square inch is about the limit. After the war petrol will hardly go below 2s. per gallon, which is about the pre-war cost of alcohol, but it is quite clear that alcohol could be sold at a much lower price than this if the industry was handled sympathetically and not overburdened by excise restrictions. The advantage of alcohol as a fuel as compared with petrol are: (a) smoother running; (b) absence of carbonization; (c) absence of unpleasant exhaust; (d) greater safety from fire owing to its miscibility with water. On the other hand it is not suitable for high-speed engines, and will not start from the cold, so that either an auxillary petrol tank and carburetor are required, or some heating device must be used. During the transition stage from petrol to alcohol it may be desirable to overcome the difficulty by mixing alcohol with some other liquid fuel such as benzine or sulphuric ether. This would both overcome the difficulty in starting from the cold and also enable existing engines to be used without alteration.

SEAY REFRIGERATION SYSTEM

In describing the Seay ammonia absorption refrigerating plant to the Liverpool Engineering Society, Mr. B. Rathmell said that it had been proved capable of making 25 tons of ice per ton of coal burned, with an estimated evaporation of 9 lb. of steam per pound of coal. In this system of refrigeration the absorbing medium used is ammonium nitrate, normally a crystalline salt. In absorbing ammonia it changes into a sticky viscous liquid form. It is stated that 3 lbs. of this salt absorbs 1 lb. of pure ammonia. Thus, in the absorber the salt takes up ammonia gas, as it comes from a refrigerator or ice-making tank at low pressure and temperature, the crystalline salt changing into thick liquid form. In the generator this liquid is heated by steam coils until the ammonia is driven off again into an ammonia condenser of any ordinary type: the salt reverting to its solid form in the process. In connection with the generator it is claimed that much economy in heating is obtainable over what can be secured in the older water and ammonia absorption plant. This is because the change of state of the salt from liquid to solid form liberates its latent heat of liquefaction, which goes towards the heat required for vaporizing the ammonia; and thus of the, approximately, 520 b.t.u.'s required to vaporize each pound of ammonia only about 200 b.t.u.'s have to be provided by the steam heating coils.—The Engineer.

ADMISSION OF AIR

To guard against the escape, unburned, of carbon monoxide gas, and of the tarry matters that are distilled off from the coal it is desirable to admit an extra supply of air, just after fresh coal has been thrown into the furnace, and also when the fires are thicker than usual. For this purpose the fire doors are usually provided with draft registers, and these should be well regulated at all times. The amount of air that enters the furnace in this way is not sufficient to take care of any considerable quantity of freshly-fired coal, however, and it is therefore desirable to keep the fire doors themselves open by a small amount while the first part of the fresh coal is burning off, unless the furnace is designed so that the requisite air can be introduced in some better way. It is usually sufficient to "crack" the doors, as the firemen call it,—that is, to leave them open by a crack. Care should be taken to avoid the admission of too great a quantity of air in this way. When the fire doors are left open to any great extent and for any considerable time, there is danger of the boiler becoming locally chilled sufficiently to start cracks or checks in it, this action being especially notable along the first girth joint of a horizontal tubular boiler, back of the fire door. Having these facts in mind, the fireman should be careful not to "crack" the doors too far, nor to leave them wide open any longer than may be necessary, when he is firing.

It is not scientifically correct to admit cold air through the fire doors, but they are very generally used for this purpose, because in most of the boiler plants of the United States no other means of admission is provided. It would be best for the air to enter the furnace through the fuel-bed, under all circumstances; but as there are times when a sufficient amount cannot be had in this way, it is necessary to consider what mode of admission is most advisable for the supplementary supply. Of the various methods that have been tried or proposed, admission at the bridge wall is by far the best, when the setting is properly designed with this in view. The bridge wall should be hollow, with a space, about half as wide as the length of a fire-brick, running through it from one side of the furnace to the other. Fire-bricks should be laid over this space to form the top of the bridge wall, the bricks being set on edge, with their lengths parallel to the length of the furnace; a clear interval about one-quarter of an inch wide being left between each brick and its neighbors, for the exit of the air. Ducts through the brickwork of the setting convey the air to the bridge wall, and dampers are placed in these ducts so that the supply can be regulated at will. Cleaning doors are also provided, for removing the fine dust that accumulates in the air passages. Air admitted in this way cannot chill the boiler, and it is much more effective in promoting combustion than it would be if admitted through the fire doors.

SOME BOILER TROUBLES, THEIR ORIGIN, PREVENTION AND REMEDY

(Continued from page 186)

grains sulphate, the remainder being silica, iron, etc.

The treatment required is as follows: 6 grains carbonate require 1½ ozs. caustic per 1,000 gallons.

$6 \times 1\frac{1}{2} \times 4 = 36$ ozs. caustic.

This will also precipitate 8.16 grains sulphate:

16.32 — 8.16 = 8.16 grains sulphate remaining

$8.16 \times 1.75 \times 4 = 57.12$ ozs. carbonate

That is, 36 ozs. of caustic soda + 57.12 ozs. carbonate of soda, will precipitate the solid matter.

The repair of a bulged or bagged plate will depend on the extent of the injury. Usually it will require the injured part to be cut out and a patch fitted. In some cases if the injury is not severe the boiler can be continued in service with a slight reduction of pressure. Sometimes the plate can be warmed and jacked up into place. This latter method should be done only when the bulge is very slight. When the bulge is deep, but of small diameter, the piece can be cut out and an oval patch fitted on the inside of the boiler. This will necessitate removing some tubes, but this is inevitable. The patch should always be fitted on the inside of the shell, otherwise a pocket is formed for the trapping of more scale and a repetition of the trouble. The rivets on the fire side should be finished off with fairly flat heads, the holes being countersunk. This will save the rivet heads from being burnt by the fire. If the patch needed is very large, one thing should be carefully guarded against; this is, the tendency of boilermakers to fit a square patch with single rivets. If a square patch must be used it should have its longitudinal seams of the same or nearly the same percentage of strength as the other longitudinal seams in the boiler. After the patch is made, the working pressure of the boiler should, strictly speaking, be calculated on the percentage of strength of the weakest point. I have seen a boiler with an 84 per cent. longitudinal joint repaired with a patch, the longitudinal seam of which was 56 per cent. The most satisfactory patch is the elliptical one, by means of which the original strength of the joint can be retained while using only one row of rivets. This is because the seam lies between a circumferential and longitudinal seam, really being a helical seam. If the bulge is say, not more than an inch deep at its extreme depth, and of fairly even proportions, in which case one can be reasonably sure that the metal has not been drawn to any great extent, a reduction of pressure can be made and the boiler allowed to run. The reduction of pressure will be ascertained by calculating the boiler as being of a diameter equal to the original diameter plus twice the depth of bulge, and making a deduction in the thickness of plate. It is a matter of judgment for an experienced man.

In the case of firebox boilers overheating is more likely to result in cracks than bulges, owing to the staybolts holding the plate up. If a good man is available with an electric welding outfit, repairs can be well and cheaply made, otherwise a patch is necessary, and soft patches can be applied temporarily. In Scotch marine boilers the danger is a collapsed furnace tube or combustion chamber crown. The furnace, if not very badly collapsed, can be jacked up and the combustion chamber crown can be drawn up if not too far gone.

The electric welding apparatus in the hands of a skilful operator is a great help in boiler repairs. Cracked tube plates, leaky seams, wasted plates, burnt door dogs, all can be repaired or built up by this process. Staybolt ends that have been burnt off can be rebuilt in place and cracked furnaces repaired. It has saved many boilers from expensive repairs or being scrapped, and is perfectly reliable if used by a skilful operator.

This article has attempted to point out some of the more frequent causes of trouble, where to locate and how to prevent and remedy them. It may be a help to many engineers in Ontario who now have the privilege of acting as boiler inspectors. It does not profess to touch on everything pertaining to the subject, and in fact only mentions the types of boilers in general use in Canada.

To do more would be impossible in the space available. What has been done the writer hopes will be of interest and use to boiler operators.

GAS FIRING FOR BOILERS

By M. M.

It has for a long time been levelled against electrical engineers that in their use of fuel for generating purposes they waste the whole of the by-products. This question has now, on account of the present-day necessity for conserving all our resources, become of great importance. The most careful conservation is especially desirable when dealing with coal, since the by-products which would be obtained were another system of combustion adopted, include a large number of chemicals that are either very scarce or very urgently needed. Among the former are dyes and chemicals, such as drugs and photographic developers, while among the latter are substances essential for the manufacture of explosives. It appears to be agreed by all generating engineers that the gas-engine is no longer an alternative for the operation of large dynamos; modern practise in power supply points to the use of steam turbo-alternators up to 50,000 or even 100,000 kw.

Hitherto gas firing has not quite achieved financial success. This is fortunately not due to any inherent defect in the system itself. Being a new process this method of using the coal is merely at an early stage of its development, and has not, for this reason, evoked sufficient confidence to be adopted to any extent in practise. When the crit-

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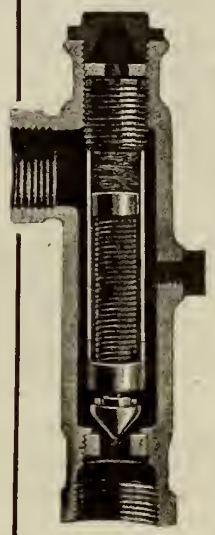

can be used anywhere in a line and for any given pressure from 0 to 200 lbs. It is cheap because it is made on the right principle. A bucket or float trap costs more because it has to store water to operate it and is therefore big and cumbersome. A return trap also has to have storage capacity and it usurps poorly the functions of a steam pump. It is not more efficiency you pay cash for, but weight and complications.

Worse still, when you conduct steam lines long distances to a big trap, you waste steam constantly in your returns.

Put a Steam Trap SARCO on every machine and at every point that needs trapping and have nothing but condensation in the return. That means efficiency; that means steam saved. Remember, the SARCO is made in all sizes from ⅜ in. to 3 in. and is as efficient for high pressure as for low.

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ical point has been reached at which a novelty is made at least as economically as existing methods, improvement is accustomed to take place rapidly. In the case of gas firing, there are two causes which are at present keeping its efficiency down. The first of these is due to the boiler itself, which, as everyone knows, is an old piece of apparatus being now used in a new way. All its dimensions and its design generally have been decided upon and standardized for the old set of conditions. For example, the diameter and length have been fixed after long experience as the best for coal firing. The circulation of water inside the boiler, which is satisfactory under present circumstances, is interfered with when the intense local heat of the furnace is replaced by a more distributed system. All these points will have to be considered before the full benefit is derived from the new method of firing. The second cause is the need of experiment with regard to the conditions under which the gas flame is produced. This is quite a new problem, and many different arrangements will have to be tried and modified before the best design is arrived at. When this is the case it will, in all probability, be found that a new era has begun for the production of electricity, and a great step has been made in the direction of national economy.

In addition to the advantages given below, the way will be thrown open to the utilization of waste products which are unfitted for direct combustion in the firebox. There seems to be no reason why such waste materials as small timber should not be gasified and their calorific value made use of in power production.

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One of the chief characteristics of the Johns-Manville organization is the unfailing tendency to develop and expand.

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The latest Johns-Manville manager compelled to seek larger office quarters to take care of past and future growth, is Louis H. Inglee, of the Denver office.

On April 15 Mr. Inglee moved from the Denver Gas and Electric building, into splendid new quarters in one of Denver's most desirable business sections, the Iron building, 1021 17th St.

Mr. Inglee will continue to be supported by an efficient sales force, trained in the best traditions of Johns-Manville service and satisfaction.

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The General Industrial Catalogue of TYCOS Instruments containing 422 pages of useful and interesting temperature information is now ready for distribution. This new publication describes the whole line of TYCOS instruments for the indicating, recording and control of temperature. Many special applications are illustrated, showing the manner in which TYCOS instruments can be adapted to diverse temperature needs. Practically every instrument manufactured by the Taylor Instrument Companies for industrial purposes is illustrated and much explanatory matter descriptive of their construction and principles of operation is given. The list includes thermometers of every description, index and recording thermometers. hydrometers, pyrometers, temperature and pressure regulators, barometers, absolute pressure and draft gauges. It is a handsome publication, well bound, printed on paper of excellent quality.

The Link-Belt Company, Chicago, Ill., have issued a bulletin number 220, descriptive of the Peck Over-lapping Pivoted Pocket Carrier for the economical and efficient carrying of coal, coke, ashes, cement, sand, ore, stone, and other materials.

Engberg's Electric and Mechanical Works, St. Joseph, Mich., have issued a catalogue descriptive of the Engberg direct current generating set, which is made in capacities of from one to fifty kw. This publication is an excellent example of commercial printing and furnishes an unusually complete description of the generating set manufactured by this firm.

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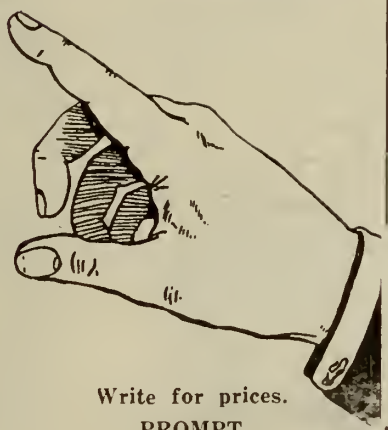

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BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G. MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
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How a "Cole" Return Trap

IS YOUR RETURN SYSTEM

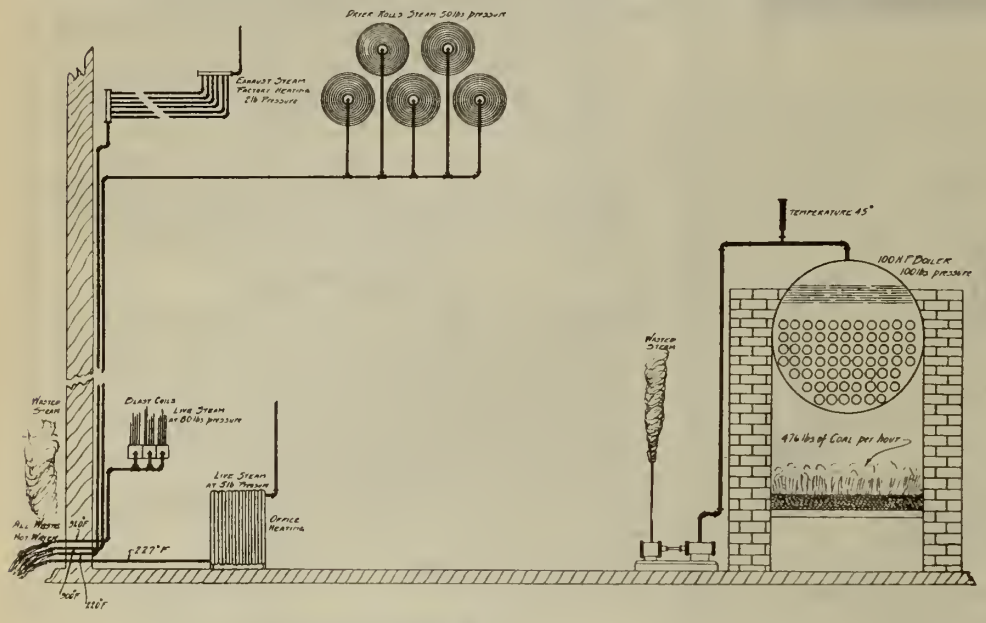
Dryer Rolls Steam 50 lbs pressure
Exhaust Steam Factory Heating 2 lb Pressure
Temperature 45°
100 H.P. Boiler 100 lbs pressure
Waste Steam
Blast Coils Live Steam at 80 lbs pressure
Live Steam at 5 lb Pressure
Office Heating
476 lbs of Coal per hour
220°F
227°F

Diagram No. 1

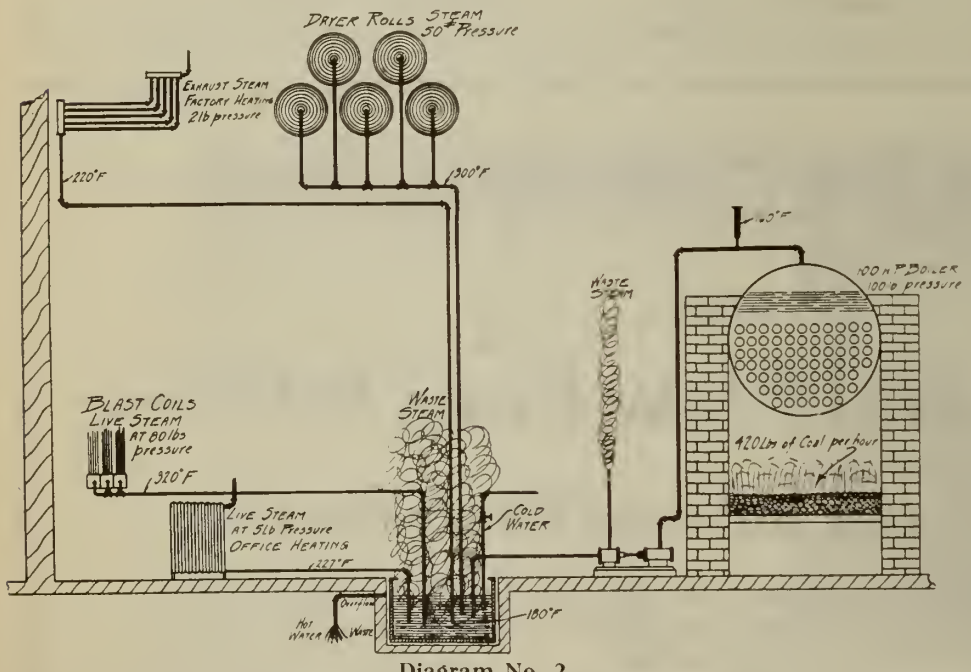

Diagram No. 2

Do you want any information on the subject of CONDENSATION HANDLING IN RELATION TO FUEL ECONOMY? Do you want to make your plant MORE EFFICIENT? Do you want to Cut expenses in your Steam plant? SAVE FUEL?

If you Want INFORMATION, write for our Bulletins. You will find them interesting.

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Every Steam line condenses SOME part of Steam which it conveys.

Every square foot of heating surface condenses MORE Steam.

Steam to be efficient in Service must be DRY and HOT. Wet Steam is NOT Hot Steam. It can't do the work you want.

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YOU KNOW THIS—You're on to your job—You Cover your Steam lines—You Dry your Steam—You Drain your lines—You Induce Circulation. O.K. THAT'S FINE. BUT What do you do with the Condensation or water which you take out of the lines and heating surfaces?

Do you treat it. as of "No further Use"? Throw it away? Like *Diagram No. 1.*

Do you drain it into a "so-called" Hot well? Cool it down so the Pump will handle it? Like *Diagram No. 2.*

Do you do better? Pass it through an "alleged" Water Heater. Cool it down again. Draw live steam from the boilers to pump the COOLED condensation (or water) into the HOT Boilers. using two Pumps to do it. Like *Diagram No. 3.*

Just mention what you are interested in.

"Boiler Feed Problems."
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System Saves Your Fuel

ILLUSTRATED HERE ?

OR, do you drain the water from the lines and heating surfaces, and dump it straight where it belongs? Under its own power, there to make more steam. HOT WATER INTO HOT BOILERS. Like *Diagram No. 4.*

The average feed water heater temperatures range between 180 and 200° F., or, 12 to 32° BELOW ATMOSPHERIC BOILING POINT. YOU KNOW THIS.

Water drained from steam lines, and heating surfaces may be as hot as 220° to 350° in ordinary steam plants, depending on the pressure.

ANYWHERE FROM 8 to 108° ABOVE BOILING POINT AT ATMOSPHERIC PRESSURE.

YOU KNOW THIS ALSO.

NOW, CAN YOU HEAT YOUR RETURN WATER UNDER THESE CONDITIONS? OR, DO YOU COOL THE CONDENSATE DOWN?

Condensation is HOT WATER (H-O-T) 220 to 350 degrees temperature. HOT Water saves FUEL. YOU KNOW THIS. WE WON'T ARGUE THIS STATEMENT.

If your Return lines are handled like sketch No. 4, we can't help you any, in handling condensation. BUT, if your Return lines are handled in any other way, we CAN help you.

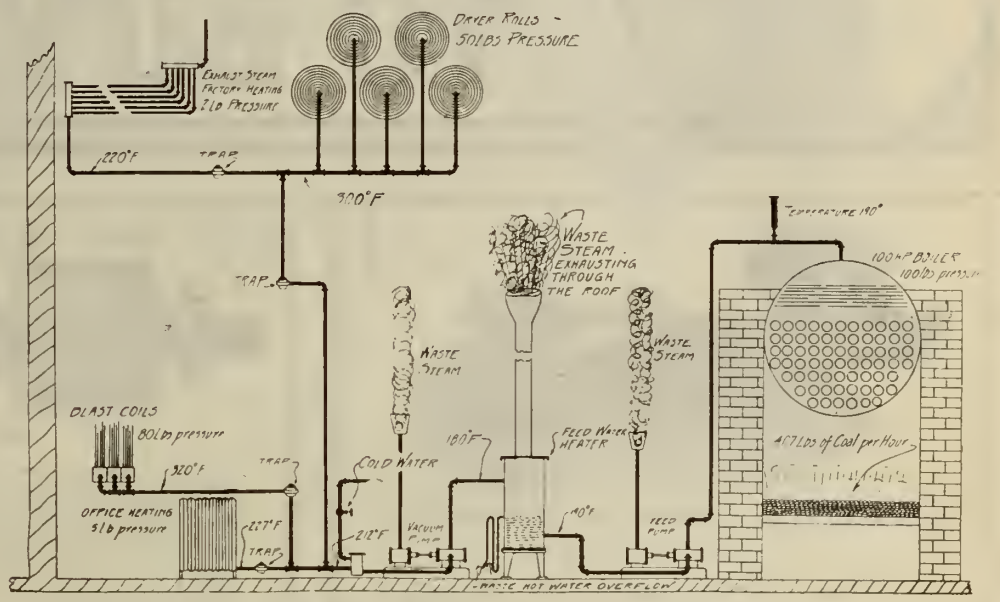

Diagram No. 3

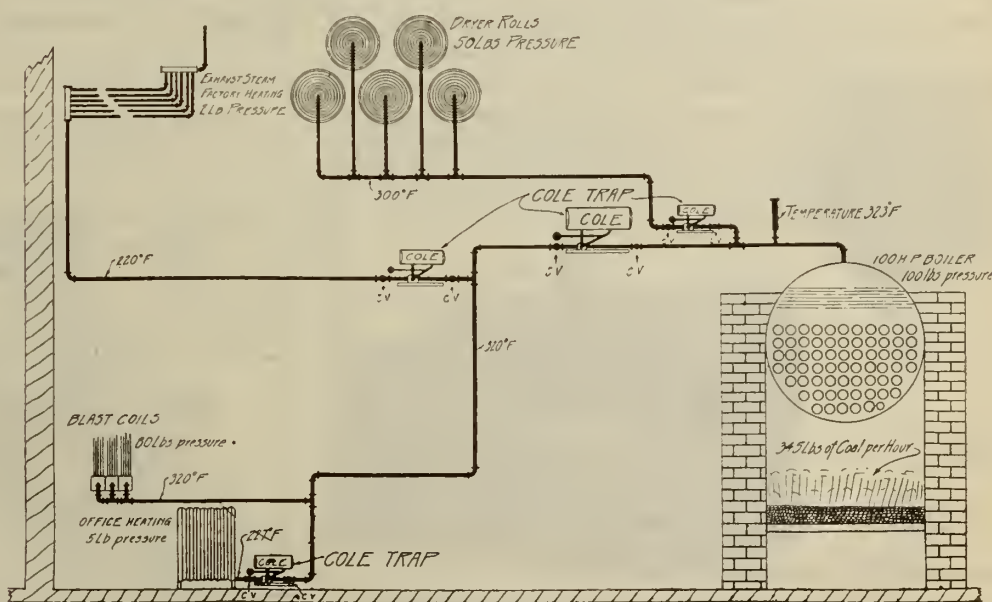

Diagram No. 4

This is the "COLE" Return Trap

In a class by itself. OK'ed by the Provincial Boiler Inspection Department.

BUILT FOR STRENGTH AND SERVICE

Examine the Grates in the four diagrams and estimate how much Fuel the "COLE" Return Trap will *save you.*

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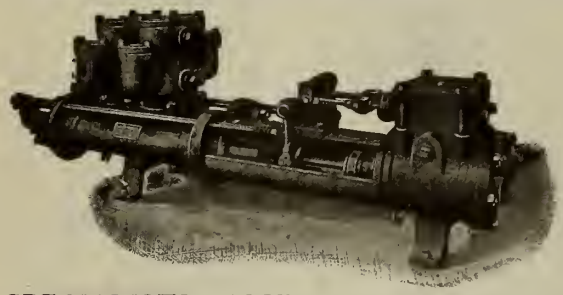

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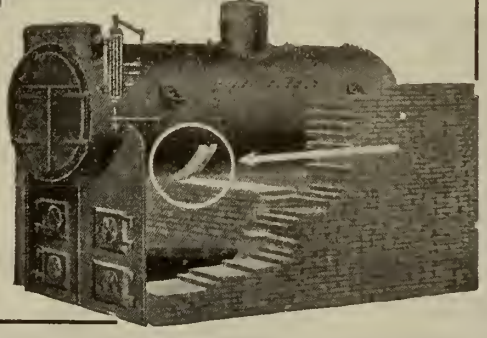
If your Boiler is not Fire-cracked it eventually will be. Prevent this by putting on a National Boiler Protector. You will save cost in repairs and prolong life of the boiler. All new boilers should be protected. If your girth seam is giving you trouble at the present time, have the seam caulked up, attach one of these protectors and the seam will remain absolutely dry thereafter.



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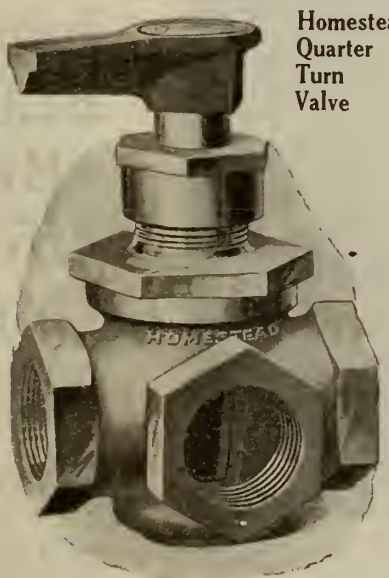

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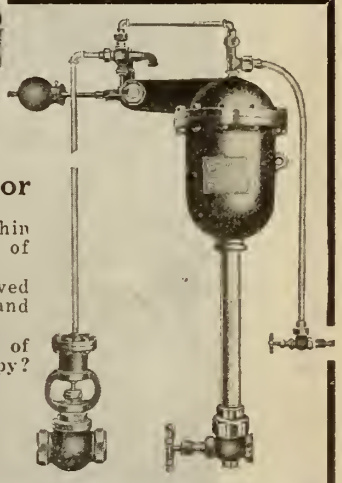

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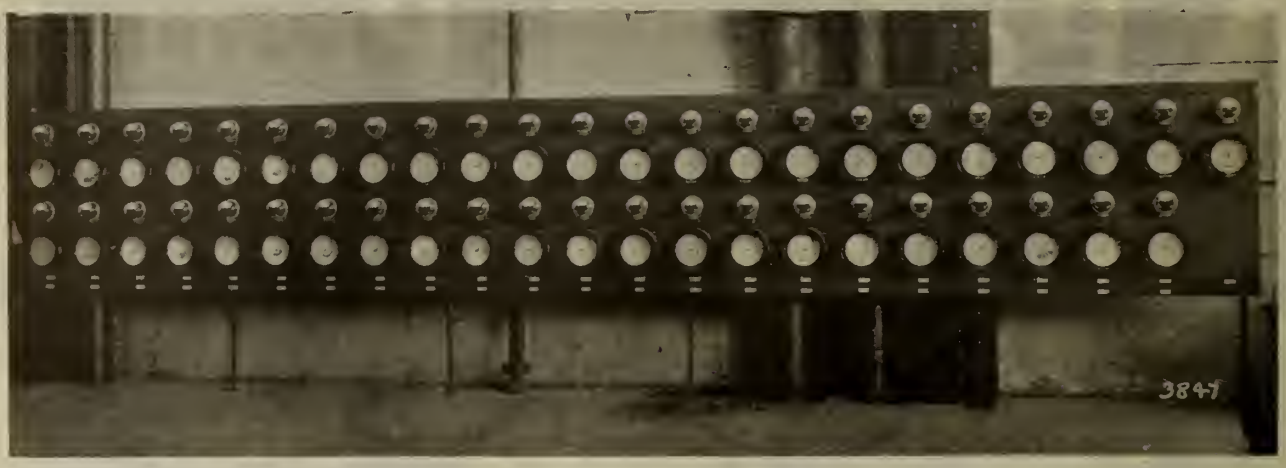

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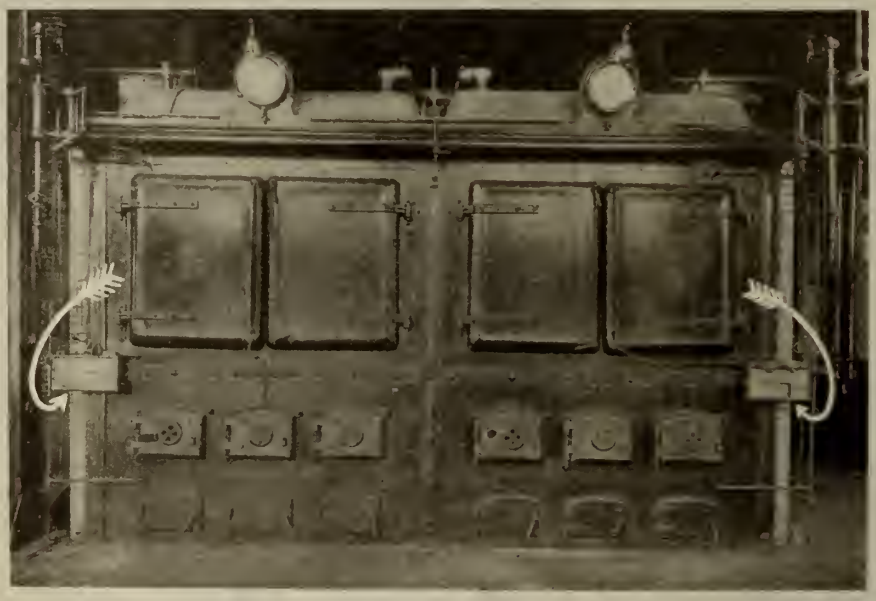

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BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. Consol. Rubber Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Vorhees Rubber Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, WOVEN COTTON
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. I. Philip & Sons, Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Metlskin Mfg. Co., Rochester, N.Y.
Shell Bar. Boico Supply, Ltd., Toronto, Ont.

BOILER SKIMMERS
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.

BOILER COMPOUND FEEDERS
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Can. Morehead Mfg. Co., Woodstock.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Coppus Eng. & Equipment Co., Worcester, Mass.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
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Darling Brothers, Ltd., Montreal, Que.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

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Metlskin Co., Inc., Rochester, N.Y.

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Lunkenheimer Co., Cincinnati, O.
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FEED WATER PURIFIERS
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Yarnall-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburgh, Pa.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Green's Economizer, Ltd., Toronto.
Laurie & Lamb, Montreal.
E. I. Philip & Sons, Toronto.

FIBRE, VULCANIZED
Beveridge Paper Co., Montreal, Que.

FILTERS
Bowser & Co., Inc., S. F., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

FILTERS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que,
E. I. Philip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittsburgh , Pa.
York Mfg. Co., York, Po.

FILLING STATION EQUIPMENT
The Mason Regulator & Eng. Co., Ltd., Montreal.
Bowser & Co., Inc., S. F., Toronto. Ont.

FILTERING AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

FIREBRICK—JOINTLESS
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FIRE BRICK
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates, John W., St. James St., Montreal.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

FLUE GAS COLLECTORS
The Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

FLUE GAS ANALYSIS INSTRUMENTS
Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL OIL SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, BOILER
Gates, J. W., Montreal, P.Q.
Green's Economiser, Ltd., Toronto.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE GRATE BARS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.
E. I. Philip & Sons, Toronto.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal, Que.
Shell Bar Boico Supply Co., Toronto, Ont.
Sarco Co., Inc., New York, N.Y.

GAS ANALZERS CO-2
The Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GASOLINE METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

GASOLINE PUMPS, SELF MEASURING
Bowser & Co., Inc., S. F., Toronto, Ont.

GASOLINE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Imperial Oil, Ltd., Toronto.

GAUGE COCKS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

GAUGE, RECORDING
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

GEARS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
Morse Chain Co., Ithaca, N.Y.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont
Goldie & McCulloch Co., Galt.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
The Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

HANGERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, STEAM, SUCTION AND WATER
Canadian Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Vorhees Rubber Co., Ltd., Montreal.

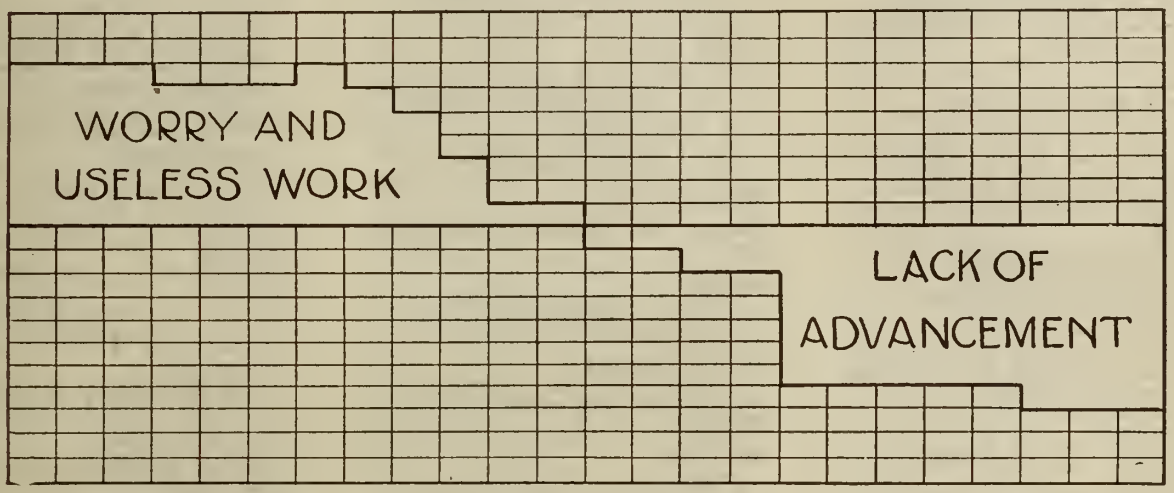
HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

MacGovern & Co., Inc., Montreal, Que.

HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.

HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.

INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, England.

KEROSENE PUMPS (SELF MEASURING)
Bowser & Co., Inc., S. F., Toronto, Ont.

KEROSENE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Ciocinnati, O.
Penberthy Injector Co., Windsor Ont.
Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. I. Philip & Sons, Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. I. Philip & Sons, Toronto.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. I. Philip & Sons, Toronto.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. I. Philip & Sons, Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
Bowser & Co., Inc., S. F., Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Ciocinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Ciocinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

OVERALLS
R. G. Loog & Co., Torooto, Ont.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durahla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesharre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Vorhees Rubber Co., Ltd., Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd, Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppua Eng. & Equipment Co., Worcester, Mass.
PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Qne.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
RAGS
Shell Bar Boico Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
RECLAIMING SYSTEMS FOR OIL
Bowser & Co., Inc., S. F., Toronto, Ont.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
REGISTERING MEASURES
Bowser & Co., Inc., S. F., Toronto, Ont.
RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.
RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.
REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.
REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.
ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
SELF-MEASURING PUMPS (OIL AND GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.
SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.
SMELTER LININGS
Beveridge Paper Co., Montreal, Que.
SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.
SPROCKETS, COMPENSATING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.

Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Can. Morehead Mfg. Co., Woodstock.
Mason Regulator & Engineering Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Bowser & Co., Inc., S. F., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.,
Mackinnon Steel Co., Ltd., Sherbrooke, Que,
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS (UNDERGROUND STORAGE)
Bowser & Co., Inc., S. F., Toronto, Ont.

TANKS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wateroua Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Inatrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

TRAPS, STEAM AND WATER-LINE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Montreal.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.

TUNGSTEN LAMP (Vacuum and Gas Filled Types)
Penherthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Engineering and Machine Works of Canada, Ltd.,
St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Engr. & Equip. Co., Worcester, Mass.
Escher Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Canadian Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNDERGROUND TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.

UNLOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VACUUM GOVERNORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Canadian Steam Boiler Equipment Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

VACUUM REGULATING VALVES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VACUUM TRAPS
Darling Brothers, Ltd., Montreal, Que.
Can. Morehead Mfg. Co., Woodstock, Ont.
Cole, Ltd., Geo. W., Toronto.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Vorhees Rubber Co., Ltd., Montreal, Que.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Darling Brothers, Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penherthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.

AIR VALVES
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Engineering Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, BRASS
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Penherthy Injector Co., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa

VALVE CHAIN WHEEL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

VALVES, FOOT
Shell Bar Boico Supply, Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penherthy Injector Co., Windsor, Ont.

VALES, HYDRAULIC
Yarnall-Waring Co., Philadelphia, Pa

VALVES, MULTIPORT
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP
Canadian Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RELIEF
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston Mass.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, REDUCING
The Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

VALVES, STANDARD, GLOBE ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Penherthy Injector Co., Windsor, Ont.

VALVES, POP
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VALVES, SAFETY THROTTLE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, O.

VALVES, STEAM
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

WASTE
Shell Bar Boico Supply, Ltd., Toronto.

WATER COLUMNS, GAGES
Darling Brothers, Ltd., Montreal, Que.
Jas. Morrison Brass Mfg. Co., Toronto.

WATER GAUGES, STANDARD, EXTRA HEAVY AND AUTOMATIC
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WATER SOFTENING SYSTEMS
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WATER HEATERS AND WHISTLES
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Will resist all Steam Pressure and Variations of Temperature.

REFLEX GAUGE GLASSES

Annealed and Hardened for
LOCOMOTIVES, STEAM WAGONS, MARINE AND STATIONARY BOILERS.

Adamite Gauge Glass Rings. Glass Tubes and Rods

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FOR REMOVING SCALE

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'SKATOSKALO'
Pneumatic Tube-Scaling Tool.

Simple, strong, speedy, reliable---these words describe its efficiency

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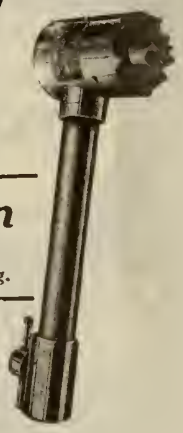

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(SOLE MAKER)
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FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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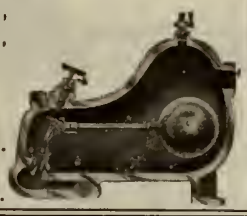

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WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

Keep the Heat Where It Belongs

PLIBRICO keeps the heat in the furnace, because it forms a jointless one-piece lining in your front door arches, entire fronts, side walls, arches, bridge walls, etc. This lining is gas and airtight, saves fuel while at the same time greatly reduces your furnace upkeep, will last longer, give better satisfaction and can be more easily repaired than a lining constructed of fire brick and fire clay.

Write for free copy of 36-page book of useful information on furnace building & maintenance

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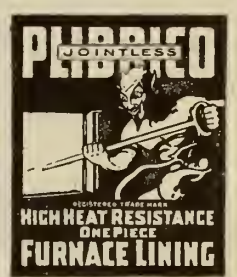

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Stand first in temperature problems, having won their superior position by painstaking and exact service in innumerable industrial applications. They do their work well, perform every duty demanded of them in temperature problems efficiently. The large number of satisfied users is ample indication of the confidence modern industry has in Tycos products.
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ST. JOHN, N.B. TORONTO, ONT. WINNIPEG VANCOUVER

Canada's Leading Machinery House

Are You An Engineer?

One of the most prominent Engineering Authorities once wrote: "A very important part of an Engineer's training is to know:

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WHAT He Wants
WHEN He Wants It."

Do *YOU* know *WHERE* to get *WHAT* you want?

Do *YOU* know that *"WILLIAMS"* have *IN STOCK STEAM ENGINES, ALL SIZES*, 1 to 1000 horse power?

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Do *YOU* know that "Williams" have *"IN STOCK" A SERVICE DEPARTMENT* giving competent, unbiased engineering advice?

Do *YOU* know that "Williams" have *"IN STOCK"* The largest line of *POWER PLANT SUPPLIES* in Canada?

Now we've told you *WHERE* to get it. Won't you tell us *WHAT* you want?

WRITE OR PHONE POWER PLANT DEPARTMENT

THE A. R. WILLIAMS MACHINERY CO., Limited

TORONTO, ONTARIO

REDUCING VALVE PERFECTION

J.M.T.

JAMES MORRISON TORONTO

It makes no difference how the initial pressure varies, this reducing valve will keep the low pressure constant.

It is the ultimate valve—it does all that a pressure reducing valve could possibly do.

Made in sizes and with reduction ranges to suit every requirement, and sold with the well-known Morrison guarantee.

May we send complete details?

The James Morrison Brass Mfg. Co., Ltd.

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POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

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Vol XII.—No. 8. Publication Office, Toronto—June 5, 1919 Published Semi-Monthly $1.00 per Year

Fig. 300
Type "K" Brass
Gate Valve
Screwed

Jenkins Bros.

Type "K" Brass Gate Valves

PARTICULAR attention is paid to every detail in the manufacture of Jenkins Bros.' Type "K" Brass Gate Valves.

Before they are delivered for shipment every valve is carefully inspected and thoroughly tested under working conditions by both steam and hydraulic pressure.

Type "K" Brass Gate Valves carry the well-known JENKINS BROS.' guarantee of **Service** and **Satisfaction.** You can tell genuine Type "K" Gate Valves by the Diamond Trade Mark—always look for it.

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64 FRONT ST., W. TORONTO, ONT.
SALES SUPPLY DEPARTMENT SERVICE

BRISTLING WITH POINTS

TO SAVE POWER AND INCREASE PRODUCTION
ARE

AMERICAN STEEL SPLIT PULLEYS

Twenty years ago steel belt pulleys appeared for the first time. To-day the steel pulley business on th.s side of the Atlantic alone has grown to an annual output of not less than 500,000 pulleys.

In steel pulleys the American just bristles with points of superiority.

Note the flat "A" Braced Arms (edge on) cut the air and save enormously in power.

Arms not riveted through pulley face, but riveted to interned strengthening rim flanges.

A rim made like a channel iron, central flanges and safety beaded edges.

Ends of arms are all milled to exact length.

Features incorporated in the American. Features that make for longevity, less belt slip. No pulley will resist shocks like the steel.

An American Steel Split Pulley is made from 40 to 60 per cent. lighter than a cast iron pulley designed for equal service.

We have one of the largest stocks of steel split pulleys in Canada and they are the AMERICAN.

This to you, the production superintendent, means the opportunity of getting maximum pulley efficiency.

Phone or write Supply Department of

THE A. R. WILLIAMS MACHINERY COMPANY, LIMITED, TORONTO, ONTARIO

A Little Letter to the Plant Engineers of Canada

Gentlemen: The following are two extracts from an article which appeared in "Power," under date April 30th, 1918, and the Editor of that Journal has informed me that he would be very glad if I could make use of same for the purpose of Educational Propaganda among Engineers.

"Well, I suppose pumps are necessary about a steam "plant, but I wish that someone would get up something "that would work without valves and pistons in handling "hot water returns. Then there would be less gloom, for "me at least. A pump is a nuisance anyway" (said this Engineer).

"Why, Williams, you don't mean to say that you don't "know of a way to get your returns back into the boiler "without a pump, do you? Didn't you ever hear of the "return loop? No? Well, I ain't got the time to tell "you about it just now, as I have got to get home so as to "keep peace in the family, but the next time I get a chance, "I'll drop in and give you a few pointers on the loop that "may come in "handy some time "or other."

The "STEAM LOOP"---Present-day method

Imagine a Steam Engineer in Canada making the first statement. Is it possible that any Engineer who reads POWER HOUSE *doesn't know about the Direct Return Trap? If so, it is not our fault.*

The writer doesn't know if Williams' friend ever returned to tell him more about the return loop, but he purposes telling you Engineers all he knows about the subject through these ads.

We have endeavoured to place the merits of the Return Trap before Engineers in many ways, and from many aspects.

We are now running a series of ads. in this Journal, which we hope will demonstrate more clearly than ever why a Return Trap should be in your plant. See May 20 issue.

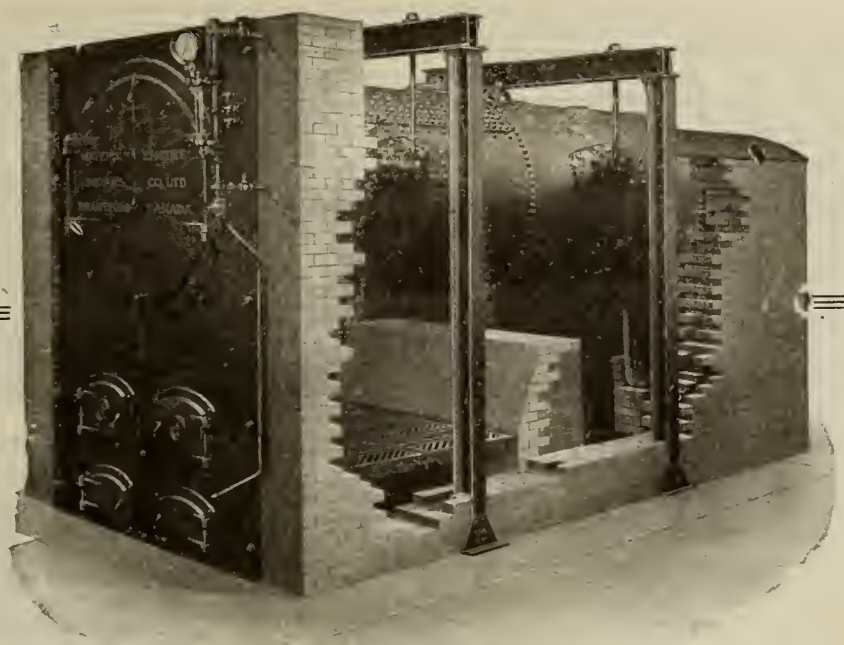
Will you do the writer a favour? Criticize the diagrams, illustrating the ads. Analyze the statements made, and if you have any fault to find, write us a letter, and tell us where we are wrong.

The ads are written for your benefit, and, we believe, have an educational value, dealing as they do with details which are very often overlooked and cause serious loss of plant efficiency.

The writer has taken a chance on Steam Engineers of Canada being open to conviction, and willing to be shown. He has written these ads. for this purpose, and all he asks in return, is, Read the ads. and criticize them, and he has no doubt, it will result in a great many plants being made more efficient by the men in charge of them.

WM. H. ROSE, Engineer.

GEO. W. COLE, LIMITED
2002 Dundas St., West - TORONTO



BOILERS

The recent additions to our boiler shops, with the installation of new and most modern machinery, have placed us in a better position than ever to take care of your boiler and steel plate work.

With a Waterous boiler installed in the Waterous way you may be sure of getting the full steam value from your fuel—whether it be wood, coal, sawdust or shavings or combinations of these. We will furnish you with a setting that is designed and dimensioned to best suit your individual needs.

Some Recent Installations

Dominion Steel Products Co.	2	66″ x 16′
United Grain Growers	3	72″ x 18′
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Kitsumkallum Co.	2	72″ x 18′
P.Q. Lumber Co.	1	72″ x 18′
Lockwood, Green & Co.	2	66″ x 16′
Couture & Rheault	1	72″ x 18′
A. A. Morden & Son	1	60″ x 14′
Slingsby Mfg. Co.	1	72″ x 18′
Southern Ont. Gas Co.	2	54″ x 14′
Paris Wincey Mills	1	66″ x 16′
B. F. Sturtevant	1	66″ x 16′
Brown Rolling Mills	1	72″ x 16′
Prack & Perrine	1	72″ x 18′

There are 75 years of experience and ability behind every Waterous boiler you purchase.

We manufacture and carry in stock Return Tubular Boilers up to 72 in. x 18 ft. If we cannot supply you from stock we can turn your order out in the shortest possible time.

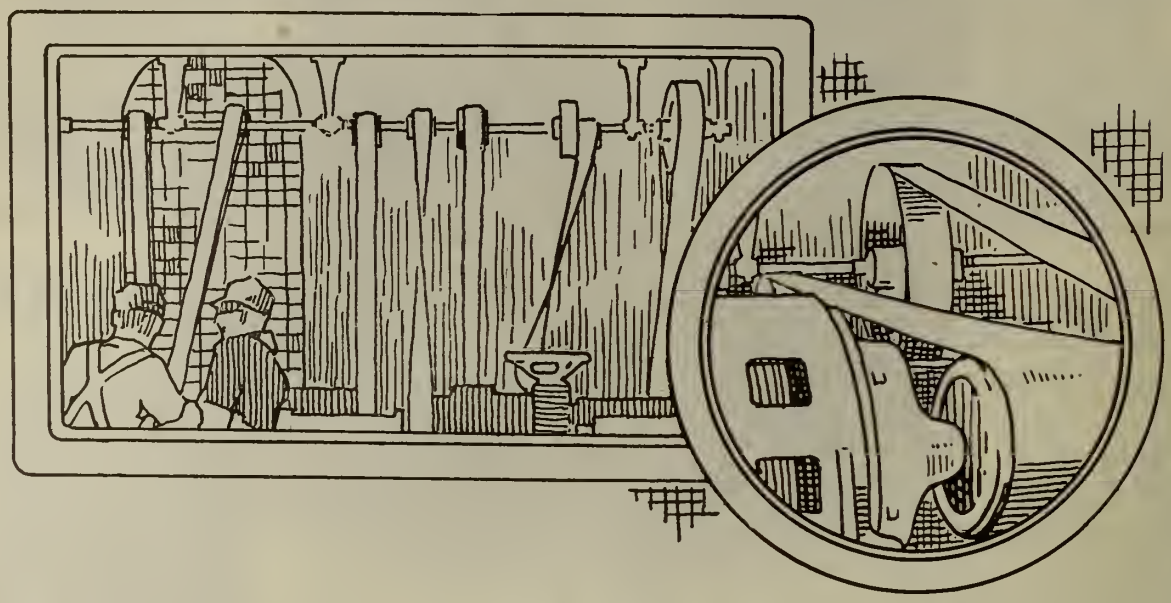
(LET US QUOTE)

Boilers in Stock

2—48 x 14 Horizontal.
3—54 x 14 Horizontal.
3—60 x 14 Horizontal
2—72 x 18 Horizontal.
2—66 x 16 Horizontal.
1—15 H.P. Vertical.
2—18 H.P. Vertical
1—30 H.P. Locomotive.
3—40 H.P. Locomotive.
3—60 H.P. Locomotive.

Waterous

BRANTFORD, ONTARIO, CANADA



Our System of Testing Insures Uniformity and Dependability in Dominion Rubber System Belting

Probably the elements that create the most satisfaction in the use of any article are an accurate knowledge of what it will do before it is made and to prove that it will efficiently accomplish its purpose after it is made.

It is on this basis that we build our belting and the knowledge of what it will do is the result of over fifty years experience and research.

We prove by careful tests that every ounce of material is up to our high standard—each individual operation is checked as the belt proceeds from one machine to the next and a sample of the finished belt is tested, both chemically and physically, to prove that it will efficiently serve the purpose for which it was made and that it has a reserve of strength for emergencies.

We want you to test not only our claims of superiority for Dominion Rubber System belting, but our free belting service, in charge of belting experts, who can help to cut your manufacturing costs, by making your equipment more efficient.

A phone, wire or letter to our nearest service branch will enable you to test this service without obligation.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

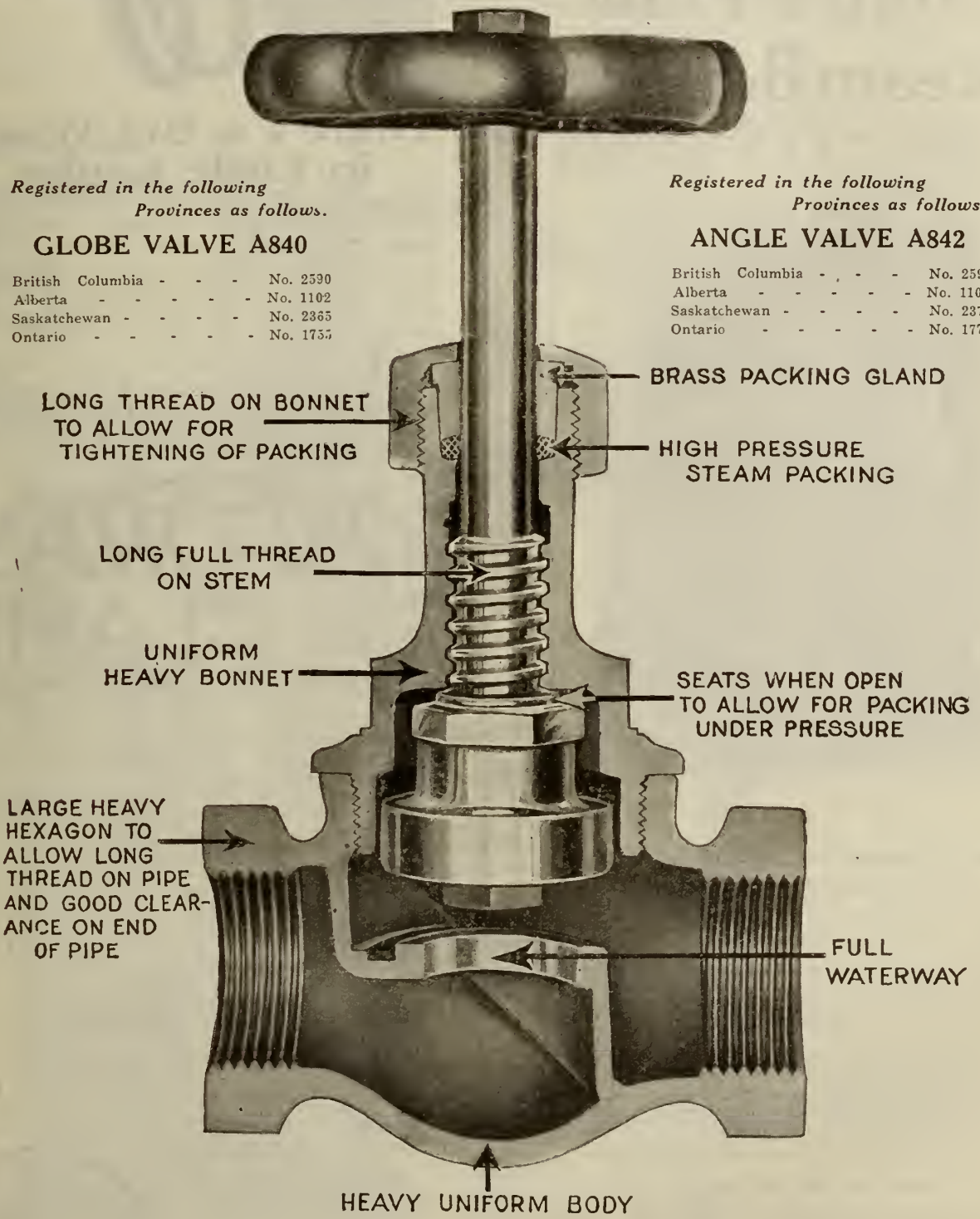
Service Branches:

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Kitchener, North Bay, Fort William, Winnipeg, Brandon, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria.

POWER HOUSE, June 5, 1919, Vol. XII., No. 8. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1.00; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

THE "EMCO" VALVE

Has Nine Points of Superiority


BRASS PACKING GLAND
LONG THREAD ON BONNET TO ALLOW FOR TIGHTENING OF PACKING
HIGH PRESSURE STEAM PACKING
LONG FULL THREAD ON STEM
UNIFORM HEAVY BONNET
SEATS WHEN OPEN TO ALLOW FOR PACKING UNDER PRESSURE
LARGE HEAVY HEXAGON TO ALLOW LONG THREAD ON PIPE AND GOOD CLEARANCE ON END OF PIPE
FULL WATERWAY
HEAVY UNIFORM BODY

Registered in the following Provinces as follows.

GLOBE VALVE A840

British Columbia	No. 2590
Alberta	No. 1102
Saskatchewan	No. 2365
Ontario	No. 1755

Registered in the following Provinces as follows

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Alberta	No. 1105
Saskatchewan	No. 2377
Ontario	No. 1775

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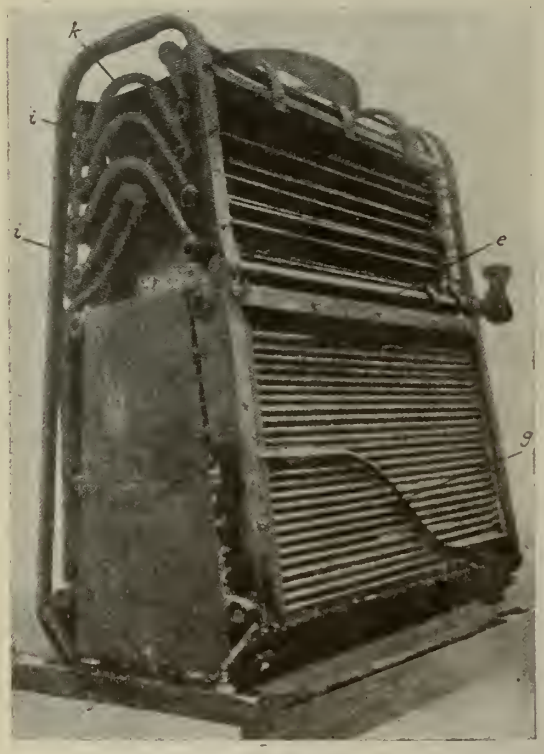
LONDON and TORONTO, CANADA

TALBOT

Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)



Head of Boiler Casing Removed

Cost of Operation is Cheaper Than Any Known Power Producer

Requires one-seventh the space of the ordinary boiler. No brickwork is necessary.

Responds instantly to sudden demands for steam through the automatic control of feed water and fuel.

Water enters the "Talbot" near the stack and leaves in the form of steam near the furnace.

The circulation is through water tubes and is forced at a high velocity by means of a pump doing away with a water drum. By preventing gravity circulation the steam is drawn directly from the lower tubes, eliminating the steam drum.

Two 1,000 H.P. Boilers in stock for quick delivery.

Write for full description to

Canadian Manufacturers and Sales Office:

Montreal General Tool Co.
Limited
675 Notre Dame, Maisonneuve
MONTREAL, P.Q.

There's a Big Waste in Little Leaks

Do you know that a one-tenth inch pipe-joint leak at 150 lbs. pressure will waste steam in a year at a cost to-day of approximately $825? Figure it out for yourself. Leak one-tenth inch; pressure 150 lbs.; 9 lbs. steam per lb. coal; coal $5.50 ton; 10 hours per day; 300 days per year.
And it's such an unpatriotic waste in these days of coal conservation—such a needless and careless waste at any time—for the leak can be stopped in a few minutes' time with a

YARWAY
PIPE-JOINT CLAMP
Formerly the SIMPLEX

More than 13,000 leaks have been stopped since this effective clamp was first placed on the market. Millions of dollars have been saved. The saving in coal can only be guessed.
The Yarway (formerly the Simplex) can be attached in a few minutes by any workman. The principle can be seen from the illustration shown here.
If there is a pipe-joint leak in any of your lines, tell us the size and we will send you a Yarway for 30 days' trial. Instead of returning it, you will probably be as enthusiastic over its success as the man who said of a Yarway Clamp, "It's worth its weight in gold."

Write to-day

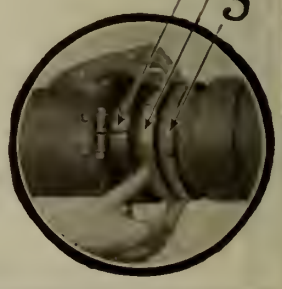
YARNALL-WARING COMPANY
7604-20 Queen Street
Chestnut Hill - Philadelphia

Calgary, Alberta
GORMAN, CLANCY & GRINDLEY CO.

Montreal, Canada
JAS. ROBERTSON CO.

Montreal, Que., Canada
A. McLELLAN,
103 St. Francis Xavier Street

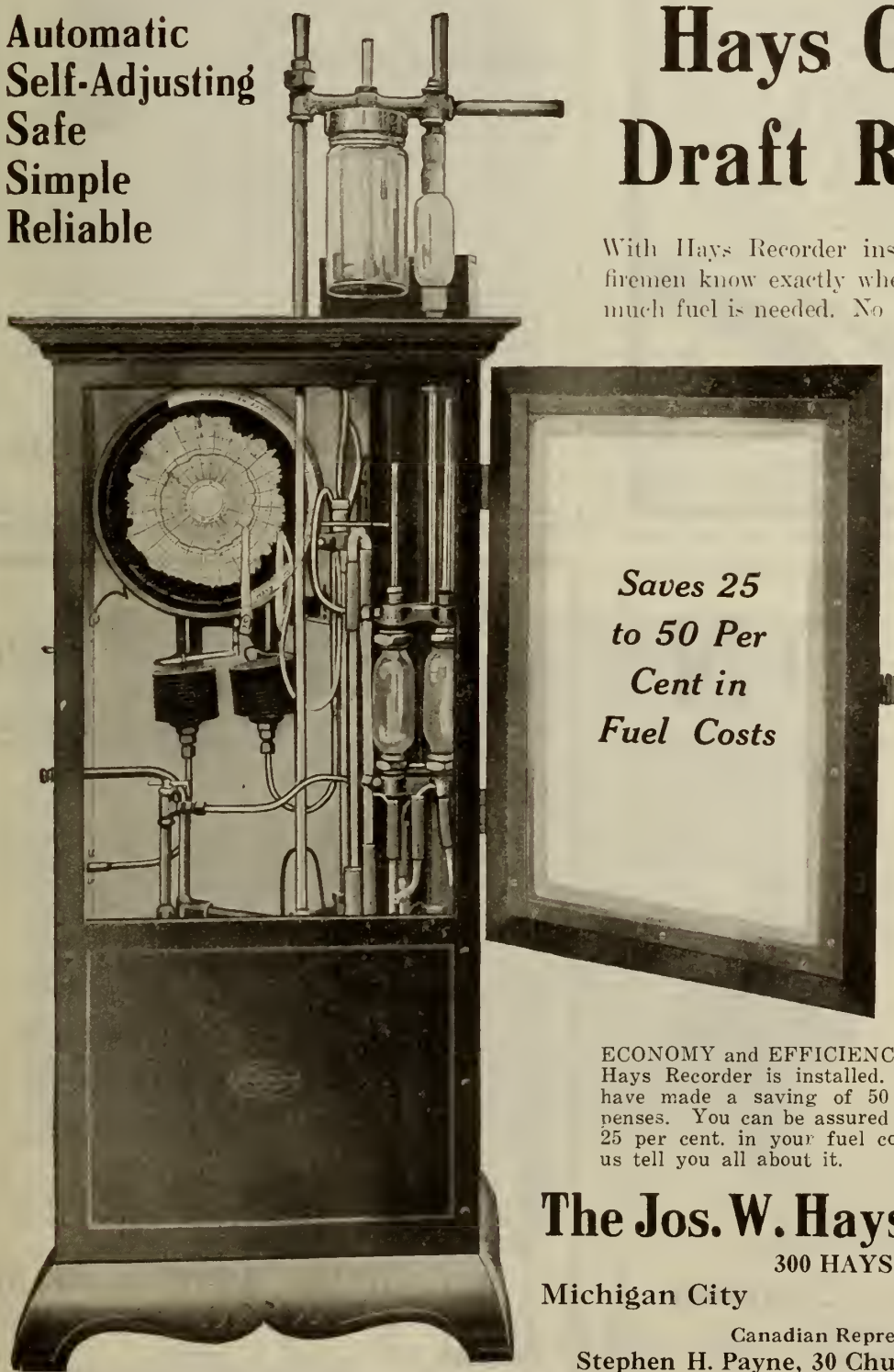
New Westminster, B.C.
CUNNINGHAM HARDWARE CO.



Guess Work in the Steam Plant is Costly

Fuel prices are high. In fact, production costs in general are on the upward trend. In face of these conditions guess work in your steam plant won't do any longer. It's too costly. Reduce your operation expenses. Put your steam plant on a scientific basis by installing the—

Automatic
Self-Adjusting
Safe
Simple
Reliable



Hays CO_2 and Draft Recorder

With Hays Recorder installed in your plant the firemen know exactly when to fire-up and just how much fuel is needed. No waste in time; no waste in fuel. If you are consuming more fuel than is necessary the Hays Recorder will tell you about it. It will expose the cause of the waste and you will easily see how it can be avoided. It points out errors in firing, errors in draft and boiler settings.

Saves 25 to 50 Per Cent in Fuel Costs

The Hays Recorder is automatic, self-adjusting and never fails. It does not depend on hand adjustment and mechanical action for accurate operation. Indications are controlled by rising and falling columns of mercury, water and caustic potash.

ECONOMY and EFFICIENCY follows wherever the Hays Recorder is installed. Some plants using it have made a saving of 50 per cent. in fuel expenses. You can be assured of a saving of at least 25 per cent. in your fuel costs. Investigate! Let us tell you all about it.

The Jos. W. Hays Corporation

300 HAYS AVE.

Michigan City Indiana, U.S.A.

Canadian Representative:
Stephen H. Payne, 30 Church Street, New York

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H.-200 to-day.

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Chicago
Pittsburg
St. Louis
Philadelphia
Los Angeles

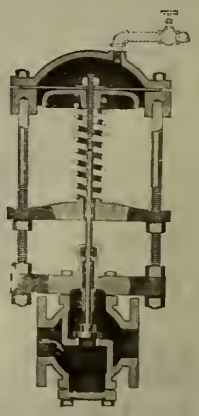
Canadian Agents:

Milton and Prentiss, Toronto.

Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

KIELEY



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(Flanged End Pattern)

Scientifically Tested

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SERVICE — For regulating and controlling steam supply to domestic water heaters, thermostatically controlled valves, cooking kettles, sterilizing apparatus and similar service.

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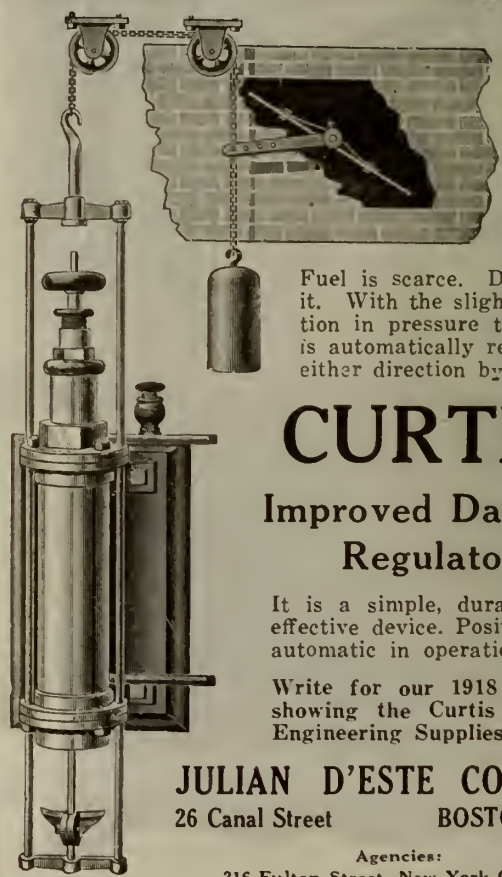

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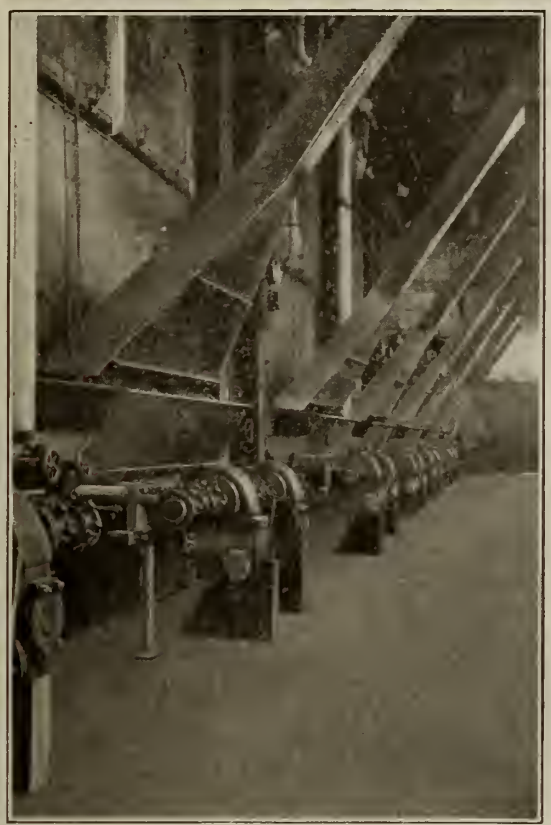

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Riley Stokers Give

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Such results have a meaning so significant that no engineer can safely disregard them.

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These valuable features are fully described in our catalogue HR-6.

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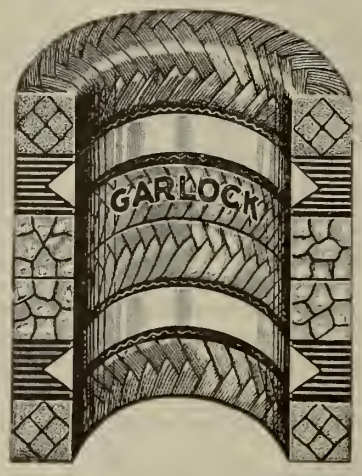

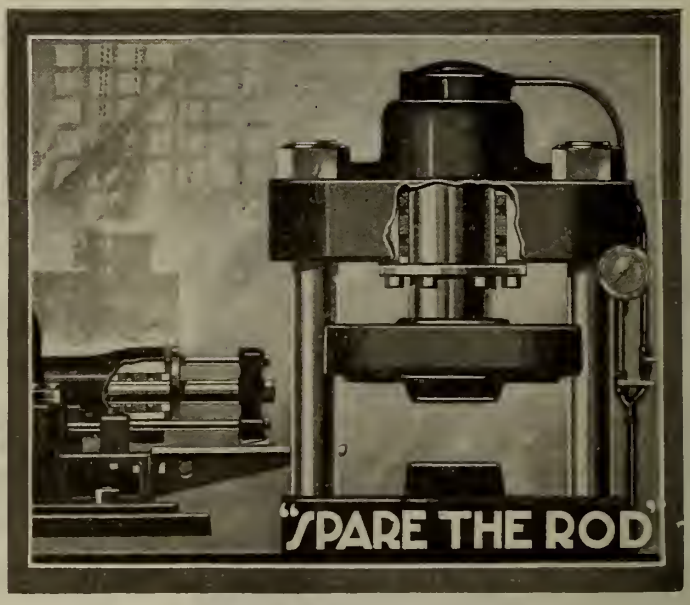

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In steel mills and blast furnaces, where pressures vary by thousands of pounds, and where rams and plungers are often exposed to grit and corrosion,

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is guaranteed to give entire satisfaction. This combination is made up of braided copper, metal wedge and waterproof hydraulic rings. It will hold a pressure of 3,000 pounds.

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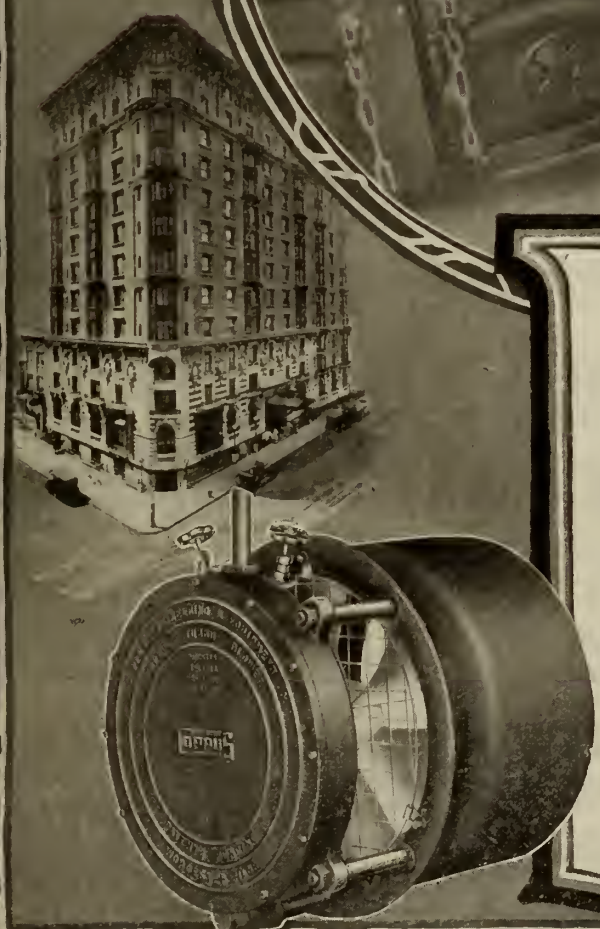

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What COPPUS Blowers have done in other plants they can do in yours. Allow our engineers to show you how **"COPPUS equipment can save you money."** Write for Blower Catalog H8.

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Is known and recognized the world over as

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We have carefully studied Refrigeration under all conditions in Canada for the past 25 years and know what is best for the Canadian Manufacturer.

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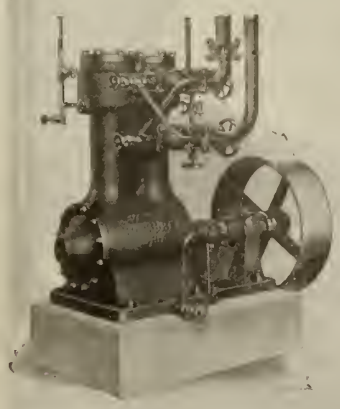

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Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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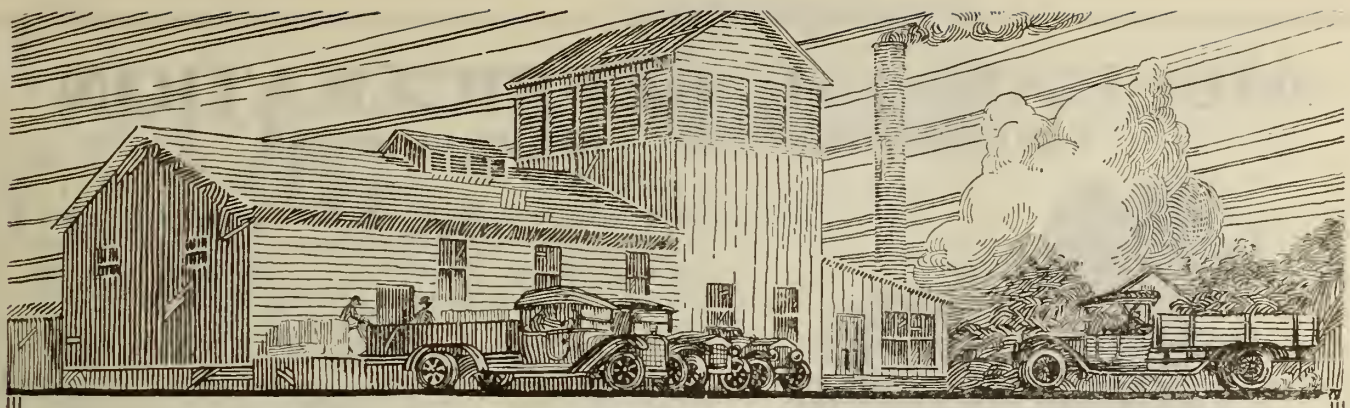

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FRICK Ice-Making Machinery will go a long way in supplying this season's enormous demand for Ice.

Durable and Efficient under heavy loads FRICK Machines maintain their superiority established 37 years ago.

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of "Ice and Frost."

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ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical—Horizontal—Absorption.

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Real Data on Steam Line Insulation

You will find this 84-page book different from most catalogues dealing with pipe coverings. Glittering generalities and broad, unsupported statements have been left out. In their place are given concrete facts, such as:

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5. A chapter on the proper insulation of underground steam lines;
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In fact, the book is most complete, covering as it does the whole question of efficient steam line insulation in detail.

Superintendents, engineers, managers and all others interested in the conservation of steam and fuel will find this book of value. It is more than just a trade catalogue, and merits a place in your permanent business library.

SENT ON REQUEST

A copy of the book and a sample of Nonpareil High Pressure Covering will be cheerfully sent on request. If you are interested particularly in insulation for tanks, feed water heaters, evaporators, ovens, etc., ask also for a copy of the booklet, "Nonpareil High Pressure Blocks and Cement" and samples of these materials.

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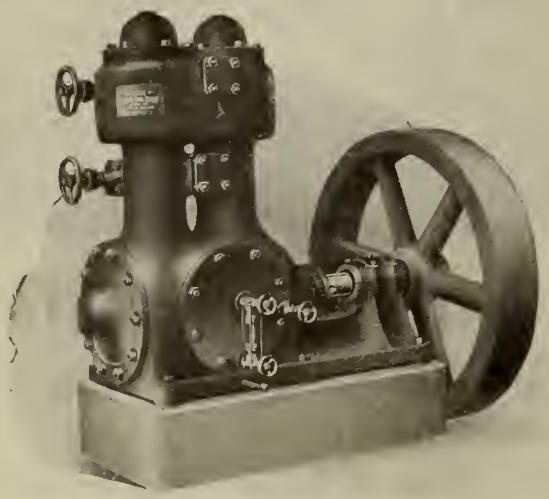
Also manufacturers of Nonpareil Insulating Brick for boiler setttings, furnaces, etc.; Nonpareil Cork Covering for drinking water systems; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile for floors in offices, residences, etc.

Nonpareil High Pressure Covering

"THE COVERING THAT'S DIFFERENT"

MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS



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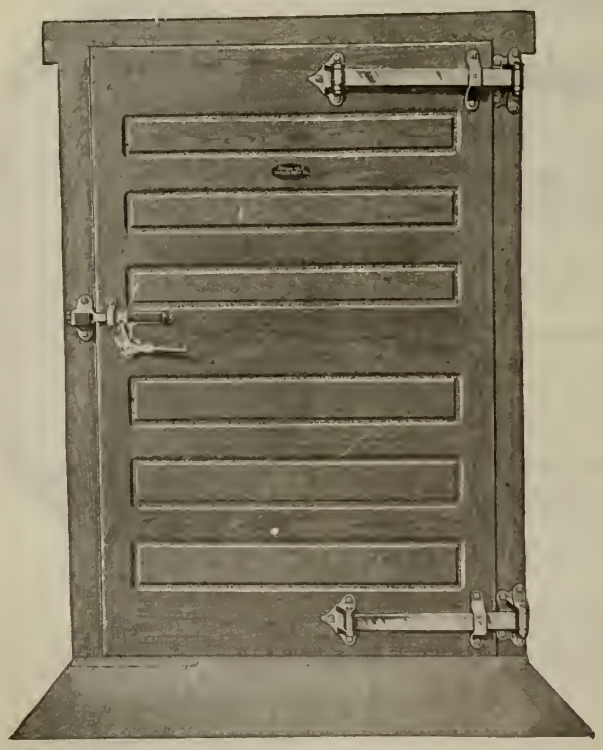

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

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"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

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Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

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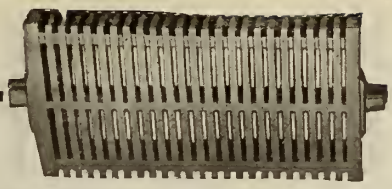
Cyclone Grates



To Get All the Energy Out of Low-Grade Coal

You have to make provision for perfect combustion. The quickest, easiest, least bothersome way to do that is to install Cyclone Grates. Their 60% Air Space and 90% underdraught prevents both the formation of clinkers and the loss of fuel gas. Their improved jarring, shaking movement sifts the worthless ashes through—but no good coal. **Our 30-Day Trial Offer** is made to substantiate these claims. **Take advantage of it to-day.**

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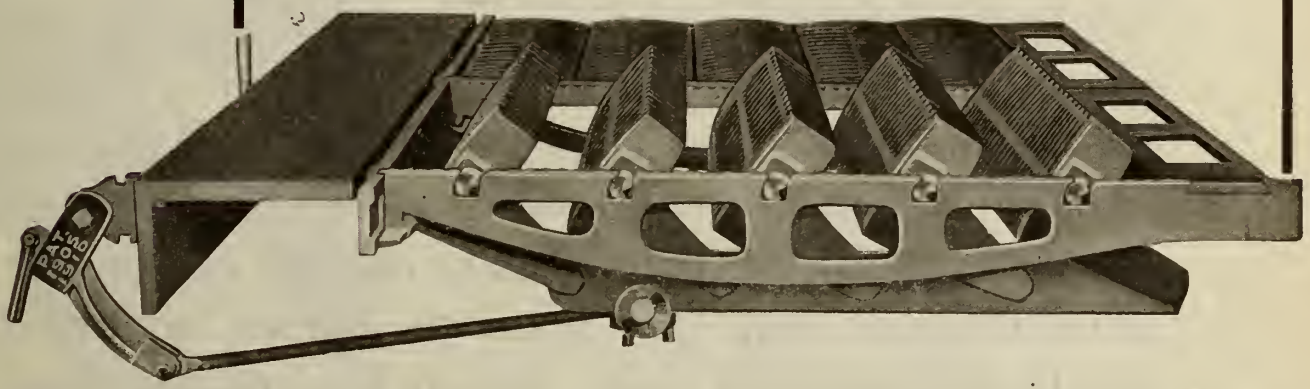


The Large Air Valve Will Never Wire Draw

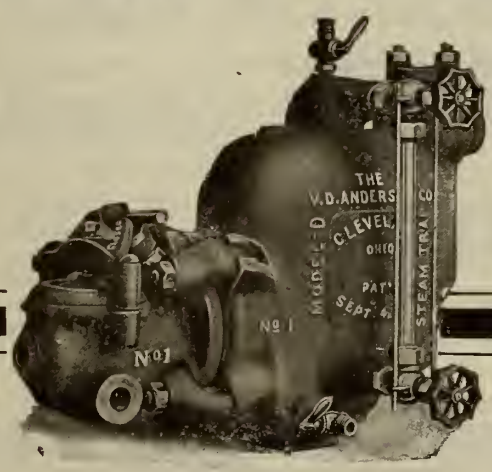
It is permanently under deep water seal. And the Lake Superior Copper Float, so nicely counterbalanced, contributes to the everlasting steam- and water-tightness of this

ANDERSON Model "D" Steam Trap

If conditions in your plant are extremely severe, your need for this Anderson Trap is urgent. And it will stay tight from the day you put it in. Think of all the further cost and troubles you can avoid by giving your plant this quick-acting, large-capacity Trap.

Booklet describes the accuracy of parts machined to solid gauge, the self-contained strainer, the outside gauge glass, the self-contained by-pass, and the simplicity of design, giving complete accessibility to every part.

Write Now.



The V. D. ANDERSON Company

1935 West 96th Street, CLEVELAND, OHIO

The Publisher's Page

TORONTO JUNE 5, 1919

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The main thing an advertiser wants to do is to tell you plainly just how and why his goods are worthy of your consideration. You can learn a great deal from that alone, because many things you see advertised are the things you buy and use in your regular daily life. By reading the advertisements, you can learn the names and read the descriptions of the things that are best and most satisfactory.

But advertising teaches even more than that. All advertisers try to make their advertisements themselves valuable to you.

A good many people have learned a whole lot about good music, good books, good food, good clothes, ways to keep healthy, ways to live comfortably, ways to keep the house and grounds looking well—they've learned all these things and many other things *just by reading advertisements.*

Read the advertisements right along, and you will learn a great deal that will be helpful and valuable to you as you go through life.

Written by LIFE'S advertising manager. POWER HOUSE *advertisments have proven of great worth to Canadian engineers. Our advertisers recognize this and prepare their messages accordingly. Keep thoroughly up-to-date by studying BOTH editorial and advertising pages.*

If a throttle valve could talk of rod packings

—it would tell of unnecessary steam waste. Not the dribble that leaks from the stuffing-box—this is insignificant. But of that which is wasted in driving an engine when the rod is gripped tightly and its free action hindered by common packings. And it would tell of Sea Rings—how they pack rods leaklessly while relieving them of friction.

Sea Rings aren't solid or inert—but are automatic, pulsating and self-adjusting.

As steam or liquid enters the stuffing box, it fills the hollow space between the "lip" and "heel" of the Sea Ring, and pressure forces the lip against the rod, with just enough pressure to stop leakage. As pressure decreases, the Sea Ring relaxes its grip on the rod.

For the rejuvenation of pump, engine or compressor, Johns-Manville Sea Ring Rod Packing is unequalled. Our nearest branch will tell you how and where to try a set and be convinced. Write them today.

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POWER SAVING MATERIALS

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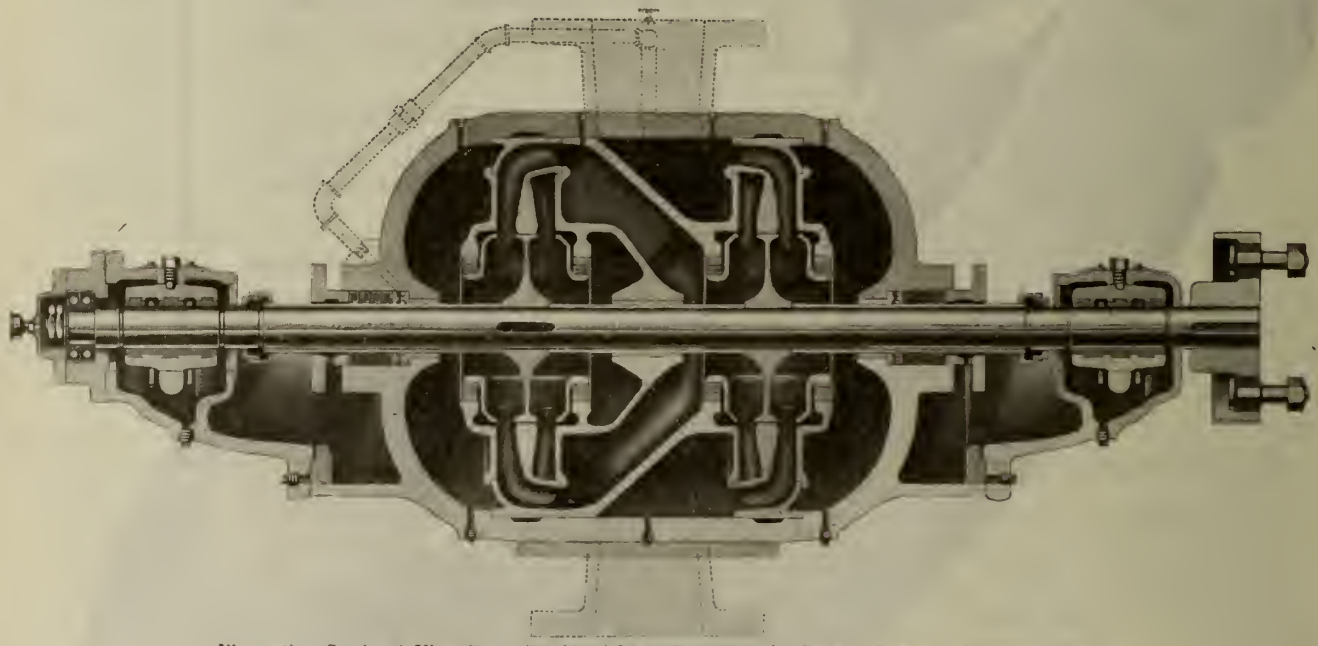
Pumping Machinery

Is in use all over the World in Waterworks, Mines, Power Stations, Irrigation Works, Pulp and Paper Mills, Salt, Chemical and General Industrial Plants where highest efficiency, reliability and the best class of Engineering are demanded.



Illustrating Sectional View Type, B.2 Multi-Stage Rees Roturbo Patent Pressure Chamber Pump.

REES RoTURBo Pumps provide a high and sustained efficiency over a wide range of duties. This means a very noticeable saving in power costs.

The Self-Regulating feature of RoTURBo design is responsible for this saving, and this same feature protects your Prime Mover from overloads on a decreased pressure head, eliminating expensive delays and costly repairs.

Our RoTURBo Pump and Condenser Catalogues, full of valuable information, are yours for the asking.

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POWER HOUSE

Established 1907

Published Semi-monthly

Hamilton Waterworks; Some Features of Design

The High Level Booster Station and the Laying of the Intake Piping Are Described, Together With Some of the Problems Encountered in the Design of a Large City Waterworks System

By F. C. PERKINS

THE accompanying illustration, Fig. 1, shows the High Head electric pumping station at Hamilton, with its 4 centrifugal electrically-operated units, while in Figs. 2, 3 and 4 may be seen the intake crib ready to be launched, the 48-in. intake pipes in 140 ft. lengths; also the 48-in. header and 30-in. valve to the main. The writer is indebted to Andrew F. Macallum, C.E., city engineer of Hamilton, Ont.

He points out the fact that the City of Hamilton, Ont., completed its waterworks system in 1859, which system was developed gradually to meet the growth of the city until 1912, when it was found that the rapid growth of the city necessitated the complete renewal of the entire system. At this time there were in operation four steam pumps, having a combined discharge of 13¼ million gallons (imperial) per 24 hours, and three mains to the city, 18 in., 20 in. and 30 in., respectively. Two of these pumps and the 18 in. main were installed in continuous use since 1859, and these pumps of the vertical walking beam plunger type are today somewhat of a curiosity. These old pumps are yet in commission, but used only in the event of interruption to the electrical-driven turbine pumps installed during the reconstruction, and when the other two and new steam pumps cannot meet the demand.

Hamilton lies at the westerly end of Lake Ontario, where, at its extreme end, a sand ridge cuts off the lake from the Burlington Bay, on the shores of which the city lies. Owing to its location and this sand ridge, through which a short canal is cut to the lake, combined with the fact that most of the sewage from the city is treated at Disposal Works before entering the bay; it has never been found necessary to treat the water taken by the intakes from Lake Ontario. This places this city in the unique position of being about the only city draining water from the lower great lakes that has not treated its water supply. In connection with the original installation, two intakes extended into the lake, one cast iron 20 inches in diameter, for a distance of 1,000 feet, and a wooden box intake, three feet square, a distance of 300 feet, each having its inner end in a settling basin, from which wooden conduits led to the wells at the pumping station.

Engineer Macallum maintains that one of these wooden conduits, placed in 1859, was found to be in first class condition after 55 years' service. It was decided to construct a new intake 4 feet in diameter and 2,100 feet in length, which would bring it to a depth of thirty-two feet of water in the lake. This steel intake pipe including intake piece, sluice valve and expansion joints, cost $20,250, delivered on the site and rivetted in lengths approximately one hundred and forty feet, on the ends of which were flanged pieces. The price mentioned included also the lead gaskets and bolts.

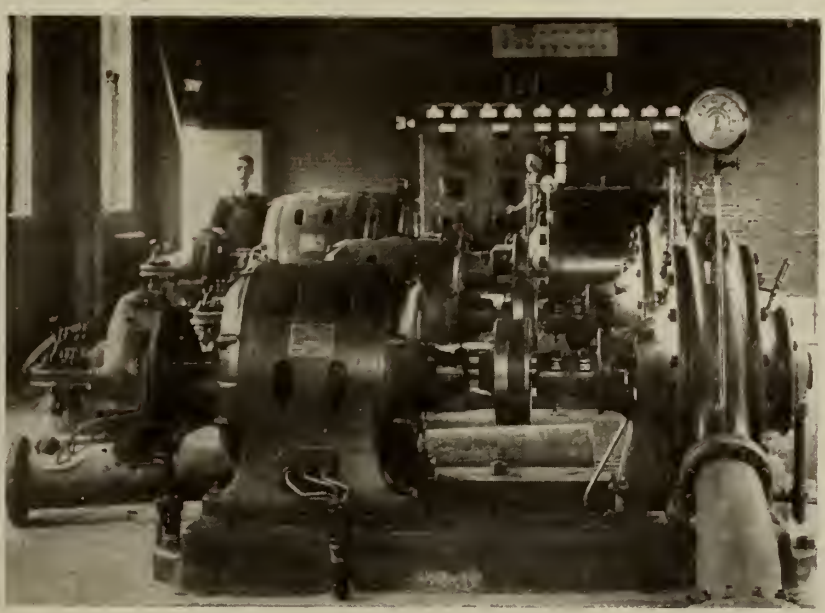


FIG. 1—HIGH HEAD ELECTRIC PUMPING STATION WITH FOUR MOTOR-DRIVEN UNITS.

The accepted tender for laying this pipe was $35,000, which included the building and placing of the intake crib and a concrete valve chamber and house at the settling basin end. As ice ridges formed out in the lake for a distance of about 1,000 feet and in some places thirty feet high, to protect the pipe, it was necessary to lay the pipe in trench on the lake bottom, so that when filled in again the pipe was covered. Concrete in bags was placed around the pipe for 300 feet from the shore line as an added precaution. Four piles were driven in the trench in such a position that when a 140 foot section was floated into position two piles would be at each end of the section. Across the two piles at each end a sill was bolted at grade and the pipe lowered to rest upon these sills and held in position there by wooden blocks on either side. A cap was bolted across the two piles over the pipe after the section had been bolted to the preceding section by the drivers. Besides alignment the object in driving these piles was twofold, first, for ease in joining up two sections clear of the sand; and secondly, to prevent as much as possible divers not bolting up the lower sections of the pipes, because of difficulty of access. As there was practically little possibility of scour on account of the method of construction adapted it was not considered necessary to space the piles closer.

In an examination of the plans for intake cribs adopted by the cities on the Great Lakes, it was found that the minimum size was forty feet square and of sufficient height that the mouth of the intake facing upwards was at least seven feet above the bed of the lake. This

FIG. 2—INTAKE CRIB AT HAMILTON READY TO BE LAUNCHED.

minimum size Engineer Macallum did not consider necessary, but designed the intake crib to be 24 feet square, placing rip rap around the outside, and this has since been found quite satisfactory. No iron was exposed about the intake opening, but these were constructed with oak plank to prevent the prevention of anchor ice. In the gate valve house were placed fish screens for obvious reasons. A reinforced concrete conduit, 4 feet in diameter and 2,000 feet long was constructed to the large well at the pumping station. This conduit before reaching the pump well passed through a screen chamber, through which the old two wooden conduits also passed.

Each of the turbine pumps fed from a small and separate well connected with the main well with a gate valve cut off. By this method any foot valve could be inspected and repaired if necessary without interfering with the water supply to the other pumps. At the inlet and outlet of each conduit was placed a sluice valve, so that any conduit could be cut off, or either part of a conduit. Engineer Macallum points out that in the construction or reconstruction of any waterworks system, the pumping plant is of paramount importance, what power used, steam, gas or electric will depend principally upon the cost of these motive agencies delivered on the shaft. Other considerations will be the capital cost of installation, including size of relative building and cost of operation with depreciation.

In Hamilton on account of the low cost of electric power ($16.50) per annum, it was decided to increase the number of electric driven pumps to meet the future demands and the pumping station for the units already installed was enlarged. Two new electric driven turbine pumps were installed, each of 6½ million Imp. gallons per 24 hours, or of the same capacity as two units already in operation. There is a steam plant also drawing a capacity of 13½ million gallons per 24 hours, which is generally held in reserve, or to carry the peak load during periods of heavy consumption.

Regarding the two stage turbine pumps that the City of Hamilton installed at its main pumping station, pumping to a head of 285 ft. with an efficiency of 75 per cent. under full load, it may be mentioned the tenders for two 6½ million gals. (Imperial) turbine pumps in place varied from 5,500 to 9,800. Extra impellers capable of lifting the water to 300 feet were included and the pumps had to be successfully operated for two weeks before acceptance. Besides the main pumping station there was built a booster station to replace steam and air lift pumps to carry the water to greater elevations than possible with the main pumping station without causing excessive pressure in the lower portion of the city. This station contains four turbine pumps, each of one million Imperial gallons per 24 hours. Two of these pumps raised the water about 80 feet above the level of the reservoir to which the main station pumps delivered the water, and two pumps raised the water 280 feet above this level. Two stage pumps only were necessary for the lower level below the Mountain plateau, but six stage pumps were required for the higher elevation. The problem at this station was to approximately determine the heads to which the pumps would generally work, so as to get the greatest efficiency out of them. The pumps were directly connected to the mains fed from the main pumping station, and about 75 feet below the level of the reservoir that the main station fed.

It is stated by Engineer Macallum that besides the usual annual and daily fluctuations in head with the added effect of the draft of these pumps on the static head was the difference in level of two reservoirs on the main system to be considered. One of these reservoirs was only used in case of emergency, or while repairing or cleaning the reservoir generally used, but as it was 60 feet lower in elevation and two miles distant across the city, and nearer the pumping station, it materially produced considerable variation and practically made the problem of obtaining maximum efficiency with turbine pumps under all working conditions indeterminate.

The pumps as built and operated give a maximum efficiency of 60 per cent.. although under certain conditions the specified efficiency of 75% is obtained. Tenders for these four pumps in place varied from $6,000 to $6,800. The main pumps are driven by 750 h.p. motors, the lower level pumps at the booster by 50 h.p. motors, and the higher level by 130 h.p. motors. All these pumps at 750 r.p.m. There were in commission from the main pumping station three rising mains 30 in., 20 in. and 18 in., respectively, being connected to the pumps in the usual haphazard way prevalent throughout many places in this country. It was decided to build a fourth main 36 inches in diameter and about equal to the other three mains in discharging capacity. Although nearly two miles of this main had to be built to bring to the outskirts of the city along a pipe line already used by the other three mains, it was decided to take a slightly longer route away from this pipe to avoid the danger of a bad blow-out putting all the mains out of commission.

FIG. 3— 48 IN. INTAKE PIPES IN 140 FT. LENGTHS.

The connections from the pumps were

FIG. 4— 30 IN. VALVE TO MAIN 48 IN. HEADER.

carried to a header pipe four feet in diameter, running at right angles and at a lower elevation than these connecting pipes. Between each of the old pipes and the header a gate valve was placed and as the new 36 in. main went off from the end of the header the whole arrangement proved very flexible in operation. On each of the mains was the usual check and gate valves, besides the venturi tube for measuring the discharge. Before laying the large main to the city and other mains throughout the city, tests were made to ascertain the relative efficiency in speed in making poured lead wool joints, also the relative efficiency of joints caulked by pneumatic hammers or by the usual hand method. It was found that with the pnuematic hammers, between four and five joints could be caulked with a poured lead joint to one by using lead wool.

It is of interest to note that the city had a small steam shovel with a half yard dipper which did the excavating and also the lifting of the pipe into the trench. A 12 ton dinky engine with cars and track cars was purchased and with this equipment (which also did the back filling) as high as fifteen 36 inch pipe were laid in a day in a trench which had a variable depth but always sufficient to give a top covering over the pipe of five and a half feet. This large main was laid to grade with blow offs every half mile to the city and having the usual gate and relief valves. The length in feet of new mains in this reconstruction comprised 12,900 ft. of 36 in. pipe and 138,000 ft. of 30 in. pipe, also 6,000 ft. of 24 in. pipe, the 20 in. and 18 in. pipe being 4,600 ft. and 2,500 ft. in length respectively. Engineer Macallum gives the total cost of this work including intake, conduit pumping stations and mains as three quarters of a million dollars.

AIR-CYLINDER LUBRICATION

In looking over some of the recent issues of "Coal Age," my attention was attracted to the inquiry of an engineer who had experienced trouble in the lubrication of the air cylinder of his compressor, and asked for information in regard to the best lubricant to use for that purpose. I have had some experience in the lubrication of cylinders and can appreciate the correspondent's position fully.

Although everything stated in the reply to this inquiry is quite true, I was surprised to find that the writer omitted to mention one of the best air-compressor lubricants manufactured or used. I refer to flake graphite, which has no equal as a lubricant not only in air-compression practice, but likewise for steam engines, gas engines, journals, valves, and, in fact, wherever a lubricant of superior quality is required.

Lubricating Qualities of Flake Graphite

Flake graphite possesses peculiar properities not found to the same degree in other lubricants. For example, its structure is such that it fills up or overlaps the roughness of metallic bearing surfaces. As it is well known, graphite has a strong tendency to attach itself to a metal surface and quickly imparts to it a superficial glaze that almost eliminates friction.

Again, as a lubricant, graphite is not only more enduring than oil, but possesses the important feature of withstanding a high degree of heat. It is this feature particularly that adapts it to the lubrication of air-compressor and gas-engine cylinders, where the heat is sufficient to volatilize or carbonize the oil and render it useless as a lubricant under such conditions.

Everyone who is familiar with the operation of air compressors or gas engines freely admits that oil has many disadvantages that render its use inefficient and often harmful. The use of graphite for the purposes named would have become universal long since had it not been for the difficulty encountered in introducing the graphite into the engine cylinder.

That difficulty, however, is more imaginary than real. Special devices have since been made for automatically feeding flake graphite into cylinders and on all bearing surfaces that must be lubricated. One of these devices is known as the Winans Dry Graphite Lubricator; another, Johnson Graphite Lubricator. It is claimed for each of these that from 50 to 60 per cent. is saved in the cost of lubrication by the use of graphite instead of oil.

In my practice, I have been using Dixon's Ticonderga Flake Graphite for the lubrication of air-compressor and gas-engine cylinders, as well as on the other moving parts, in all classes of mechanical equipment. Permit me to name a few of the advantages I have found that graphite possesses over oil when used as a lubricant. They are as follows:

Graphite, in lubrication, (1) is unaffected by high-temperatures; (2) cannot be carbonized or ignited; (3) cannot give off explosive vapors; (4) does not clog discharge valves; (5) will not accumulate dust or grit; (6) enables a large saving in cost of lubrication; (7) avoids danger of explosion in air-compression practice.

Last, but not least, I have found that the use of graphite in cylinders improves the fit of the piston, while at the same time reducing friction, making repairs less frequent and saving trouble and expense.

—An Engineer, in "Coal Age," from "Graphite."

CHEAPER ELECTRIC WIRING

A special committee of the Institution of Electrical Engineers (Great Britain), has been formed to consider the revision of the existing rules for electric wiring in buildings. This committee is the outcome of a growing conviction that the high quality of British cables and accessories justifies a relaxation of the standards hitherto imposed. During the war an enormous number of army buildings have been wired on the surface and in other ways not consistent with standard British practice, and the experience that is gained will be turned into account in cheapening the cost of installation and materials. British manufacturers of wires, switches, insulators, and other accessories will thus be led to expand the production of types which will be peculiarly adapted to meet the needs of overseas markets. Satisfactory quality will be ensured by the National Electric Proving House which is about to be established in Great Britain. The Proving House will put the hall mark of good design, material, and workmanship on every class of electrical apparatus, thus giving British productions the full benefit of the high reputation they have always held.

LEARNING SOMETHING NEW

A reader of POWER HOUSE writes: "I look over the advertisements the first thing for new machines or new advertisers. I thereby learn something about machines I may never see." The value of looking over the advertisements of POWER HOUSE lies in the information gained regarding new equipment, etc. The more the engineer knows about efficiency in equipment the more up-to-date will he be in his ideas. He will become more efficient himself, too, and his advice will be sought by the company when new equipment is being selected. Our advertisers take great pains with the preparation of their message, and this is appreciated by POWER HOUSE readers.

The Use of Oil and Powdered Coal as Fuel

In a Paper Read Before the International Railway Fuel Association and Reported in Power Plant Engineering, the Author Gives Some Interesting Data Relative to the Use of Both Fuel Oil and Powdered Coal in the Production of Steam

By JOSEPH HARRINGTON

As the situation exists to-day, crude or fuel oil forms almost the only fuel in use for heating the small industrial furnace. This fuel has been developed in its application to a high degree of refinement.

As it comes from the ground, as the so-called crude oil, it contains the entire series of hydrocarbon compounds, although not always in the same proportions. Western oils are as a rule richer in the heavier constituents, while those from Pennsylvania contain more of the lighter or more volatile elements. Another broad division as to character is determined by the nature of the residuum left when all the volatiles are removed. Certain oils, when subjected to complete distillation, leave an asphaltic substance, and others a paraffin. These so-called "bases" seem to be the body or element binding the parts together and determining the "weight" of the oil. The words "heavy" and "light" are terms indicating in a general way the proportion of base in the oil being described. This base, being in solution in the lighter and more fluid parts, affects the density or specific gravity to a marked degree. Since the base is a combustible hydrocarbon, it follows that an increase in density increases the number of heat units in a given volume, the gallon being the volumetric unit commonly used in the oil trade.

Following this line of reasoning, it would seem that of two oils offered for sale, one weighing 7 lb. and the other 7½ lb. per gallon, the latter would contain the greater number of heat units. This is actually the case, the purchaser getting about seven per cent. more heat in each gallon.

There is a practical limit, however, to the extent to which one can apply this reasoning. As the density of the oil increases, the fluidity decreases, and difficulties are encountered in pipe lines and nozzles. Increased temperature will offset to a large degree the tendency toward viscosity, and care must be taken, if heavy oils are to be burned, to provide adequate heating facilities, both at the tank and along the pipe lines.

At the burner also increased air pressure must be provided, or difficulty will be had in properly atomizing the oil. The necessity for complete atomization increases as the density of the oil increases, since the natural volatility is becoming less. This is a function of the "oil burner," which is strictly a misnomer when applied, as it so often is, to the nozzle or injector. The combustion chamber really deserves this name if any one part of the combination is to be so called.

An astonishing number and variety of oil feeding devices have been devised and built, and the subject of injecting oil fuel into a furnace for combustion purposes has been the subject of the most elaborate and extensive experimentation. It is therefore to-day a highly developed branch of combustion engineering, so that it is relatively definitely defined in its methods and results. Oil is a more uniform fuel than coal, and it is a most interesting thing to note that the heat value per pound is about the same, whatever kind or density is taken. Crude oil varies from 18,500 to 20,000 B. t. u. per pound, and if the constituent parts are tested the same range of heat values are obtained. Accurate heat determination is more difficult than with coal, and similar samples will apparently show as much as 500 or 600 B. t. u. difference.

On the whole, however, the fluid fuel can be fed to a furnace with considerable uniformity, air supply can be nicely regulated and combustion efficiency secured and maintained.

There are two general principles upon which oil feeding is based, and these will be described in order.

The first method is one which depends upon the heat of the furnace and its incandescent brickwork to volatilize the oil and put it in shape for rapid combustion. This in a sense is a gasification of the oil from bulk state. Oil is injected into a furnace of high temperature, and a rapid absorption of heat causes the liquid to vaporize and rise to the ignition temperature. In this state it becomes highly inflammable and burns with an intense heat. If the furnace, however, is not in suitable condition for the quick volatilization of the liquid, the combustion is delayed and heat is developed beyond the point where it is most desired.

The essential weakness of this method lies in its dependency on the furnace heat for volatilization of the oil. There are two variables here to contend with: first, the volatility of the oil itself and, second, the furnace temperature. Both may and do vary. Another defect of this method is the fact that if too high pressures are used for the furnace served, some of the oil may actually reach the distant wall in liquid state, and, by adhering thereto, become carbonized and partially lost. Not only may this be the case, but the temperature may be so intense from the blowpipe action of the oil jet, that destruction to the brickwork may result. A final variable is the changes in oil or air pressures.

The second method is the mechanical vaporization of the oil by means of a spray head or nozzle arranged in such a manner that the oil is of necessity divided into very fine particles or globules. In this condition the amount of exposed surface relative to the volume of oil becomes greatly increased, and oxidation may proceed with the utmost rapidity and completeness. This system differentiates very sharply between the gasification or volatilization of the liquid by virtue of a highly perfected mechanical subdivision. It is obvious that a liquid may be so finely divided that it will remain in suspension an appreciable time, like a cloud of steam. This is what is commonly observed in the case of water with lawn sprinklers or cooling nozzles for spray cooling.

If this process is effected by means of compressed air, it can be accomplished with about 20 per cent. of air required for the complete oxidation of the fuel. A basic fact must not be overlooked in this connection: The very idea of mechanical atomization carries with it the thought of a diffusion of spray in a volume of air, and the surrounding of each globule with an atmosphere of air. It is an easy step, therefore, both in one's mental conception of this condition, and in the actual furnace, to add and intimately mix more air to the now gaseous fuel. If this air is injected by mechanical means in such a manner as to blend rapidly with the cloud of oil spray, the flame takes on the character of the Bunsen burner flame, the mixture being perfect and the temperatures exceedingly high. It is quite possible, however, to induce the balance of the air requirements through adjustable ports or openings surrounding the spray nozzle. When the oil spray, with its portion of carrying air, is given a swirling or spiral motion, it has a decided tendency to disperse under the action of centrifugal force, largely losing its axial velocity. Under these conditions it is noted that the combustion takes place right up to the tip of the burner and melting temperatures may be obtained within 6 or 8 in.

An important means of judging the temperature of a flame is by its color or luminosity. The luminous element is the carbon particles heated to incandescence just before being burned or oxidized. Aside from the fact that such particles are a part of the flame and

that they are an index of the flame temperature, contributing their share of heat thereto, they have no exclusive monopoly of the temperature control, and are not a necessary adjunct to high gaseous temperatures.

The Bunsen burner produces an almost invisible flame, yet high temperatures may be developed. A proper atomization of fuel oil and commingling with the right amount of air will produce the elements of perfect combustion. The flame will be short and intensely hot, and will not fill the furnace with a great luminosity, yet the furnace temperature may be much higher than when full of flame. This is the principle underlying the Billow system.

Much has been said in regard to the destructiveness of the oil flame at close quarters, and efforts have been unceasing to find a refractory substance which is able to withstand the high temperatures developed. One of the fundamental principles of furnace design is that the temperature is directly affected by the proximity of the furnace walls and roof.

At the present time, and probably for some years to come, all refinements in the selection or purchase of fuel oil must be forgotten. Users are fortunate in being able to get anything that will burn, and prices are several times those of a year or so ago. The tremendous demand for motor fuels and the ever-increasing requirements of certain special industrial processes tax the country's output to the limit and render a consideration of other fuels timely and appropriate.

Powdered Coal

Engineers have recently become much interested in the use of powdered coal as fuel for furnaces. Fulfilling as it does the requirements of a gaseous fuel, it combines the possibility of high efficiency with a cost indicative of great economy.

It is unnecessary to give the specifications for pulverized coal, but I would like to emphasize the fact that in certain classes of service an extra fine grind repays the trouble and expense of obtaining it. Coarse coal results in offsetting substantially all of the fundamental advantages of pulverized coal, and too great care cannot be given to this item.

It is entirely possible to adapt this fuel to any size of furnace. It is a fuel of such a nature that intelligent care must be expended on the furnace design and application thereto. There is nothing in the nature of this fuel to prevent its successful use on any scale whatsoever. Powdered coal nozzles or so-called burners are being made, scarcely an inch in diameter. Those required for the larger furnaces may run up to 18 in. in diameter. The pressure of the air required for its introduction must be carefully controlled and adapted to the particular service. Ordinarily the pressure should be as low as possible, and dust introduced in a slow rolling cloud, widely diffused.

On account of the independent control of both fuel and air, it is readily possible to obtain any gas analysis that may be desired. I show a tabulation which illustrates some actual gas analyses taken by the writer in an annealing oven. The air in this case was held at a constant volume, the amount of coal varied by means of speed control in use at this plant. This was a variable speed motor with a 10-point rheostat. When the maximum CO_2 was reached, CO began to develop because of the limitation to combustion imposed by the size of the furnace. If coal had been introduced in still further amount, CO would have amounted to a considerable percentage, and the CO_2 would have been appreciably reduced. We would then have had almost a gas producer effect, under which condition the furnace temperature would have rapidly declined.

Gas Analyses

Air Supply Constant		Coal-Supply Constant	
Rheostat Point No.	CO^2 at Flue	Air Gate Notch No.	CO^2 at Flue
1	13.1	1 (open)	13.0
2	14.0	2	14.0
3	14.1	3	14.5
4	15.9	4	15.7
5	16.3	5	15.7
6	16.8		
7	17.1		
8	17.1 (smoky flame)		

The question of furnace temperature enters into this consideration just as it does in the case of oil. It is quite as possible to melt out an entire interior of a furnace with powdered coal, and economy of fuel and floor space almost always dictate the furnace design. In a given furnace the temperature rises as the excess of air is cut off, and this may be so great as to be destructive. At the same time, however, it must not be forgotten that reduction of excess air may be carried to the limit without excessive temperatures, if the furnace proportions bear the correct relation to the amount of coal fed per unit of time. In the furnace from which the gas analyses above quoted were taken, the temperature was maintained constant at 1500 deg. F., and at the same time between 17 and 18 per cent. of CO_2 was developed. This furnace, however, had about 200 cu. ft. of cubical contents per pound of coal per minute. If this had been 10 cu. ft. with the same amount of coal per minute, temperatures would have been developed which would have melted the brickwork rapidly.

I quote these two figures because they happen to be actual cases wherein temperatures were observed. Intermediate temperatures would have been obtained with volumes between the two limits stated. It is therefore a possibility that high combustion efficiency can be obtained without the production of destructive temperatures.

Powdered coal really takes on the character of gas when diffused throughout a current of air. Its finely divided condition permits it to be carried in suspension for an almost indefinite time, provided the velocity of the carrying current is maintained. It is quite possible, therefore, to supply a series of widely separated furnaces with this fuel by means of a pipe line, much the same as would be the case with a directly gaseous fuel. The advocates of powdered coal call attention particularly to the marked advantage this fuel has over oil as to cost. With a 12,000 B.t.u. coal at $2 a ton and fuel oil at 3½c a gallon, 1c will purchase 3.2 times as much heat in the form of coal as in the form of oil. While no reference has been made in this paper to natural gas as a fuel, it is interesting to include it in a tabulation design to illustrate the relation between the amount of heat purchasable with 1c. and the amount purchasable in the form of oil and coal. In this case prices existing at the present time are used, and a fairly good grade of Pittsburgh coal is considered.

Comparative Purchasing Power of One Cent

Oil—

B.t.u. per lb.	19,000
Weight per gal.	7 lb.
B.t.u. per gal.	133,000
Cost per gal.	5c.
B.t.u. for 1 cent.	26,600

Gas—

B.t.u. per cu. ft.	960
B.t.u. per 1,000 cu. ft.	960,000
Cost per 1,000 cu. ft.	25c.
B.t.u. for 1 cent	38,400

Coal—

B.t.u. per lb.	14,000
B.t.u. per ton	28,000,000
Cost per ton	$3.00
B.t.u. for 1 cent	93,333

Ratios—

1 cent will buy 1.44 times more heat in gas than oil.

1 cent will buy 3.54 times more heat in coal than oil.

1 cent will buy 2.43 times more heat in coal than gas.

Coal can be sold for $10.62 per ton and equal oil at 5c. per gallon.

Coal can be sold for $7.29 per ton and equal gas at 25c. per 1,000 cu. ft.

Oil would have to be bought for 1.4c. per gal. to equal coal at $3 per ton.

Gas would have to be bought for 10.7c. per 1,000 cu. ft. to equal coal at $3 per ton.

A rather marked difference is noticed in favor of the coal, which goes far in paying for the initial cost of the pulverizing plant. The cost of coal preparation per ton has been given by Mr. Robinson. I shall briefly quote the tables showing these figures:

Capacity of Plant in Short Tons per Hour.	Average Total Cost for Preparation per Short Ton.
2	from 25 to 50c.
3	from 20 to 45c.
4	from 16 to 40c.
5	from 14 to 35c.
10	from 12 to 30c.
25	from 10 to 20c.

The fuel required for drying the coal will average from 1 to 2 per cent. of the coal dried.

The distribution of the total cost may be approximately stated as:

Fuel for drying	10 per cent.
Power for operation	30 per cent.
Labor	30 per cent.
Maintenance and supplies	25 per cent.
Interest, taxes, insurance and depreciation	5 per cent.
Total	100 per cent.

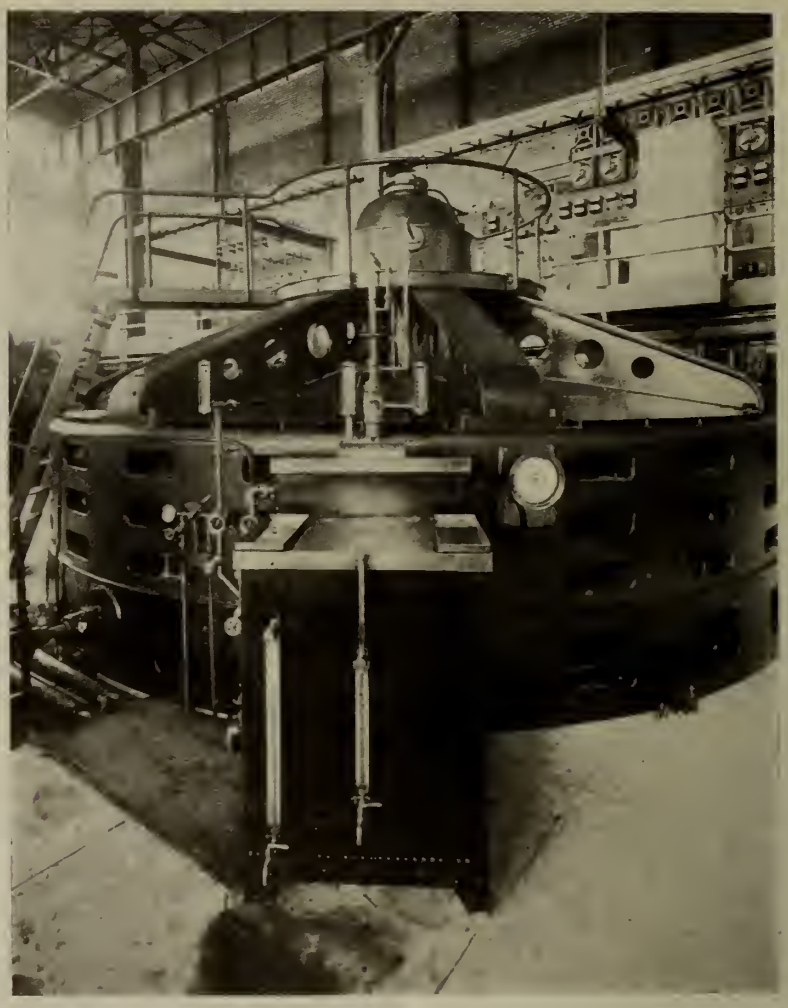
One of the matters most frequently mentioned in connection with this fuel is the disposal of the ash and its effect on the surrounding brickwork. The effect and control of the ash is a topic of sufficient magnitude to form the subject matter of an extended article in itself; and no attempt will be herein made to analyze this subject in detail. In the steam boiler the effect of ash is probably more difficult of control than in the metallurgical furnace. because, as a rule, the ash dust reaching the hearth is not in sufficient quantity to affect operation seriously.

A HYDRO-ELECTRIC OILING SYSTEM

The accompanying illustration shows the efficient equipment developed at Milwaukee, Wis., as a complete oiling system for the installation at the Hydro-Electric plant of Columbia Mills, Minetto, N. Y. The photograph shows the manner in which the oiling system is arranged on each wheel. There are six 2,000 h.p. generators in this station which is equipped with a circulating, cooling and filtering system.

The oil from the thrust bearing and guide bearing flows by gravity to the filter, and after passing through the process of filtration and cooling, it is again returned through these bearings, which is accomplished with a rotary pump, belt driven, from the generator shaft; this pump being located just below the rotor in the base of the machine. All supply and drain lines are furnished with thermometers, indicating at all times the temperature of the oil. It may be mentioned that a recording thermometer is used to record the temperature of the oil in the tub surrounding the bearing, and slight flow indicators are placed in the supply lines leading to the bearings. These indicators show at a glance whether or not oil is flowing, and are provided with electrical connections so that, should the flow of oil cease, an alarm will be turned in at the station switchboard.

Each individual system is designed to filter 3 1-2 gallons of oil per minute and in addition, an emergency system was included which consisted of a filter, not shown in the photograph, together with necessary pumps and overhead storage tanks which are so arranged that in case of failure of the pump or filter on any one of the units, the particular unit affected could be supplied with oil from the emergency system without having to shut down for a moment.



OILING SYSTEM APPLIED TO HYDRO-ELECTRIC SYSTEM.

POSITION OF BOILER FEED VALVES

By M. E.

It is usual to place the boiler feed valve somewhere near the surface of the water in the boiler, so as to avoid, as far as possible, the possibility of the cold feed water from coming in contact with the boiler plates or the furnaces. This tends to reduce distortion of the plates and consequent corrosion. It must not be forgotten that even when a feed-water heater raises the temperature of the feed to approximately 212 F., this temperature is considerably lower than that of the boiling water in the high-pressure boilers such as are widely employed at the present time, and therefore, the distortion referred to above is very liable to occur unless great care is paid to the question of design and the locality of the inlet pipes. In his paper on "Feeding and circulating the water in steam boilers," Mr. John Watson suggested the use of a device to automatically raise the temperature of the feed water to something approaching that of the water in the boiler, and he advocated the placing of the device low down in the boiler at its coolest part, thereby reducing the possibility of distortion, and at the same time assisting the natural circulation of the water. The idea certainly appears to be a good one, and it would be a good thing if experiments could be performed in order to test the value of the arrangement. In another type of feed valve, which is being tried on certain railway locomotives, the feed is introduced through a valve on the tap of the drum, in the form of a very fine spray, so that by the time it reaches the surface of the water in the boiler its temperature is probably not very different from that of the water itself. This device is also worthy of being tried on marine boilers. It may be found, of course, that it tends to cause priming, although where superheaters are employed no trouble need be feared on this account.

PROPOSED CENTENARY FOR JAMES WATTS

The Mayor of Birmingham has called a meeting with the object of organizing a centenary memorial celebration in honor of the inventor of the steam engine. The engineers of Birmingham have decided that a James Watt chair of engineering ought to be founded at the Birmingham University, and that a James Watt memorial building should be erected.

Watt, it will be remembered, was born at Greenock in Scotland in the year 1736. He died in Birmingham in 1819.

Power Plant Management; Coal and Ash Handling

PART IV

This Article in Continuation of Former Articles on the Same Subject Takes Up the Vacuum and Steam Jet Ash Conveyors and Deals With Their Installation in the Power Plant

By ROBERT JUNE, Mechanical Engineer

IF there arises in the mind of any reader of these articles on power plant management, a question as to why we have paid such detailed attention to the matter of the selection of economical systems of coal and ash handling equipment, let us say at once that it is easily the most difficult problem confronting the power plant operator. On no other question is it so easy to make a costly and almost irremediable mistake. Nowhere is it harder to be dogmatic in assertion regarding the merits of any particular system for a given set of power plant conditions.

With a dozen possible systems to choose from, each costing from a few thousands to tens of thousands of dollars, depending upon the size of the plant, the power plant operator may be excused if he throws up his hands in despair. The situation is not made easier by the practical necessity which he is under to make a choice. The increased cost of labor and coal, together with the uncertainty regarding deliveries of the latter, have made imperative adequate coal storage and economy in the cost of handling coal from the time it reaches the power plant yard to its final disposition in the form of ashes.

In our previous articles, we have discussed the applications and limitations of various types of chain and belt conveyors, telphers and skip hoists. We have indicated the desirability of separating the coal and ash handling systems, but have yet to examine two of the most important systems of ash disposal—the vacuum and steam jet systems.

Vacuum Conveyors

In the vacuum conveyor, a line of hard cast iron pipe is extended from the ash pit, or if there is no ash pit, from a point under the boiler room floor, immediately in front of the furnace, to an air-tight ash storage tank. Vacuum is established in the storage tank by a motor or steam turbine drive centrifugal exhauster. An air washer is installed between the storage tank and the exhauster, to remove ash dust from the expelled air.

When the exhauster is in operation a current of air, moving at very high velocity, is produced in the pipe through an intake port at the end of the line. Ashes, when introduced, are whisked through the pipe and into the storage tank.

The advantages of this system are:

1. Flexibility: The pipe can be carried in any direction, up or down, right or left, with discharge point a considerable distance from boiler-room.

2. Adaptability: Easily installed in all types of boiler-rooms, old and new.

The disadvantages are:

1. Limitations of Service: Ashes can only be removed from one furnace at a time, as the opening of an intake near the tank will destroy the velocity at an intake farther away. Only about 2,500 to 3,500 h.p. of boilers can be served by a single system—above that h.p. additional complete systems must be installed.

2. Leakage: Both pipe line and tank must be maintained in an air-tight condition at all times.

3. Explosions: There is danger of explosion of ash dust and gases in the storage tank. The introduction of water into the pipe line has been tried in an effort to overcome this, but the success of such a means is doubtful, since a sufficient quantity of water to quench the ashes thoroughly will probably prove enough to choke the pipe with wet ashes. Water will also cause trouble by freezing the ashes in the tank in cold weather. and packing them so that their removal is difficult in other seasons.

4. Maintenance: As in all ash removal systems, except the skip hoist, maintenance is high on account of the abrasive character of the ashes. Pipe renewals, especially bends, can be expected after 6,000 to 8,000 tons of ashes have been handled. Exhauster repairs, especially to the impeller blades, are to be expected, due to some ash dust coming through the air washer.

STEAM JET CONVEYOR INSTALLED BELOW ASH PIT.

Steam Jet Conveyor

Like the vacuum conveyor, the steam jet conveyor primarily consists of a pipe line into which the ashes are fed, and through which they are transported to a discharge point. The similarity between the two systems is not great, however. In the vacuum conveyor the ashes are moved by suction through the entire length of the pipe line, while in the steam jet conveyor, suction is employed only in what is called the suction line immediately in front of the boilers or ash pits.

Suction is created by the action of high velocity live steam discharged into the centre of the pipe-line, in the direction of travel of the ashes. The steam discharge tends to create a vacuum behind it, which in turn creates a current of air through the air intake at the end of the line, similar to the action of the vacuum conveyor. The effective suction distance of one steam jet is, of course, limited, and if this discharge is exceeded, it is necessary to install booster jets. The discharge of the ashes beyond the steam jet is really an objection due to the force of the jet actually pushing the ashes through the pipe, hence the effective discharge distance of a steam unit is much greater than its suction distance, therefore in the average system no additional steam jets are necessary in the discharge line.

The advantages of the steam jet conveyor are :

1. Flexibility: Pipe can be carried in any direction. Any type of discharge may be used, as for instance,

(a) Where it is desired to fill a gully, or other low ground, the ashes are merely blown from the end of the pipe without any restraint. As the ashes are blown 50 to 75 feet beyond the end of the pipes, some ashdust will be carried over the neighborhood, even when the most effective water jet is installed in the line.

(b) For loading cars, wagons, etc., a baffle box may be used. Some trouble due to the dust may be anticipated with this system, but if properly designed the dust may be so minimized as not to be objectionable in manufacturing districts.

(c) Where an ash storage bin is desired, the most careful attention must be paid to design, so that no dust will be discharged with the exhaust steam; no trouble will be caused by water of condensation; no water will be allowed to come in direct contact with the ashes in the bin; ashes will be discharged into the bin without any remaining downward compound of the conveyor force, which will cause packing; impact of the incoming ashes must be taken by a suitable baffle, as ashes discharged against the bin walls will soon cut holes through them.

2. Adaptability: Can be installed in practically any plant, no matter how crowded.

3. Low Initial Cost: Owing to simplicity and freedom from mechanism, this is probably the cheapest effective system, so far as first cost is concerned, which can be installed.

The disadvantages of the steam jet conveyor are:

1. Clinkers: Clinkers must be broken to size to pass through intake openings. Under average conditions, burning run-of-mine bituminous coal, this is not a serious disadvantage, as clinkers can usually be easily broken with the hoe. In cases, however, where the ash produced is made up almost entirely of large hard clinkers, steam jet conveyors should not be considered.

2. Steam Pressure: Not less than 80 lbs. of pressure is required.

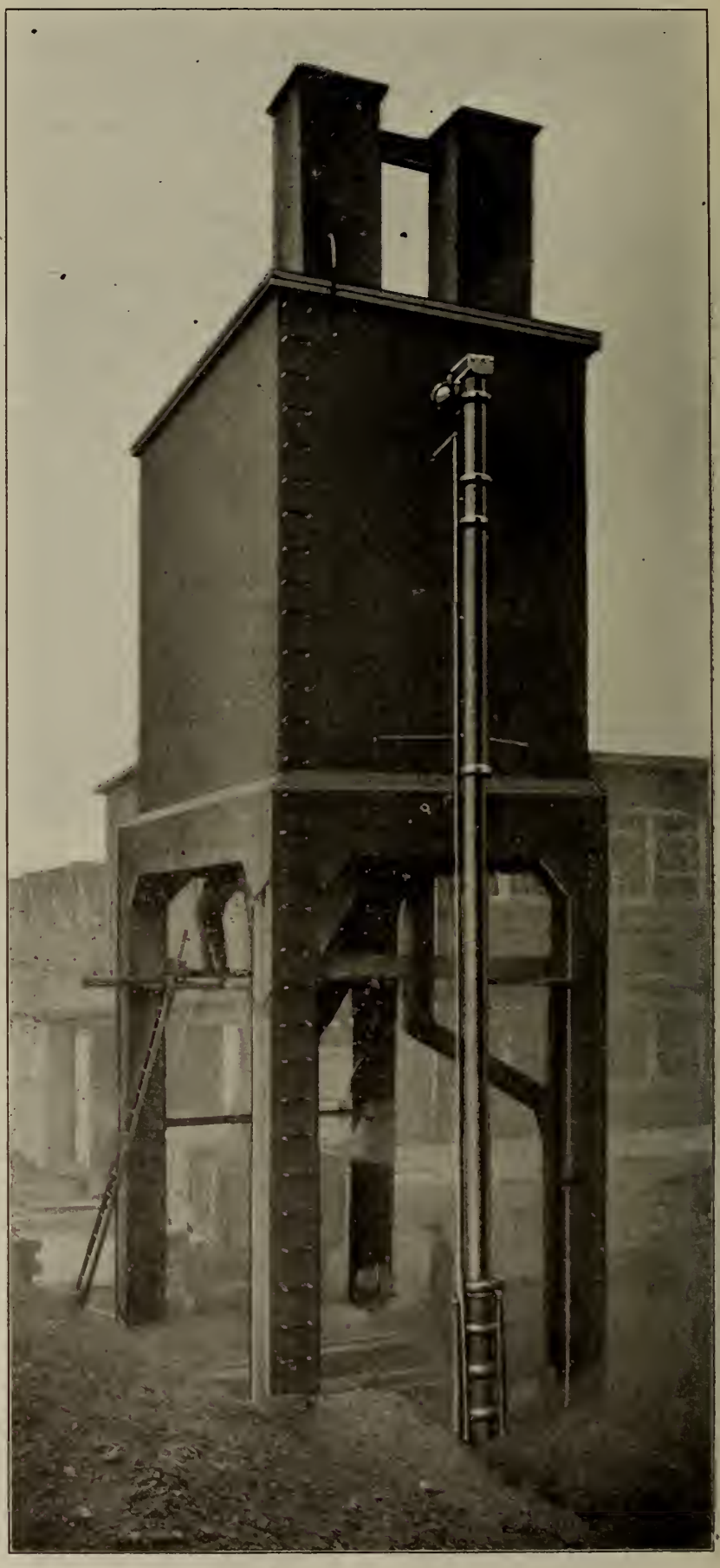
3. Wet Ashes: Generally speaking, wet ashes cannot be handled on account of packing at turns in the line. This eliminates certain types of installations, as for instance, water-sealed gas producers.

4. Limited Capacity: 2,500 to 3,500 h.p. of boilers is about all which can be handled by a single system; above that h.p. additional systems must be employed.

5. Maintenance: The abrasive character of the ashes render pipe renewals, especially at bends, an expected occurrence after 6,000 to 8,000 tons of ashes have been handled. In order to cut down renewal expenses, elbows are made with removable backs, and where possible long sweep bends are employed.

6. Ash Freezing: Ash freezing in storage tanks is to be looked out for in cold weather.

An idea of steam cost for a typical



TYPICAL STEAM JET CONVEYOR STORAGE BIN.

steam jet conveyor system may be obtained from Table I:

TABLE I

Boiler No.	Distance from Ejector.	Steam Pressure.	Quantity of Ashes Moved	Time.	Tons per Hour.	Pounds Steam Used per Min.	Steam Used per Ton Ashes Moved	Cost of Steam per Ton Ashes Moved.
1	4 ft.	110	300 lbs.	1'0"	9 00	37. 3	349.3	$.068
2	19 ft.	109	292 lbs.	1'0"	8.79	37 10	253.2	.07
3	35 ft.	109	284 lbs.	1'0"	8.45	37.10	274.9	.078
4	52 ft.	108	234 lbs.	1'0"	7 04	36.85	314.0	.088
5	64 ft.	109	210 lbs.	1'0"	6.30	37.10	353.3	.098
Average	34' 8"	109	264 lbs.	1'0"	7.92	37.10	289.0	$.080

As indicative of the labor saving effected by a conveyor of this type, one user reports the elimination of 1 ash wheeler, 1 teamster and 1 horse, at a saving of $12.00 per day. Conditions are described as follows:

"The only expense for maintenance, after six months' constant operation, was the replacement of the first section, beyond the steam nozzle, which was completely worn out. The conveyor handles the ashes from a battery of five (50) 150 h.p. boilers, and one 500 h.p. boiler. The coal used is a fine dirty slack, stored on the open prairie, and containing, owing to the inclusion of mining machine dirt, about 25 per cent. of ash. The ashes are left on boiler room floor in front of boiler until cleaning is completed, and are then put into conveyor, which handles the complete cleaning in about seven minutes. The grade conveyor pipe line rises about 80 per cent. for 200 feet, then 45 per cent. for about 40 feet, discharging onto an open pile."

Determining Class of Equipment to be Installed—By Calculation

We have now discussed all the important types of coal and ash handling equipment. Regarding our ash conveyor question as disposed of, let us give a final glance at the problem of making an intelligent selection between flight, pivoted bucket, and belt conveyors for coal handling.

Reginald Trautschold is authority for the following table of annual operating costs:

TABLE II

ANNUAL OPERATING COSTS IN DOLLARS PER TON-MILE

Equipment	Fixed Charges	Operating Expenses	Power Expenses
Flight Conveyors (including 20% elevation)	17.5/N	0.55	5.30 Pc.
Belt Conveyors (including 20% elevation)	109.5/N	0.15	2.15 Pc.
Pivoted Bucket Carriers (including 33 1-3% elevation)	520.0/N	0.40	2.65 Pc.

N—equals hours per year equipment is in operation.
Pc—equals cost of power per horsepower.

As an example of methods of determining by calculation the type of equipment to be installed, let us assume that a power plant requires 40,000 tons of coal a year, and that the distance from the track hopper or point of delivery to the far end of the conveying system is 440 ft., we have thus 3,333 ton miles per year. Let us also assume that when in operation the conveyor system must handle 80 tons per hour.

We know that the initial cost of the belt conveyor will be considerably heavier than that of the flight conveyor, but our choice will be governed by consideration of costs per ton moved, as well as initial costs.

SAMPLE CALCULATIONS

(a) Flight Conveyor System: 40,000 tons annually.
440 ft., 80 tons per hour.
Power cost, 2c per HP.
Hours of operation $\frac{40{,}000}{80}$ equals 500 hrs. per year.
Annual cost: Refer to Table II.

3,333	x $\frac{17.5}{500}$	equals	$116.65
0.55	x 3,333	equals	1833.15
5.30	x 3,333 x .02	"	353.30
Total			..$2303.10 or 5.76c ton

(b) Belt Conveyor: Same conditions as (a)
Annual cost:

3,333	x $\frac{109.5}{500}$	equals	$729.93
0.15	x 3,333	equals	499.95
2.15	x 3,333 x .02	"	153.31
Total			..$1403.19 or 3.66c ton

(c) Pivoted Bucket Carries: Same conditions as (a), except length, which is 220 ft. Service 1,667 ton-miles per year.
Annual cost:

1,667	x $\frac{520}{500}$	equals	$1733.67
0.40	x 1,667	equals	666.70
2.65	x 1,667 x .02	"	88.35
Total			..$2488.72 or 6.22c ton

The foregoing examples are, of course, merely illustrative of the principles of calculation. If conditions were changed, the results would not be relatively the same. Nor do such figures alone tell the story, since it must be remembered that the pivoted bucket carrier could be used for ash handling as well. The one rule then is to take a given set of plant conditions and to work out the actual costs of installation and operation for each of all these various types of conveyors, which might be installed. Only by thorough investigation can the proper equipment for any plant be chosen.

Some experiments, the results of which are recorded in the "Journal" of the American Leather Chemical Association, have been carried out with the object of determining the wearing qualities of leather from different parts of the hide. They showed that leather from the butt wore on an average at least twice as long as that from the belly portion of the hide, and about one and one-third times as long as that from the shoulder portion.

The relative merits of different classes of explosives were given by Professor J. Young in a recent lecture, as follows: Where the material is to be displaced, but not shattered, a slow-acting explosive is required. Black gun-powder, with a velocity of explosion of 300 m. per second, is good. Blasting powder is still slower in action, and is suitable for quarrying where stone has to be obtained in large blocks. Bobbinite, still slower in action, is much used in coal mines with soft coal. All these are comparatively weak explosives, and large charges are required. Where great power and rending effect, with a moderate shattering effect, is required there is little to choose between the ammonium nitrate class and the perchlorate explosives, except that the former are the safer to handle, but most susceptible to moisture. Some grades of amatol made for military use would also be suitable, and vast quantities should now be available. Where the greatest power in the smallest bulk is required—this will be the case where hard rocks are to be blasted and small drills are used—the nitroglycerine explosives are decidedly best, as they have a high density, great power, and a high velocity of detonation.

A letter from "Over There" tells of the first experience in the trenches of a negro waiter who had been boasting of the things he meant to do to the Germans when he got a chance. Arrived in the first line ditch, Rastus (the other half of his name seems to have been lost somewhere in the shuffle) climbed over on the firing step and glared over in the direction of the enemy. Then, waving his rifle aloft, he shouted:

"Hey, dere, you Bush solders, show me sumpin! Come on, you Kaiser! Come on, you Kruppses! Gimme some dem bombs! Gimme some scrapnel! Gimme some shells on toas'! Gimme 'em! Das all, jes gimme 'em!"

About that time a big shell exploded about 50 feet from where the doughty ex-waiter was standing, the concussion knocking him head over heels back into the trench. Ruefully he fumbled his person to see if he had been wounded.

"Well," he said as he gingerly touched himself here and there, "you kin say whutcher please about dem Germans, but they sho do give service!" — Exchange.

Factors Affecting the Proper Area of Safety Valves

The Following Article Was Received in Response to a Question Asked in Our Question Box, April 5th Issue. The Information Given is Interesting From the Standpoint of Design and Proportioning of Safety Valves

By J. E. MacCORMACK

THE recommended proportion of safety valve area to grate area is one square inch of valve area to two square feet of grate area if the valve is of the ball and lever type, or one square inch of valve area to three square feet of grate area if the valve is a spring loaded "pop" valve.

Other conditions being equal, the larger the grate area the more fuel can be burned, and thus the more steam produced in a given time; therefore, if all other vents are closed, more safety valve area is required to permit this steam to escape without undue accumulation of pressure in the boiler.

The following nominal sizes of pop safety valves have been recommended:

2 in. pop valve for 9.4 sq. ft. of grate surface.

2½ in. pop valve for 14.7 sq. ft. of grate surface.

3 in. pop valve for 21.2 sq. ft. of grate surface.

4 in. pop valve for 37.6 sq. ft. grate surface.

5 in. pop valve for 58.9 sq. ft. grate surface.

6 in. pop valve for 84.8 sq. ft. grate surface.

Although it has been customary to calculate the required safety valve area on the basis of the grate area installed, a (seemingly) more correct method would be to make it proportional to the quantity of steam the boiler is capable of producing, when worked at its full capacity. The reasonableness of this is apparent when one considers the difference between two similar boilers, the one under natural draft, and the other under forced draft. A safety valve adequate for the one might be somewhat too small for the other.

Prof. Rankins' rule is: "Multiply the number of pounds of water evaporated per hour by .006, and the product will be the required area of the valve in square inches." This allows 6-1000 of a sq. in. valve area per each pound of water evaporated per hour. The U. S. Navy Dept. deduced from a series of experiments this rule: "Multiply the number of pounds of water evaporated per hour by .005 and the product will be the area of the valve in square inches." This allows a smaller valve than does Prof. Rankin's rule.

Another method suggested is to calculate the valve area by the area of the heating surface, and the following is a part of a table prepared by a New York firm:

Boiler pressure in pounds above the atmosphere	Area of orifice in square inches for each square foot of heating surface
90	.000796
100	.000719
150	.000481
200	.000364

But as the ratio of heating surface area to grate area varies within wide limits and is not all equally effective, being less effective the further removed from the immediate vicinity of the furnace, the heating surface alone is not a criterion.

Then, too, the pressure carried has a bearing on the subject. A British B.O.T. rule for spring-loaded valves is: "The area of the valve per square foot of grate equals 3.75 divided by the absolute pressure per square inch." In other words, to ascertain the total area, multiply the grate area by 3.75 and divide by the absolute working pressure of the boiler. It will be noticed that in these last two rules the area of the orifice decreases as the pressure increases. This is evidently on the basis that as the pressure increases more steam can escape through a given opening. One might infer from this that a boiler having on it a safety valve only large enough to serve it at a high pressure would require a larger valve in the event of pressure being subsequently materially reduced as a safety precaution, owing to boiler deterioration. On the other hand, however, when valves rise from their seats under increased steam pressures the ratio of lift to area is diminished. This ratio has been carefully determined by experiments covering a considerable range of pressures and records made by tabulation.

Normally, a boiler should be furnished with a steam pipe of a horse power approximating that of the boiler. A rule for determining the capacity in horse power for a given size of pipe is: "Multiply the square of the diameter by six," and by the method of using a ball and lever safety valve with connection below for boiler, side outlet for escaping steam, and another side outlet for steam pipe connection to engine or other steam consumer, the valve will naturally be of a size nominally as large as, or larger than, the nominal size of the steam pipe used. This would appear to be a logical solution of the problem since the duty of the boiler, if used for power purposes only, would, to an appreciable extent, be governed by the size of the steam pipe connecting it with the engine, and as the boiler would most likely be fired accordingly, the safety valve would thus have a direct ratio to the normal rate of combustion adopted, but I have known this suggestion to prove unreliable under some conditions. Another feature that steps in here is the claim made that "the maximum desirable diameter for safety valves is four inches, for beyond this the area and cost increase much more rapidly than the effective discharging capacity." Given two boilers, one having four times as much grate area as the other, and the smaller one requiring a three-inch (diameter) valve, then, if we put a six-inch (diameter) valve on the larger boiler, we have quadrupled the valve area, but have only doubled the circumference around which the steam escapes; thus, to quadruple the area of opening the larger valve must have twice as much lift as the smaller one has, and now, too, we realize a possible chance of misunderstanding printed rules, if uncertain whether they are meant for determining the area of valve face or for determining the area of valve opening, or orifice.

A rule proposed for determining the size of safety valve required for a boiler under given conditions is as follows:

"Find how much water the boiler can possibly evaporate under the given conditions by multiplying the greatest amount of coal which can possibly be burned per square foot of grate surface per hour under the given conditions by the grate surface in square feet and by the greatest number of pounds of water which each pound of coal would evaporate; and provide valve area to amply allow of the discharge of that amount." And to find the necessary area of opening: "Multiply the absolute pressure at which the valve is to be set by 51, and divide the number of pounds of steam possible to be generated per hour, determined as above, by the product." This procedure involves some factors not readily determined with exactness without conducting a series of experiments under the given conditions and recording the data obtained, some of which, however, would not be applicable for use in accurately solving the safety valve problem, where conditions were different. Then after having ascertained the required opening we would necessarily calculate by the circumference of the different valve heads, their bevel and

their (assumed) lift when choosing one from among the nominal or stock sizes; and by calculations involving these factors, determine the nominal size or the particular make and size of valve to install.

It is no new thing to find that a plant designed for a certain work and output has in later years expanded, increased its business and output, or perhaps added side lines, added more machinery, and, owing to the position and original plan of the building, there cannot conveniently be added sufficient additional boiler units to supply the demand for steam when working at a normal capacity; therefore, their boilers become overloaded and are forced if the required amount of steam is provided.

The U. S. Geological Survey Bulletin 367, prepared by Walter T. Ray and Henry Kreisinger, and entitled "The significance of drafts in steam boiler practice," says in the introduction on page 5: "The experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers. These increases require about double and treble the quantities of air to be put through the fuel beds and boilers." On page 56 it says: "A caution is in place here. The attempt must not be made to put more air through existing boilers by running the fans a great deal faster, because the power consumed will increase far faster than the above calculations estimate. New fans and engines must usually be installed of sufficiently larger size to supply the larger quantities of air at as high an efficiency, if not higher."

"As has already been suggested, one way of reducing the work required from the fan in the case of doubling the capacity of the boiler is to increase the grate surface, so as to avoid a high increase of pressure drop through the fuel bed, increasing materially only the pressure drop through the boiler proper. A low pressure drop through the fuel bed would also insure better combustion of the fine particles of coal which would be carried out of the stack unburned if high gas velocities through the fuel bed were employed, the high velocities being obtained by high pressure drops."

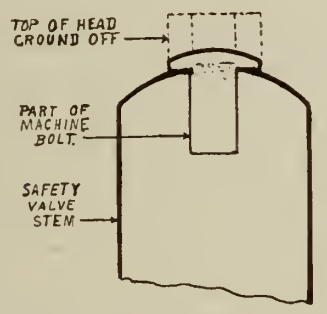
On page 56 it says: "If two or three times the usual amount of gases be forced through a stoker and boiler, so as to produce nearly two or three times as much steam, the total work expended on the fans will be increased perhaps 8 and 27 times respectively (2^3 and 3^3)."

After giving some estimates on steam required for the forms, and giving a couple of tables, it says on page 59:

"Doubling, trebling, and perhaps, with larger grate areas, even quadrupling the rate of working a boiler seems to be sound commercial practice. Furthermore, by carefully designing a fan the above steam consumption could nearly be cut in half. This we must admit if we study efficiency tests made on fans of various makes by trustworthy experimenters, who have shown that the efficiency of a blower from the shaft to air delivered lies ordinarily between 10 and 50 per cent.

Bureau of Mines technical paper 63, entitled "Factors Governing the Combustion of Coal in Boiler Furnaces," says on page 39: "For a rate of firing of 28.4 pounds of coal per square foot per hour, a combustion space of 2.9 cubic feet per square foot of grate area should be sufficient to reduce the combustible content of the flue gas to 0.2 per cent." And a little further on it says: "Practically complete combustion may be obtained, however, with a rate of firing of 60 pounds if the combustion space is more than five cubic feet per square foot of grate area."

It is obvious that for high draft velocities combined with economy especial care is necessary with regard to preventing all air leaks through the setting, though the leaks make less difference if, in the case of mechanically-generated draft, the said draft is produced by a pressure fan at the ash pit and an exhaust fan at the uptake, the effect of their united action being so regulated as to provide the required pressure drop



REPAIR TO SAFETY-VALVE STEM.

through the fire and through the boiler, yet maintain practically atmospheric pressure in the combustion chamber. Then the air pressures inside the setting and those outside the setting at this point will, by nearly balancing each other, minimize the effect of air leaks in the masonry.

The proportion between grate and heating surface should be, to a large extent, determined by kind of fuel to be used, the draft available being also a factor to consider either with a view to increasing it to suit a given fuel or given grate area, or else as a determining factor fixing the minimum of grate area below which it is not practicable to go when using a given fuel. A large grate area lowers the rate of combustion (per sq. ft.) and thus permits the use of inferior grades of fuel, which could not be economically employed in furnaces having a small ratio of grate area to total heating surface. Aside from the use of average steam coal for fuel there is the factor of differently constructed grates with different percentages of opening for other grades of fuel, and in some plants Dutch ovens are installed and others have an increased grate area designed for use with unusual fuels as sawdust, spent tanbark, etc. In such furnaces a change to a good fuel would call for a reduction in grate area used, either by cutting out boiler units or by (if the change was to be for a short time only) removing a portion of the grates and inserting dead plates, for with too large a grate area to admit of using the proper amount of draft for that fuel the combustion rate per unit of area is slower, the furnace temperature is lower, and the waste heat units to the uptake becomes a greater proportional amount of the total heat generated in the furnace, for speaking of low furnace temperatures, it must be remembered that the only heat the boiler can utilize is that due to the difference in temperature between the fire and the water in the boiler. Thus the kind of fuel used, the rate of combustion and the amount of heating surface in the boiler, all modify the amount of grate area desirable.

In summing up all the above we seem to get nowhere, except to realize that numerous factors have a bearing on the safety valve problem. Some of these are rather difficult of determination without the aid of certain indicating devices, which are not always provided, and, anyway, the combined effect varies with individual plants. Obviously, the manufacturer cannot accurately forecast the various conditions under which each of his boilers will ultimately be operated, and in choosing the grate area rule for determining the size of safety valve he has not only as definite a single factor as any to work from, but it is also a factor easily ascertained by any operator at any time, and if the area is increased or decreased later, the operator can estimate that also, and ascertain if his grate area and valve area conform to the rule. Probably the manufacturer assumed that the grate area used would be a length equal to the diameter of the boiler and a width six inches less than the diameter of the boiler, and he put on a safety valve accordingly. At any rate the problem of the size of the safety valve installed is almost always, if not always, determined for the operator, the valve having been already in place when he arrived on the scene. I think the best he can do is to add a second valve if he finds the original one inadequate. I will now give three object lessons from personal experience:

Considerably over a dozen years ago I visited the scene of a boiler explosion. One of the principal machines had failed to operate satisfactorily and the engineer had been signalled to shut the engine down. Before the faulty machine was again put into proper working order, the boiler exploded. When questioned, no one appeared to know where the steam gauge hand was pointing just previous to the explosion, but several had noticed that the safety valve was working for some time, or, at least, a little while before. A number stated that they had, on previous days, been in the boiler room and saw

the steam gauge hand climb to 120 or higher, while steam was escaping at the safety valve, and one man claimed to have seen the hand at 135 lbs. under similar conditions. Wood was the fuel used, and wood embers do not cool down as quickly when draft is reduced as does a bituminous coal fire. Of course, there were legal proceedings about it, but that is an aside from the subject now in hand.

On another occasion and in another mill I went down to the fire hole at a time when the engine was, and had been for some minutes, temporarily shut down. The man in charge and two or three other men were standing in front of the boiler, apparently quite at peace with each other and with the world in general. Steam was escaping from the safety valve and the steam gauge hand was pointing at 120. As I had myself set this safety valve at 110 lbs. some time before this, I now took quick steps to have the heat from the fire still further reduced. Soon the pressure gradually lowered, until at 110 the valve closed again. This valve was a ball and lever type, and of the same nominal size as the steam pipe used. There was a spring pop valve of less than half the area on a discarded nearby boiler, and in the side of the dome of the used boiler just mentioned, there happened to be a plugged hole right size for this pop valve. Next Monday morning before steam was raised the said pop valve, by means of a nipple and elbow, was attached to this used boiler and subsequently set to nearly correspond with the ball and lever one. As a result there was no more accumulation of pressure after it rose enough to open the second valve. The following year the setting was pulled down and rebuilt and the furnace front arrangement changed. The pop valve was removed for re-grinding, and as this job had been neglected and was not yet finished when the plant was ready to be put into operation, it was decided that they would do with but the one valve for a day or two at first. Before long it was found that the changes made had rendered the second valve unnecessary and it was never reinstalled. In this case the differences in the condition of the setting and arrangement of the furnace so modified the amount of control the fireman had over his fire, that it made the difference between requiring, and not requiring, the second safety valve.

Let no one think that in the above criticism I wished to compromise the abilities or character of the man in charge. On the contrary he was a good hand, but in charge of poorly designed equipment.

On one occasion an American was given charge of a steam plant using sawmill coarse refuse for fuel. He brought with him some ideas new to the local operators. One of these ideas was that in this type of plant no bridge wall was required, and accordingly he removed it. He did not (and apparently it was through motives of his own) remain for the full season, and his successor when questioned as to the effect of removing the bridge wall assumed a non-committal and somewhat evasive manner; but in a neighboring plant where the idea was copied as an experiment, it was found that the boiler did not steam easily in the morning until sufficient coals had accumulated behind the grates to (in effect) serve as a bridge wall in so far as directing the course of the products of combustion was concerned. Whuen shutting down, as at noon or night, this bridge of coals (wood embers) continued to give off heat for a time and thus increased the duty of the safety valve at these times and more especially so when an unexpected shutdown occurred during working hours, and might in extreme cases call for the putting on of a small second safety valve. It was anticipated that a new bridge wall would be put in.

Some old safety valves have been worn and reground until the upper edge of the lever is no longer level but slopes downward towards its outer end. This causes the ball to slowly work its way along the lever until the valve no longer lifts at the pre-determined pressure. Different plans have been adopted to prevent this, and some of them may be acceptable, but in any case I prefer to have the top of the lever level, or, if anything, sloping slightly upward towards its outer end, thus preventing this tendency of the ball to work further out, and, by this means, avoid the use of the above devices, some of which may I think interfere with the free rising of the valve. As I have already written and sketched what I consider a most easily made and at the same time reliable method, I will here suggest a different one, namely—drilling axially, in the top of the valve stem, a hole not exceeding in diameter, say, one-quarter the diameter of the valve stem, and inserting in it a piece cut from the head end of a machine bolt to fit. If necessary file or grind some off of the top of the head of this bolt, leaving it a little higher at the centre than at the outer edges. The accompanying sketch is supposed to represent a sectional view with the hole in the stem bottomed out flat, as this would let the body of the bolt bear weight without jamming so tight as to be difficult to remove subsequently if this was desired.

In making the repair care should be taken to see that no chips or filings attach themselves to the valve stem or get a chance to work into any part of the valve mechanism, and this should be attended to before re-assembling the valve. It would not do to attempt this repair with the valve assembled. When firing up after making this or any safety valve repair, one should carefully watch both the steam gauge and the safety valve to see that they correspond as before.

With regard to accumulation of pressure after the safety valve lifts enough to let steam escape, there are rules which allow an accumulation of 7 to 10 per cent., but as a matter of personal opinion I do not like to see the pressure rise very much after the valve once lifts, and more especially so if the draft is at the time reduced to a minumun or nearly so. At any rate by the B.O.T. rule, which allows of an accumulation of ten per cent., the test is that in the presence of a person authorized or appointed by the Board, the boiler shall be under full steam and full firing for twenty minutes with feed and all stop valves closed. Obviously a valve amply large to permit of this with an accumulation of only 10 per cent. should allow but little accumulation in the case of a temporary shutdown of the engine and with the furnace draft then reduced as far as practicable.

In the event of a valve already installed proving itself inadequate by allowing too much of this accumulation, some one or more of the rules given in the beginning of this article may help toward deciding what size auxiliary valve (if any) is required.

In one or two cases I have known a valve to drizzle and blow some at 3 to 5 lbs. pressure, below that at which the valve actually lifted from its set, and in these cases proper regrinding put them so that there was no apparent accumulation after the valve began to blow, although to a bystander there would appear to have been while they were in their former leaky or worn condition. To the engineer, however, the cause of the apparent accumulation was self-evident. He would be quick to distinguish between an apparent accumulation due to a worn valve, and an actual accumulation due to small valve area, and would apply the proper remedy when circumstances permitted work on the valve.

HOW TO BLACKEN BOLT HEADS

JOHN H. BEDELL

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Specially prepared lacquers can be obtained from supply houses for giving metal work for electrical switchboards a dull black finish. If such preparations are not available, dull black paints, which will serve in emergencies, can be obtained in ten-cent. or larger cans at most hardware stores or paint shops.

The following process has been used successfully for giving bright-finish steel cap bolt heads a dull black finish: First, heat the bolt to a dull red in a blow-torch flame, then dip it in asphaltum paint. Now burn the paint off with a blow-torch and rub it with a cloth while it is still warm. If the bolt is permitted to cool before it is rubbed with a cloth, the resulting finish will be glossy instead of dull.

The Cooper-Hewitt Electric Company, Hoboken, N.J., have issued an attractive calendar well illustrated with half-tone engravings showing installations of their lighting systems. This calendar shows installations in various classes of manufacturing establishments from machine shops to textile mills.

Supports for Wrought Iron Conduit

Many Circumstances Arise in Which the Ordinary Pipe Hanger or Clip Cannot be Used for Supporting Conduit Work—The Author Gives Some Practical Hints Which Help in the Erection of Conduit or Pipework

By E. A. HUGHES

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IN planning industrial-plant wiring installations for electric light and power, the designer must frequently use, for supporting conduit runs, devices which cannot be obtained commercially. This is true particularly when the wiring is being installed in a building of structural steel construction. Where a concern erects considerable wiring, it is always advisable to insure minimum cost, to standardize a line of conduit supports. However, it may happen that the amount of wiring which is installed does not justify this procedure. Under such conditions the engineer must design his supports as he proceeds with the planning of the job. It is the intention to show in this article some supports which have been used, particularly in steel mill buildings, for sustaining conduit, and which experience demonstrates are entirely satisfactory.

Probably the fitting applied most frequently for supporting conduits is the

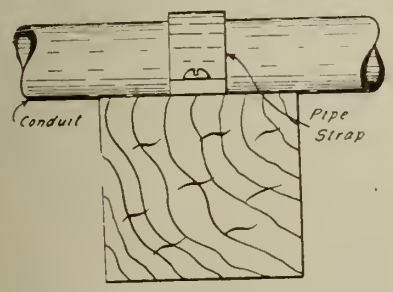


FIG. 1—CONDUIT FASTENED TO TIMBER BY A PIPE STRAP.

standard galvanized pressed-steel pipe strap. This can be obtained at the plumbers' supply houses for pipe of practically any commercial size. On

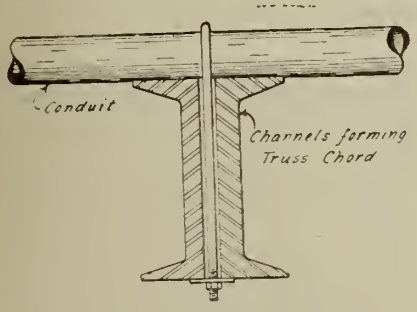


FIG. 2—CONDUIT CLAMPED TO CHANNEL BY MEANS OF V BOLT.

wooden surfaces, the strap, with the conduit clamped under, it can be attached with round-head wood screws, as shown in Fig. 1. Sometimes flat-head screws are used for this purpose, but they are not well adapted for it. Where a flat-head screw is applied, the flat part of the head of the screw will project above the surface of the metal of the pipe strap. It thus provides a place where dirt and dust can collect and upon which cloth or waste will catch if these materials are used for wiping off the conduit. When the conduit run is located where it will not be seen, this feature is of no importance, but close to the floor, or around the machines where the conduit may be wiped occasionally, it should be considered.

Where pipe straps are used to clamp conduit runs to the faces of steel columns, or to other members, small holes can be drilled in the members and then tapped for the accommodation of machine screws that will pass through the holes in the pipe strap. U bolts are very useful for clamping conduit runs to the chords or to other members of trusses, which a conduit run crosses. Figs. 2 and 3 show typical applications. Usually there is a space between the two members comprising the top or the bottom chord of a truss. This slot is the thickness of the gusset plate to which the members are riveted.

It is the practice of the fabrication plants to make these gusset plates as thin as is consistent with good design. Sometimes the slot is only 3-16 in. or ¼ in. wide. If such narrow slots are provided in the truss, it is not possible to get a U bolt big enough to have adequate strength through the slot. The U bolt for this purpose should be made of rod at least ¼ in. in diameter. A 3-16 in. rod can be used where the space available will not accommodate a larger one. However, experience has been that the wiremen, in tightening up the bolt on a 3-16 in. thread, will twist the rod asunder at a thread.

If the matter is considered prior to placing the order for roof trusses, arrangements can be made with the fabrication plant to provide a wide space, at least 11-16 in., between the steel members forming the truss chords. The bolts used in any space should be 1-16 in. in diameter smaller than the width of the space, to provide adequate clearance. A 5-8 in. bolt can be used in an 11-16 in. slot. A bolt of this size is much larger than is required for supporting conduit, but it is none too large for supporting steam and air pipe lines, heating and ventilating ducts and shaft hangers. It is seldom that a U bolt made from a rod larger than 3-8 in. is required for supporting conduit; 1-4 in. rod is more frequently used and is the best all-round size. As above noted, 3-16 in. rod is too small for best results.

Fig. 2 shows a line of conduit supported on the upper flanges of two channels comprising the lower chord of a truss. Space between the channels is ½ in. wide, and the U bolt is of ¼ in. stock. A punched washer is inserted under the nuts of the bolts, so that the corners of the nuts will not catch on the edges of the channel when the nuts are turned. Fig. 3 shows a similar arrangement wherein a conduit line is clamped to the upper edge of a truss chord composed of two angles. This arrangement provides a very secure support, because the relatively sharp edges of the angles dent into the conduit slightly, due to the pressure exerted in turning the nuts. The dents made by the angle edges, though usually deep

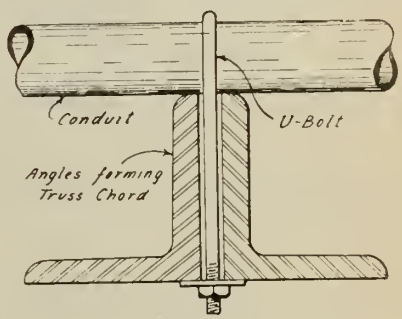


FIG. 3—DETAILS OF "U" BOLT FOR 2 IN. CONDUIT.

enough to prevent lateral movement of the conduit, are not deep enough to injure it appreciably. It is impossible to exert enough pressure by turning the

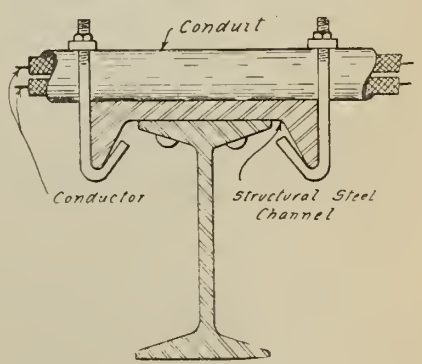


FIG. 4—CONDUITS CLAMPED BY HOOK BOLTS.

nuts of a ¼ in. U bolt to crush the conduit. The ¼ in. rod will break at the threads before the conduit will crush.

Each angle is 6 in. x 4 in. x ⅜ in. section. The U bolt is bent from ¼ in. stock. When making the U bolts, the

ends must be threaded before the ends are bent into a U form, because after it is bent there is not sufficient clearance for turning the die for threading. U bolts can be made very quickly from ¼ in. rod by cutting the stock cold for the required number, and then threading the ends, and bending the threaded rods around a piece of the conduit of the required size. The rods can be bent cold. Punched washers are provided in Fig. 3

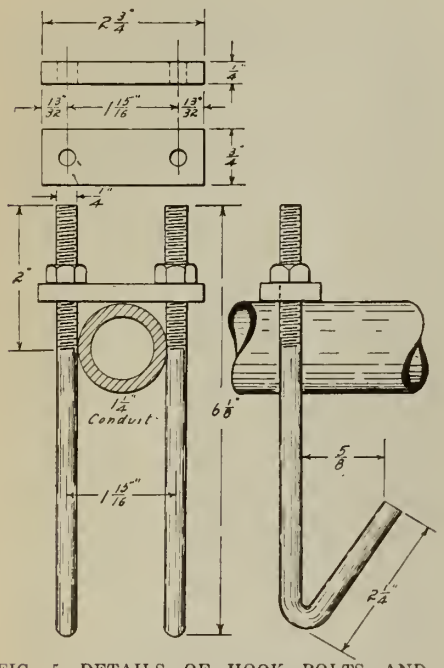


FIG. 5—DETAILS OF HOOK BOLTS AND STRAP FOR 1¼" CONDUIT.

to prevent the corners of the nuts from catching on the edges of the angle when the nuts are turned.

Sometimes it is necessary to attach a conduit run to a girder composed of a channel and I beam, as shown in Fig. 4. Two hook bolts and a strap similar to those detailed in Fig. 5 for 1¼ in. conduit can be used for making the attachment. The bolts are bent from ¼ in. rod. The hook on each bolt can be formed by bending it over the flange of a channel, or an I beam of suitable section. The pitch or slant of the flanges on all standard I beams and channels is 6:1, and the hook on the end of the bolt can be bent accordingly, if a section suitable for a bending form is not available. The strap for use with each pair of hook bolts can be cut cold with a shear from bar, and the 5-16 in. holes in each strap can be punched rather than drilled.

A method of supporting a conduit up to the face of a column is outlined in Fig. 6. In a location where neatness is essential, it is much better to support a conduit run up a column like that of Fig. 6, with pipe straps held by round-head machine screws turned into tapped holes in the column, than with the clamp illustrated. However, where a great many attachments have to be made to column faces, and where they are in non-conspicuous locations, it is usually cheaper to make up a clamp similar to that of Fig. 6 in the shop and send it out to the jobs, than it is to drill and tap screw holes in the columns for the pipe straps.

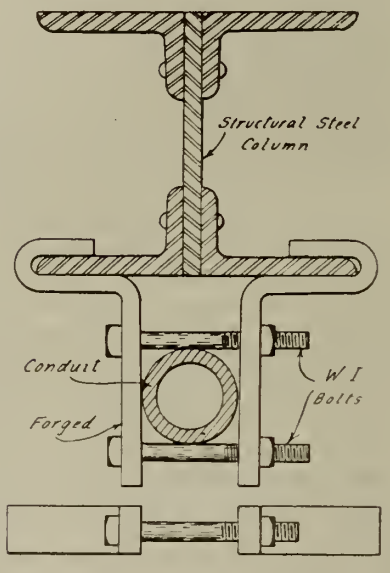


FIG. 6—CLAMP SUPPORTING CONDUIT ON FACE OF COLUMN.

NEWLY-DISCOVERED PRODUCT

Everybody knows that the Zeppelins failed in the war owing to their vulnerability, due to their being filled with hydrogen. German chemists failed to find a substitute, but the British Admiralty has found one and has arranged for its production in large quantities. The Canadian Mission, whose offices are in Regent Street, state that helium has been found in Canada. Next to hydrogen, this is the lightest known gas. Helium is a most suitable filling for airship envelopes, in that it is non-inflammable and non-explosive, and, if desired, engines could be placed within the envelope and a smaller internal envelope could contain the gas. By its use it is possible to secure additional buoyancy by heating the gas, and this fact may possibly lead to considerable modification of air ship manoeuvres and navigation. The loss of gas from diffusion through envelope is less with helium than with hydrogen, but, on the other hand, the lifting power of helium is 10 per cent. less than that of hydrogen.

It became evident from preliminary investigations made by Sir Richard Threlfall, and from calculations submitted to him as to cost of production, manipulation, etc., that there was ground for believing that helium could be obtained in large quantities at a cost not prohibitive. Professor J. C. McLennan, of Toronto University, was invited by the Board of Inventions of the Admiralty in 1915 to determine the helium content of the supplies of natural gas within the Empire, to carry out a series of experiments with the helium available, and also to work out all technical details regarding the production on a large scale of helium and the purification of such supplies as might be secured. In the course of investigations it was found that large quantities of helium were available in the natural gas in Ontario and Western Canada, which could be produced at the cost of 1s. per cubic foot. In the summer of 1917, when the United States had decided to enter the war, and when the investigations of Professor McLennan were well under way, proposals were made to the authorities in the United States to co-operate by developing the supplies of helium available in the United States. These proposals were made on behalf of the Admiralty, through the Board of Inventions and Research, by Sir Ernest Rutherford, and a special commission consisting of Commander Bridge, Lieut.-Commander Lowcock, and Professor John Slatterly. The proposed co-operation was agreed, and large orders were at once given by the American authorities for machinery and plant. By July, 1918, the production of helium in moderate quantities was accomplished, and from that time onward the possibility of securing large supplies was assured.

At the same time, all the practical details of the production of helium-borne airships and their navigation were developed by the Airship Production section of the navy. Also under the direction of Professor McLennan, steps were taken to erect and equip a station for purifying the helium which might become contaminated in service. Experiments were also made with the object of developing the possible technical and scientific use of helium. The progress made by the time the armistice was declared warrants the opinion that at the end of another year large quantities of helium would have been produced in Canada at low cost, helium-filled airships would have been in service, and great strides would have been made in exploiting the technical and scientific uses of the gas. This is a wonderful achievement—an achievement which, before the war, would have been scouted as impossible even by scientific men. That it has been accomplished is due to the enterprise of the Admiralty and the expert knowledge and skill of a Canadian scientist and his colleagues.

The Simonds Manufacturing Company, Pittsburgh, Mass., have issued a publication on Simonds' products in the war. This is a very attractive and interesting publication dealing with the part the Simonds Company played in the winning of the war. The development of the American Steel Helmet was in large measure due to the activities of this firm and the manufacturing of armor plate for machine guns and other purposes. The steel used by this firm was found to be of extremely high quality.

The Whitman & Barnes Manufacturing Company, Akron, Ohio, have issued Number 91, descriptive of twist drills, reamers, special drop forgings, and other manufactured products.

The Energy Liberated by Boiler Explosions

The Boiler is Potentially as Full of Mischief as an Ammunition Dump and May Cause as Much Destruction. This Article Deals With the Amount of Energy Liberated and the Sequence of Events

By T. H. FENNER, Editor Marine Engineering

A QUESTION was recently asked in the Question Box of POWER HOUSE, relative to what is the sequence of events during a boiler explosion.

The whole catastrophe takes place in too short a time to permit of any detailed observation, and the unfortunate party in close proximity rarely has the opportunity of relating his impressions, at least, on earth. However, our knowledge of the forces involved gives us a pretty fair idea of what happens, and thus we can explain the phenomenon with some degree of accuracy.

In the first place, it must be clear to everyone that the rupture precedes the explosion, and is the cause of it. The explosion does not cause the rupture.

Let us consider for a moment just what we have in the way of potential energy confined in the interior of the boiler.

Suppose we have a 72-inch diameter horizontal return tube boiler, with 72 four-inch tubes, and 18 feet in length. The cubic capacity of the interior, deducting the space occupied by the tubes, will be roughly 395 cubic feet. The space above the water level, assuming the water to be carried at half glass, a fair working height will be represented by a segment 14 inches high, and the full length of the boiler. This will be equal to a volume of 69 cubic feet.

We have, therefore, a volume of water of 326 cubic feet, and as a cubic foot of water weighs 62.5 lbs., the total weight of water contained in the water space will be 20 375 lbs. We will say, roughly, 20,000 lbs., to keep the members in round figures. Suppose for pressure we assume 1250 lbs. gauge.

In order to arrive at a computation of the energy contained in the boiler we must study the subject of latent heat a little.

Whenever the physical state of a body be changed, such as a liquid changing to a gas, or a gas to a liquid, the change is accompanied by the addition or subtraction of heat, which is energy. For instance, when the liquid ammonia in a refrigerating machine is passed through the expansion valve from the condensor to the cooler, in order to change from a liquid to a gas, it extracts the necessary heat from the brine coils. This heat is not to be confused with temperature, which is a different thing. In the same way, water in changing into steam extracts the necessary heat from the fuel. In changing from steam back to water the heat is given up, either in doing work on a piston, or in heating the surrounding air, or is carried off by condensing water. By the first law of Thermo dynamics, "Heat and mechanical energy are mutually convertible, and heat requires for its production, and produces by its disappearance, a definite number of units of work for each Thermal unit.

The British Thermal unit is the amount of heat required to raise one pound of water one degree in temperature, and is equal to 778 foot pounds of work.

The heat applied to water to raise its temperature is called sensible heat, as it is apparent by the raising of the temperature, as shown by the thermometer. The heat applied to water to change it from water at 212° to steam at 212° is called latent heat. That is, the heat has been supplied to the water to change its state without raising its temperature, but has increased its energy by a definite number of foot pounds, corresponding to 778 foot pounds for every unit of heat added.

To change water at atmospheric pressure to steam at atmospheric pressure and 212° temperature, requires the addition of 966 units of heat, and the total heat contained in the water will be 1,146 Thermal units.

As the pressure is raised the total heat is raised, but the relation between latent and sensible heat does not remain the same. The amount of latent heat decreases and the temperature increases, till at 125 lbs. gauge the total heat is 1189.5, the latent heat is 865.5, and the temperature 352.8, the quantity of heat above 32° to raise the water to the new boiling point being 324°, instead of 180° at the atmospheric boiling point of 212°. The total heat is affected slightly by the specific heat of water, which varies with temperature and pressure.

Specific heat, like specific gravity, is used to compare properties of different liquids with water. Water at 62° has a specific heat of one ,and above and below that the specific heat increases. For instance, one unit of heat is required to raise one unit of water one unit of temperature from 62° to 63° F., while to raise the same unit of water one unit of temperature from 32° to 33° would take 1.0094 units of heat, and from 320° to 321° would require 1.0285 units of heat.

To come back to our boiler. We have a quantity of water and a quantity of steam contained in one vessel.

The steam occupies 69 cubic feet, and the weight of a cubic foot of steam at 125 lbs. gauge is .316338 lbs. Multiplying this figure by 69 gives us 21.82 lbs.

Total heat of steam at 125 lbs. gauge pressure is 1189.55 B.t.u. and this figure multiplied by 21.82 represents the total heat in the steam. This product is 25955.98, say, 25956 B.t.u.

In the water space of the boiler we have 20,000 pounds of water at a temperature of 352.82, corresponding to a total amount of heat above 32° of 324.003. (The discrepancy shown by this latter figure, as compared to the result of subtracting 32 from 352.8? which would give 320.82 instead of 324.003, is due to taking into account specific heat.)

324.003 x 20,000 = 6480060 B.t.u.'s in the water.

Now, supposing a plate gives way, what occurs? The water in the boiler is suddenly reduced from a pressure of 125 lbs. to atmospheric pressure, and the steam in the boiler likewise. Now, at atmospheric pressure the total heat in steam is only 1,146 B.t.u.

We have available in the boiler a total quantity of heat amounting to 25,956 B.t.u. contained in the steam, and 6,480,060 contained in the water, altogether 6,506,016 B.t.u.

The water being released of its confining pressure, will flash into steam, absorbing heat to do so. There is sufficient heat present to change 5,655 lbs. water into steam at atmospheric pressure, and as steam at atmospheric pressure occupies a volume 1,646 times that of the water it is generated from, the whole of this energy will be available for removing obstacles to its expansion. Assuming that only 5,000 lbs. of water changes into steam, we have a total heat energy of 5,000 x 1146.6 = 5,733,000 B.t.u. Each of these is equivalent to 778 foot lbs. energy. Therefore, we have a force of 5,733,000 x 778 = 4,460,274,000 foot lbs. Dividing by 2,000 for foot tons we get 2,230,137 foot tons.

Allowing the force to be in operation ten seconds, the horse power developed would be 810,834.

Supposing the boiler weighed 18,000 lbs. and the water not vaporized weighs roughly, 14.000 lbs., say a total weight of 32,000 pounds. If the total energy could be concentrated on raising this weight it would be sufficient to lift it a height of 26 miles.

However, the energy is dissipated in other ways. Part of it is utilized in tearing the plates apart, and again there is an enormous air resistance against the irregular shaped masses of steel tending to stay their progress.

Suppose it started at an initial velocity of 3,000 ft. per sec., as a projectile is fired from a long-range gun, leaving the ground at an angle of say 60°. Then the range would be about 80 miles, equal to the best efforts of our friends, the enemy.

Therefore, in the light of the foregoing, avoid explosions.

THE WATER POWER RESOURCES OF AUSTRALIA AND THEIR POSSIBILITIES

By SIR DOUGLAS MAWSON, in the "Commonwealth Engineer."

THE material greatness of a nation is measured by its output of energy. In this, human effort is supplemented and may be greatly augmented by the application of the energy available from coal and water-power. Lands blessed with such natural stores of energy are endowed with an enviable asset. The jealous eyes of less fortunate neighbors are certain to be turned towards them, so it behooves the Governments concerned not only to develop such resources as far as practicable, but to safeguard the proceeds in the interests of the citizens themselves.

With a view to the conservation of the national assets, a policy should be adopted of utilising water-power in preference to coal wherever economically possible; for the former remains undiminished by its application, whereas the latter is steadily used up. Even though the existing coal measures promise to meet the demand for a very long time to come, the winning of coal is likely to become more expensive as time goes on, if only for the reason that the wider and more accessible seams are worked out first.

Water-power has come into great prominence during the last two decades, and more recently its advantage over coal as a source of power for certain special industrial purposes has been clearly demonstrated. Moreover, as wages, which constitute the major portion of the cost of coal, are steadily and surely rising, the economic conditions of the future will still further favor water-power and tend to limit the employment of coal. Statistics show that in the United Kingdom, prior to the outbreak of war, wages amounted to 63 per cent. of the total cost of coal at the pit mouth; this was slightly exceeded in the U.S.A., where the figure was 69 per cent. So there is every reason to expect that year by year the price of coal will rise. In this connection somebody has predicted that after the disappearance of sailing craft from the ocean traffic, an era will some day eventuate when, on account of the high cost of coal, wind propulsion will once more come into vogue, and all vessels save mail steamers will voyage under sail.

The case for water-power on its own merits is certainly a strong one. A survey of the hydraulic possibilities of a country is quite as important as the estimation of coal resources. The fuel reserves of the British Empire are known, but there is no such information existing regarding the available water-power. In connection with after-war reconstruction a move has been made to ascertain what are the possibilities of this nature within the Empire. Already an introductory report has been issued by a water-power committee of the conjoint board of scientific societies, Burlington House, London, the object being to urge colonial Governments to take up the subject with a view both to the development of such potential energy and to the passage of controlling legislation. In the report an endeavor has been made to indicate roughly the contribution to be expected from each part of the Empire; the aggregate is shown to be not less than 50,000,000 e.h.p. In the case of Australasia the data available is very fragmentary, so that Professor T. W. E. David and myself, who were called upon to furnish the figures, had to make the best of the meagre information published to date. However, embodying such definite values as have been published, and for unsurveyed areas adopting figures suggested by an examination of the rainfall and topographical charts, certain rough totals were arrived at which are at least suggestive of the possibilities. The actual figures published are as follows:—

Australia	1,000,000
Tasmania	400,000
Papua	8,500,000
New Zealand	3,822,000

Great possibilities are indicated for Papua, prospects equally shared in Dutch New Guinea and the former German section. The Commonwealth Government would do well to investigate Papua and ascertain by hydraulic survey to what extent water-power is actually available. In the case of New Zealand, a complete hydraulic report is available, published by the Government works department. There, a record of available schemes is set forth aggregating 3,822,000 b.h.p. In this respect, therefore, New Zealand is one of the most richly endowed territories in the world, being at the rate of 37 h.p. per square mile of area. One single scheme, that proposed for the shores of George Sound, is planned to yield 750,000 b.h.p.

The great strides made in electrochemistry during recent years have widened the outlook for hydro-electric developments, but the latest turn in this connection, namely the fixation of nitrogen from the atmosphere, has revolutionized the economic possibilities. For this purpose, in Norway alone, over 400,000 b.h.p. is now absorbed. The world's annual consumption of nitrogen in its various combinations is about 750,000 tons, and the demand for nitrogenous fertilizers is growing yearly. There is no doubt that a large proportion of this power in Australasia can be realized at a sufficiently low figure to allow of competition in the world's markets. A few years ago, either in Norway or America, £20 per kw. installed would have been regarded as a high figure, but now all the cheaply developed sites have been taken up and £26 per kw. installed is regarded as a moderate figure. New Zealand, especially with its wealth of water-power, should have a great manufacturing future, and might well specialize in nitrogen fixation. To illustrate the importance of its application in this respect it is only necessary to refer to the scheme indicated for George Sound. There, something like 750,000 kw. is available at the foreshore which could be employed converting the nitrogen of the atmosphere into ammonium or other forms ready for shipment. A 750,000 kw. plant is capable of producing annually by the arc process 416.250 tons of concentrated nitric acid, equivalent to 92,250 tons of combined nitrogen, or by the cyanide process 1,635,000 tons of cyanide equivalent to 327,000 tons of nitrogen. Were the electrical power to be generated by steam from coal-fired boilers, to produce the same result 4,875,000 tons of good coal would need to be consumed annually.

AN EMPLOYER'S SCHEME

By L. P.

Regarding the coal and gas shortage, the head of a well-known cutlery concern has posted up in his works the following notice: "In regard to the coal and gas shortage, it is necessary for workpeople to do all in their power to economize. This is not on any account because of the increased prices of these commodities, but because, at the moment, it is a national necessity. If economy is not used in coal and gas it is very probable before the end of the coming winter, the hours of work will be restricted owing to the lack of light and heat. To encourage the workpeople to put forward every effort to save coal and gas wherever possible, I am making the following offer: For every ton of coal saved during the coming winter as compared with the amount used last winter, dating from Sept. 1 to March 31, I will pay the sum of one pound. For all the gas saved in comparison with the corresponding period of last year I will pay the equivalent amount based on the present cost of gas in comparison with the cost last year. The money will be paid into the Works Club funds, and all workpeoeple, whether male or female, must equally divide. It is therefore in the interest of every person to do their utmost to save and also to see that other people do not waste." If such an example were followed by other industrial establishments we should soon have an army of coal and gas-saving enthusiasts.

Electric Furnaces.— The Electric Furnace Construction Co., Finance Building, Philadelphia, reports a repeat order from the Ford Motor Co., for a "Greaves-Etchells" electric furnace installation. The initial furnace was installed last year and it is reported that it has given extremely good results. In England further orders have been received for furnaces from Woodward, Gatty, Saunt & Co., Ltd., Birmingham, and G. & J. Weir, of Glasgow.

INDUSTRIAL USE OF GAS MASKS

During the last year the Bureau of Mines, Department of Interior, Washington, has received many inquiries regarding the use of army gas masks in the industries for protection against poisonous and irritating gases. These inquiries show a general belief on the part of the public that this type of mask will protect the wearer under all conditions against any gas whatsoever, even in absolutely irrespirable air to the exclusion of the more cumbersome mine rescue breathing apparatus. This erroneous belief will no doubt be further confirmed by millions of discharged soldiers who have been trained in the use of the gas mask and have been taught that it gives them absolute protection against all gases used in warfare or likely to be used. These men will not realize that out in the open air of the battlefield the percentage of gas in the air can never be anywhere near as large as may occur in the confined spaces of a factory operation. A mask may afford complete protection under outdoor conditions, and break down at once when used indoors where a gas container has burst and filled the room with a greater concentration of gas. It must also be remembered that the absorbents in the army respirator, which filter out the poisonous gas, are specially designed for the gases used in warfare, and as a matter of fact do not protect against the more common industrial gases as, for example, illuminating, natural, producer and blast furnace gas.

The army gas mask never should be used in mines because of the uncertainty there is of the kinds and amounts of gases in the atmosphere and liability of insufficient oxygen to support life.

In view of these limitations of the army gas mask, which, if not realized, will lead to serious acidents and fatalities, the Bureau of Mines is issuing this brief statement of the industrial use and limitations of the several dust respirators, gas masks, and oxygen breathing apparatus.

Dust Respirators

Protection from dust and liquid mists is obtained by the use of a simple dust respirator, which removes these particles by means of a filter of moist sponge, cotton, or wool pad, porous paper, or even a very fine mesh metallic gauze. The respirator may enclose the mouth and nose only, or it may be combined with a face mask containing eye pieces if the eyes also must be protected. The simple "pig snout" respirator, containing a moist sponge, has been on the market for years. It is highly uncomfortable to wear, rather insufficient for removing fine dust, and most workmen prefer to tie a large handkerchief over their nose and mouth. Some improvement has been made in recent years, but on the whole a really efficient and comfortable dust respirator that workmen will wear continuously is yet to be devised. On account of the urgent need of such a device for safeguarding the health of workmen in the mining and metallurgical industries, the Bureau of Mines has undertaken a study of dust respirators with a view to seeing that as satisfactory a model as possible is available to these industries.

Army Gas Mask

The army gas mask consists of a face piece of rubber and cloth fabric, containing eye pieces and connected by means of a flexible rubber tube to a canister containing charcoal and soda-lime for filtering out the poisonous gas from the inhaled air. The canister is supported in a knapsack slung from the neck.

The army gas mask is by no means the unusual protective appliance that it is popularly believed. It does not afford universal protection against all gases, nor can it ever be used safely in low oxygen atmospheres. It furnishes no oxygen to the wearer and can only remove comparatively small percentages of poisonous gas from inhaled air, usually less than 1 or 2 per cent. Higher percentages will immediately penetrate the canister and "gas" the wearer. The standard army gas mask will furnish protection against percentages not exceeding two per cent. of the following gases in air: Sulphur dioxide, hydrogen sulphide, chlorine, carbon bisulphide, nitrogen peroxide, aniline vapor, benzyl bromide, benzyl chloride, chloracetone, chlorpicrin, hydrogen chloride, phosgene, sulphur chlorides, xylyl bromide, stannic chloride, titanium tetrachloride, and silicon tetrachloride.

It will be seen from the above that the field of usefulness of the army mask is confined to certain of the chemical industries, around smelters and roasters, where sulphur fumes are given off and in the industries using chlorine and bleaching powder. The army canister also contains cotton filter pads, which remove irritating and poisonous dusts, which increases its usefulness around smelters where sulphur and arsenic fumes must be removed.

The army mask furnishes no protection whatever against carbon monoxide. This is the poisonous constituent of blast furnace, producer and illuminating gases, and of mine gases after fires and explosions in coal mines. Carbon monoxide is also likely to be present in ordinary fire-fighting conditions met by fire departments. Moreover, in all of these cases there is likely to be a deficiency of oxygen. Therefore, for adequate protection against these conditions the oxygen-breathing apparatus must be used, and reliance on the army mask may be fatal.

The Bureau of Mines is working on a carbon monoxide mask and hopes to develop one that may be used in the future for low concentrations of this gas, but such a mask is not now available.

Ammonia is another gas that will penetrate the standard army canister. However, a special chemical may be placed in the army canister which will adapt it for use around refrigerating plants.

Oxygen-Breathing Apparatus

The self-contained oxygen-breathing apparatus can never be displaced by the gas mask for use in atmospheres deficient in oxygen. Such atmospheres are encountered in mine rescue work, in gas mains, blast furnace stoves, gasoline tanks, etc. Aside from the lack of oxygen, carbon monoxide is also present, for protection against which the army mask is useless.

The oxygen-breathing apparatus must also be used instead of the army gas mask wherever there are large quantities of irrespirable or poisonous gases, as for example, in entering a gasoline tank containing some residual liquid, or similar tanks, towers, and other closed spaces. The concentration of vapors produced by volatile liquids in closed containers is too high to be entirely removed by gas mask absorbents. The only recourse in such cases is a self-contained appliance in which the wearer does not breathe any of the irrespirable atmosphere.

Importance of Expert Advice on Protective Breathing Appliances

Owing to the many factors entering into the use of protective respiratory appliances the importance of competent advice on the selection and use of such appliances cannot be over-estimated. The fact that the army and navy used gas masks has been widely disseminated, and its significance is likely to be misunderstood, especially by men who have had some training in their use. It also should be made known that both the army and navy used the oxygen-breathing apparatus in its appropriate place.

In connection with the Bureau of Mines work of safeguarding the health of miners and workmen in the metallurgical industries, a general investigation of respirators, gas masks and breathing appliances is being undertaken at the Pittsburgh Experiment Station of the Bureau. This research will be conducted by experienced chemists and engineers who had charge of gas mask research in the Bureau's war gas investigations and subsequently in the Research Division of the Chemical Warfare Service, U.S.A.

The industrial respirator investigation will include:

(1) Advice on the suitability of the standard army gas mask for use in various industrial gases.

(2) Approval of industrial gas masks and respirators, when properly submitted to the Bureau by the manufacturer in accordance with a schedule to be announced later.

(3) Instruction of workmen at plants in the use of masks and respirators in a manner similar to that now being given by the Bureau in the use of oxygen-breathing apparatus.

Ackersand High Head Electric Plant

A Description of a Swiss Power Plant Using Water at the High Head of 2,000 Feet and Generating 27,000 Horsepower

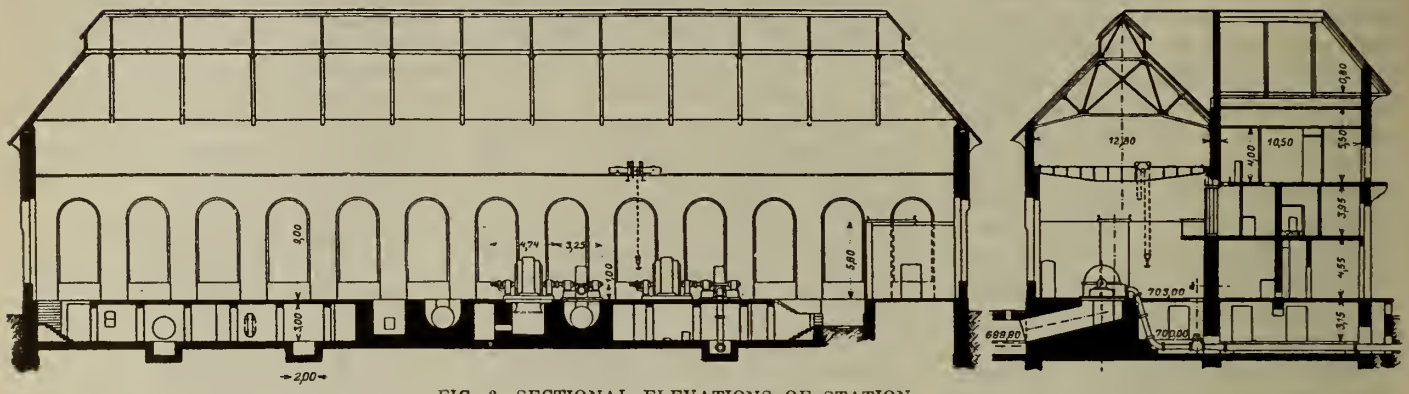


FIG. 3—SECTIONAL ELEVATIONS OF STATION.

THE accompanying illustrations, Figs. 1 and 2, and drawings, Figs. 3, 4 and 5, show the Pelton water wheels of 5,550 horsepower and the details of construction of the Hydro-Electric equipment of the Ackersand power plant. The original equipment of this central power station of the A. G. Elektrizitatswerk Lonza, located on the Zermatter and the Saaser Visp, was designed for a capacity of 27,000 horse power. The turbines were built by the Societe an. des Ateliers, Piccard, Pictet & Cie, of Geneva, Switzerland. These Pelton turbines operate under the enormous head of 700 meters, or over 2,000 feet. The speed of the turbine is 500 revolutions per minute. Each turbine is directly coupled to a 3-phase alternating current generator of 5,100 K.V.A. capacity, supplying a current of 15,500 volts pressure.

A 25-ton traveling crane on the Hydro-Electric station served to handle the turbine and generator parts during installation and repairs.

These hydraulic turbines of the Pelton type take 750 liters of water per second, and the regulation is automatic in operation with provision for hand regulation as well. The power is transmitted a distance of 6 kilometers to factories at Visp; also for electric heating and lighting service.

The intake is located at 1,400 meters above sea level, with a drop of 700 meters at the power house to 700 meters above sea level at the turbines. The upper portions of these penstocks were constructed by the Atelier de Constructions Mechaniques de Vevey, and the lower portion by J. P. Piedboeuf and Co. These lower sections of the penstocks are of great strength, the thickness varying from 13 millimeters to 30.5 millimeters.

The power house was designed by Architect M. Burgener of Siders and is a most artistic structure, extremely pleasing to the eye, yet its utility is unquestioned. The building is 66 meters long and 12 meters wide, with a tower 20 meters in height. The original plant provided for 5 units of 5,500 horse power as indicated in the drawing, Fig. 3, the turbines being of the horizontal Pelton construction, shown in the photograph, Fig. 2, and drawing, Fig. 4, and the automatic regulating mechanism of the type noted in drawing, Fig. 5. The turbine water wheels were constructed of Siemens-Martin steel, 280 millimeters in diameter, operating with automatic oil bearings. It is stated that this plant has given excellent service, and has been of great value in the industrial development of the surrounding country.

CONCRETE HOUSES FOR ENGLAND

Proposal For Speeding Up Buildings—Rental About $2 Per Week

LONDON, ENG.—A new method of reinforced concrete construction under the Government housing scheme has been designed to facilitate the erection of houses, and is now under consideration by the local and municipal authorities in the United Kingdom.

The system is said to be similar to that adopted for housing the American troops in France, and has been patented under the title of the "Lightning Construction System." Its superiority lies in the method of moulding the slabs. This is done on the actual site in portable

FIG. 1—TURBINE WITH DOUBLE REGULATION IN FRONT. IN THE BACKGROUND, TURBINE WITH HAND REGULATION AND AUTOMATIC REGULATION OF THE JETS.

FIG. 2—WHEEL WITH UPPER CASING REMOVED.

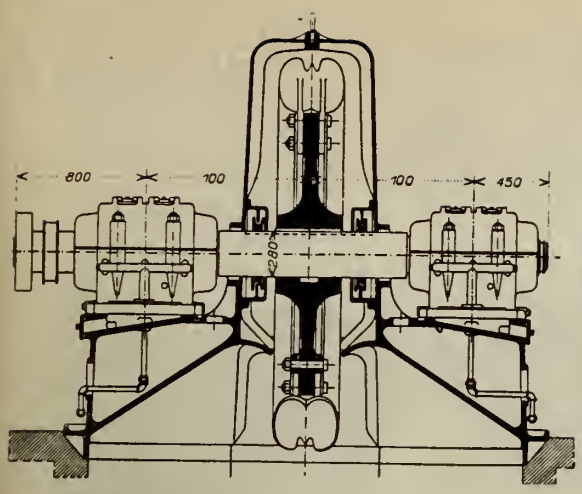


FIG. 6.

moulds. It is claimed that a block of three five-roomed houses can be built by twelve men in three days, using unskilled labor under skilled direction.

It is estimated that such houses when completed will cost the British public about £390 per house, or £415 including the cost of land with twelve houses to the acre. The houses would let at about $2 a week, according to local rates. The buildings will include the latest modern improvements. such as central heating.

Ball Bearing Manufacturers Combine.—Of interest to all users of bearings is the just announced reorganization, effective May first, whereby the products of The Hess-Bright Manufacturing Company, the SKF Ball Bearing Company, the Atlas Ball Company, and the Hubbard Machine Company will be sold through one central organization. The new company, under the name of SKF Industries, Inc. will thereby be able to offer a comprehensive line of ball bearings, including the Hess-Bright deep-groove type, SKF self-aligning radial and thrust bearings and ball bearing pillow-blocks and shafting hangers. Through the medium of its engineering organization, backed up by a well equipped laboratory, the new company will be able to place at the service of bearing users the knowledge gained in many years of anti-friction bearings of all kinds. On request, manufacturers' problems will be analyzed in detail and that type of bearing recommended which (independent of sales considerations) is best suited to the conditions met. In addition the laboratory staff will carry on research studies affecting anti-friction bearing design and application. The new company—SKF Industries, Inc.—will be under the direction of B. G. Prytz, President, W. L. Batt, Vice-President, J. P. Walsh, Comptroller, and S. B. Taylor, Sales Manager. The principal office will be at 165 Broadway, New York City, with branches at Boston, Philadelphia, Atlanta, Buffalo. Cleveland, Detroit, Cincinnati, Chicago and San Francisco.

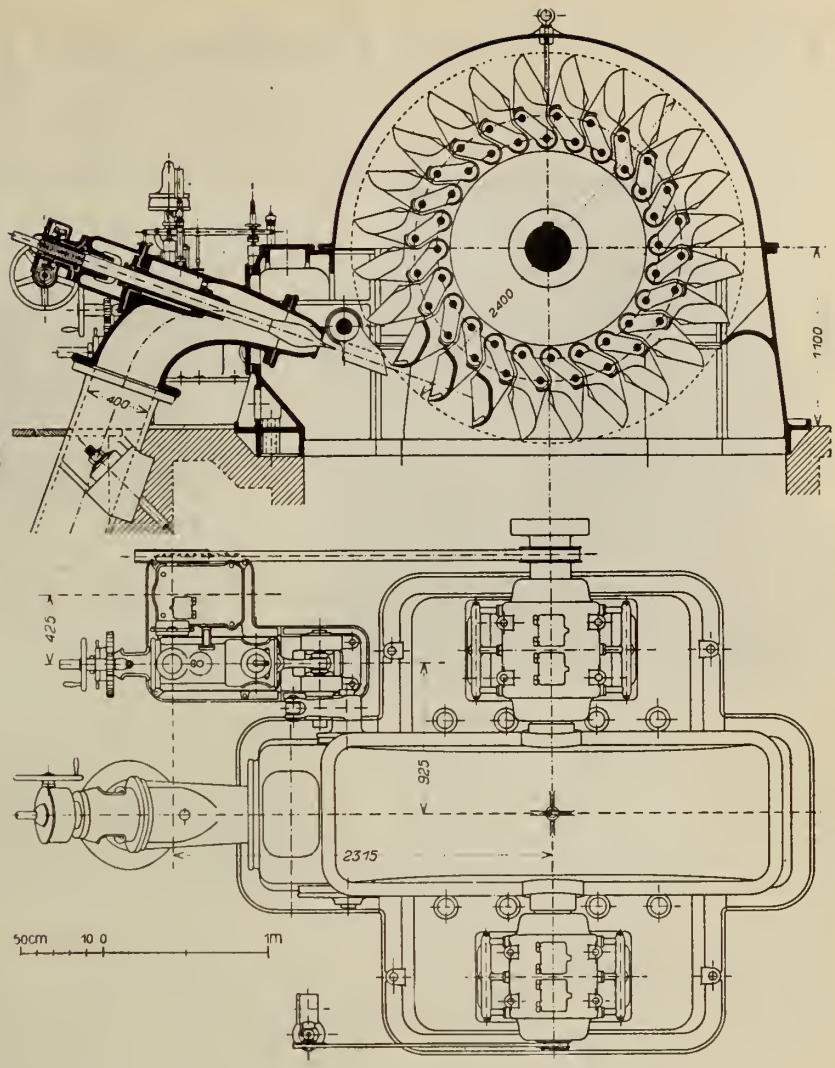


FIG. 4.

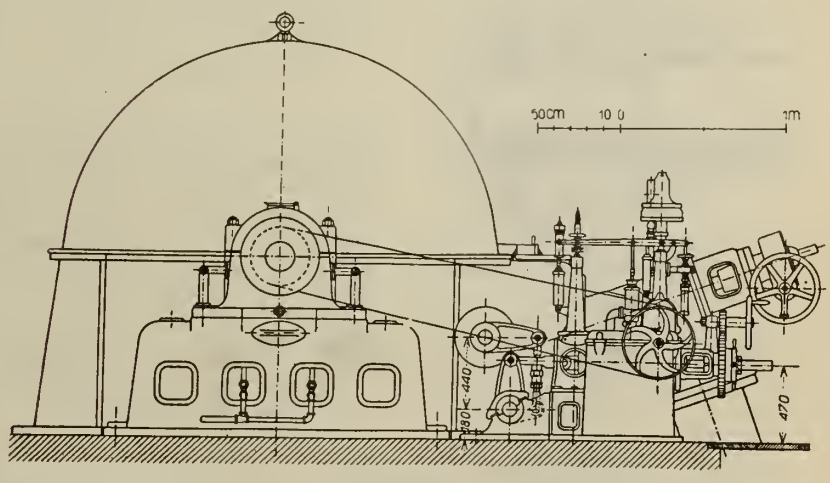


FIG. 5.

Buy Coal Now.—The Canadian Manufacturers' Association are sending out the following circular in regard to bituminous coal: As in the past two years, we again urge our members, in order to avoid congestion at the frontier in the fall and winter, to put in their season's requirements of bituminous coal in the summer months. Another factor which points to the wisdom of early action is that, as a result of shortage in the labor supply, production of bituminous mines shows a marked falling off. They are now running about 7,000,000 tons per week, as compared with 12,000,000 tons per week during the war. This condition leads to the belief that production is less than concurrent consumption, the difference being accounted for by the use of reserve stocks, accumulated at the instance of fuel administrations.

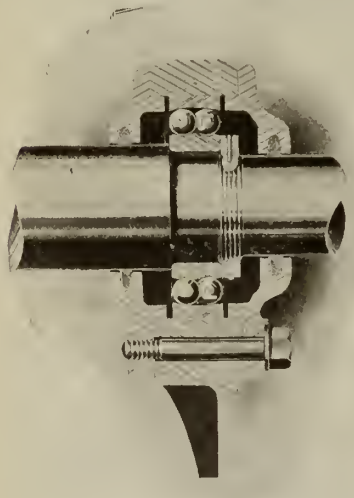
The Use of Ball Bearings for Electrical Machinery

Advantages of Ball Bearings—Enable the Builder to Use a Smaller Air Gap—Better Commutation Due to Greater Precision —Enhanced Efficiency Over Plain Bearing—Dimensions Smaller

By H. M. TRUMBULL

INDUSTRIAL operations are carried on for profit, and profit depends upon the difference between selling price and cost. This difference, due to the events of the past few years, has been steadily decreasing—especially in the manufacture of electrical machinery. For, on the one hand, the cost of all raw material has been advancing, as has also the cost of labor and the expense of marketing the product; on the other hand the manufacturers of electrical machinery, because of keen competition in this line, have not deemed it expedient to advance their selling prices in proportion to the increasing costs. The service rendered by electrical machinery produced by the various manufacturers is so nearly identical that no one company has considered it wise to take the initiative in marked advance of selling price. Such conditions might soon prove disastrous and so each manufacturer has been endeavoring to incorporate in his design some material improvement which will net the customer a present and ultimate economy and induce him to pay an increased first cost.

Almost simultaneously many of the manufacturers have answered this question by incorporating ball bearings in the design of their standard equipment. No other single improvement has been made in the last five years which has increased the ruggedness and economy of motors as much as ball bearings. This improvement has proven to be a sales advantage and ball-bearing equipment, because of its strong sales appeal, puts motor selling on a more profitable plane.



MOUNTING ARRANGEMENT WITH BALL BEARING ON MOTOR SHAFT.

For a number of years the desirability of using ball bearings on electrical machinery has been the subject of discussion by engineering societies both in this country and in Europe, but now this question has been taken out of the realm of discussion and made a cold dollars-and-cents proposition.

Not only has the incorporation of ball bearings in motors and generators lessened the selling expense for the manufacturer and allowed him to charge a higher price, but it has also offered such economies to the user of these machines that the higher initial cost has been much over-balanced and additional profits made possible. In fact, progressive mill owners, mine superintendents and shop managers all over the country, who are facing the same problems of advanced costs of materials and labor, are forced to introduce better machinery and to grasp every opportunity for completing a manufacturing operation in less time and at a decreased expense, and so they are specifying ball-bearing equipment.

In order to obtain an idea of the advantages of the application of ball bearings to electrical machinery, a series of questions was recently submitted to motor-manufacturing engineers and users of ball bearings throughout the country. A careful analysis of the replies, giving the tests and experience of motor designers and users, shows the following advantages in favor of ball bearings.

Maintained Air Gap

Among the principal advantages of ball bearings on motors are their precision and freedom from wear. The bearing adjustment remaining constant keeps the rotor in the center of the magnetic field. This permits the motor manufacturer to employ air gaps with clearances so slight that they could not be considered on motors having any other type of bearing. On induction motors a close air gap is of vital importance in the improvement of the machine efficiency and the power-factor.

Chief among the difficulties with plain bearings is the fact that after a period of service the bearings wear down to an amount varying with the load and service conditions. If this wear continues it will finally permit the armature to touch the pole pieces with resulting trouble—perhaps a stripped armature.

In a ball bearing, hardened steel balls roll on hardened steel bearing races, thus rubbing friction is practically eliminated and accuracy is maintained.

On axle-driven generators used for railway car lighting, the bearings must maintain the air gap or a stripped armature results. Ball bearings have replaced plain bearings for this service almost entirely because of the greater dependability attained. Records of 200,000 car-miles, where ball-bearings are used, have become common in spite of the frequently excessive tension of the belt. The shock and distorting action on the shaft due to crossovers, switch frogs and uneven track, the snap of the generator belt when flying ballast is picked up and passes between the belt and pulley, all deflect the armature shaft. It is found that self-aligning ball bearings accept these shaft deflections without binding or wear.

DIEHL TYPE K ADJUSTABLE SPEED INTERPOLE MOTOR FOR OPERATING STEERING GEAR ON SUBMARINES.

Improved Commutation

On direct-current machines, the fact that ball-bearing heads are sealed so as to prevent the escape of lubricant keeps the commutator clean. Commutators are thus protected against a conducting "slop" of dust and oil, and good commutation is maintained.

Precision and durability of bearing setting also insure better accommodation.

Freedom from sparks from the commutator in flour mills, in coal mines, in textile mills, in woodworking plants, or wherever there is combustible dust, reduces the possible danger of ignition or explosion, thereby materially decreasing the fire and accident hazard.

Comparative Frequency

On motors in which the shaft is subject principally to rotating action (torque), bearing friction is a very small percentage of the motor losses. This is the case in direct-coupled units, centrifugal pumps, motor-generator sets, etc. The bearings carry but little, if anything, in excess of the weight of the rotor; therefore pressure between shaft and

bearing lining is inconsiderable and bearing friction is a minimum.

Where the motor shaft is subject to bending action, however, bearing friction becomes an important consideration. This is the case with belt and gear-drive motors. The bearings are subject to severe bending, pounding or shock strains, especially at the driving end. Ball bearings in these cases show a decided saving over plain bearings. This is due to the fact that in ball bearings the friction is practically constant over a wide range of pressures, and because rolling is substituted for the rubbing action of plain bearings.

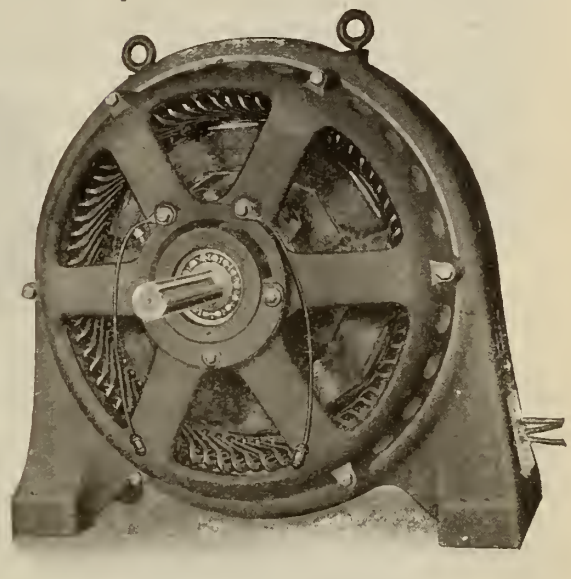
ROBBINS & MEYERS CO. THE END CAPS OF THE TWO RIGHT HAND MOTORS ARE REMOVED TO SHOW BEARINGS

Compactness

Compactness is required in conditions usually found in general industrial applications for induction and direct-current motors. To get this feature of compactness, motor manufacturers develop the greatest possible horsepower from a given size of motor frame. This reduced size per horsepower capacity gives the greatest driving power in limited space conditions.

The length of the motor bearings affects the question of compactness to an important degree.

Babbitt bearings are usually designed with the box length two and one-half to three times the diameter of the shaft which they support. Contrasted with this, the length of ball bearings along the shaft usually is not over one-third of the shaft diameter. Surrounding the ball bearing is the lubricating chamber, which at its outside limits is one-half to one-third shorter along the shaft than the plain bearing for the same motor, with the result that the over-all length of motors can be reduced 10 to 27 per cent.



FAIRBANKS-MORSE MOTOR EQUIPPED WITH BALL BEARINGS.

by the employment of ball bearings.

Where a consideration of aisle room, floor space, machine arrangement, etc., is necessary, a ball-bearing motor goes a long way towards solving the problem, as shown in the following table:

PLAIN DIRECT-CURRENT MOTORS.

Size of Motor.	—Motor Length Over All— Sleeve-Bearing Motor. Inches.	Ball-bearing Motor. Inches.	Reduction in Length. Per Cent.
5	26⅛	23	12
6	26⅞	24¼	9.8
7	31 11/16	26	18
8	35½	29¾	16.2
9	38⅞	32⅛	17.4
10	41 9/16	34¼	17.6
11	45⅞	37 7/16	18.4
12	49⅞	38¾	22.4

INTERPOLE MOTORS.

Frame Size.	—Motor Length Over All— Ring-oiler Bearing Motor. Inches.	Ball-bearing Motor. Inches.	Reduction in Length. Per Cent.
½	18⅞	16¼	13.9
1	20 15/16	18	14
2	23 7/16	19 7/16	17
3	25⅛	19⅝	21.8
5	28⅛	22⅛	21.2
7½	33	25 9/16	22.6
10	37	28¾	22.3
15	43⅛	33¼	22.9
20	45½	33 3/16	27.1
25	45⅝	37¾	17.3
30	51⅜	38 1/16	26
40	53 3/16	41⅜	22.2
50	57⅛	42 13/16	25

Simplicity and Cleanliness

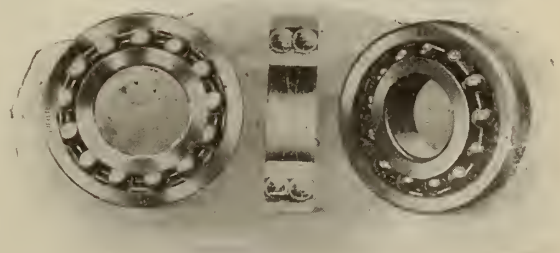
The use of ball bearings reduces the head construction to its simplest terms. Instead of oil rings, chains, wicks, waste packing or other devices which are required for plain-bearing motors, ball bearings require no oiling devices other than the ball bearing itself. Ball bearings are in themselves positive self-lubricators. Instead of necessitating frequent inspection of the bearings, renewal of the lubricant and possibly occasional rebabbitting, ball-bearing motors require no attention other than periodic lubrication—the length of time between inspections being from one week to six months, depending upon the service.

Ball-bearing motors are clean. The ball bearings are encased within bearing heads with sealing grooves on each side of the bearing, preventing the leakage of lubricant. With this protection, dripping or leaking of oil is eliminated and there is no danger of goods becoming soiled or contaminated with oil from this source.

Gear-Drive Motors

Where gear drive is used, ball bearings on electric motors are of particular advantage. In order that gears shall run smoothly and quietly, the proper distance between pinion and gear centers must be maintained. It is a fact that noisy, chattering gears may be caused by wear having taken place in the bearings supporting the gears. After long service

DISASSEMBLED VIEW OF MOTOR, SHOWING BALL BEARINGS.



SKF RADIAL BALL BEARING SHOWN IN NORMAL POSITION AND IN DEFLECTED POSITION.

with this type of drive, ball bearings show no appreciable wear and consequently the gears mesh properly, giving longer and better service.

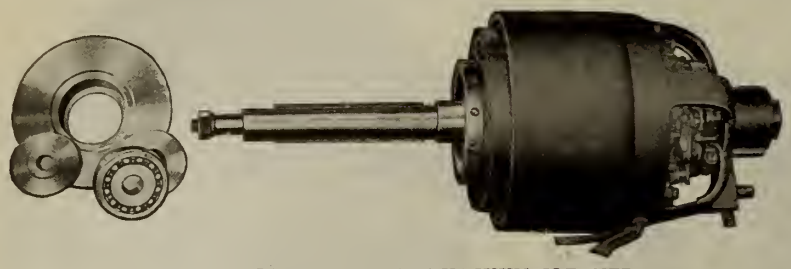
Plain bearings must be designed so that the pressures are well under the limit for the corresponding speed of the bearing. To reduce unit pressure in the bearing surfaces, it is necessary to increase the rubbing area. This may be done in either of two ways:

First, by increasing the journal length. This of course offers the disadvantage of increased floor space required by the motor, and where compactness is a desirable feature this is a serious handicap.

Second, by increasing the shaft diameter. Increasing the diameter increases in direct ratio the speed of the rubbing surfaces which should be kept as low as possible, because each increase of rubbing speed directly increases the likelihood of hot bearings. Larger shafts also mean heavier and more costly motors.

Whether, therefore, the bearing length or the shaft diameter be increased, the plain bearing is confronted with positive limitations.

Ball bearings are designed for high speed and heavy loads. The housings are short and the motor on which they are used may be made very compact. Because of the compact construction the distance between the bearing and pinion is reduced, hence the overhung load on the bearing is proportionately reduced.



BALL BEARING USED WITH VACUUM CLEANER.

Ball Bearings on Axle Generators

Ball bearings are now used almost exclusively on axle-driven generators for railways. A few years ago these machines were equipped with plain bearings. The service is so severe, however, and the attention which can be given is so small, that ball bearings have proved to be the only equipment that will "stand up."

The generators are exposed to snow and ice, heat, dirt and water, the jolts and shocks of passing crossovers and switches, and the continual jar of heavy truck suspension. These conditions all play havoc with plain generator bearings.

The testimony of a superintendent of inspection of one of the largest railroads in the country is eloquent with the advantages of ball bearings on these generators. He says, "The cost of generator maintenance has been reduced—on coaches, 66 per cent.; on diners, 46 per cent. We have never had a hot bearing, have not lost any fields or armatures, the inside of the generator is dry, and we have no trouble due to grounds or short circuits." This is typical service where self-aligning ball bearings are used.

The Lubrication Problem

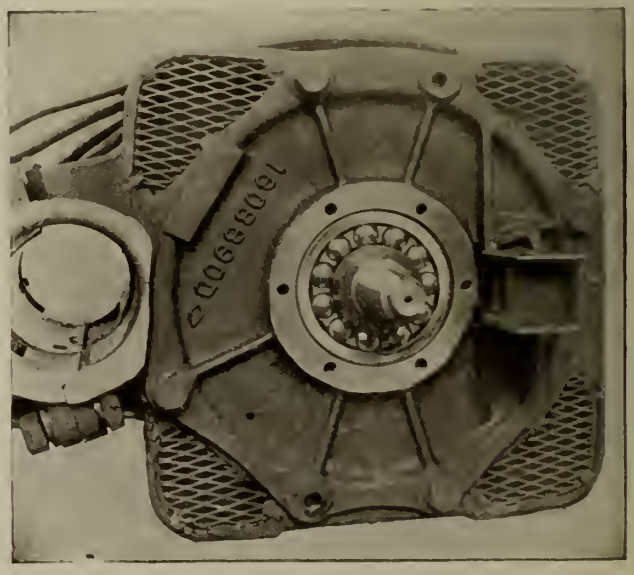
Ball bearings offer the motor user one solution of his lubrication problem. The ball bearings are contained within simply constructed bearing-head brackets with liberal lubricant chambers which are sealed on both sides and by end caps. These end caps are fitted close to the motor shaft and are practically proof against leakage of lubricant, as well as the intrusion of moisture, dust, lint, grit or other foreign substances from without.

CHARGING MOTOR GENERATOR FOR STORAGE BATTERY WORK. EQUIPPED WITH BALL BEARINGS.

Ball bearings are positive self-lubricators. The ball spacer or retainer is of such construction that the bearings are open at the sides, thereby giving free

Continued on page 227

FAIRBANKS-MORSE VERTICAL BALL BEARING INDUCTION MOTOR.



GENERAL ELECTRIC TRACTION MOTOR

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Questions Asked In Last Issue

13. If your safety valve has been blowing off at 100 lbs. and now commences to blow at 80 lbs., what would you do to remedy the same, in the event of the steam gauge indicating 120 lbs. before the safety began to blow? What would you consider the possible cause, and what would you do to remedy the same? What action would you take?

14. If you were taking charge of a boiler where the safety valve steam gauge and water column had been taken off to prevent damage to same, and you were in doubt as to the correctness of the steam gauge, how would you set the safety valve when it was replaced on the boiler in order that it might blow off steam at 100 lbs. pressure, and in replacing the water column how would you set it at the correct height on the boiler?

15. Explain the construction and action of an expansion point as used on a main steam pipe. What omission in the construction of expansion joints would lead to serious accidents when steam is first applied?

16. Explain fully the construction and action of a safety valve spring-loaded pop. In what does it differ from the other ordinary spring-loaded valve? What is the advantage of the pop over the ordinary? How does the connecting of a long discharge pipe affect its working?

17. What is the meaning of factor of safety as applied to steam boilers? What is the real limit of the strength of a boiler? Explain the manners in which frequent variations of steam pressure affects the strength of boiler, and why?

18. Show by sketches and explain different ways of staying the segments of boiler heads above the tubes, stating the advantages and disadvantages of each method.

19. What is the difference between a direct current dynamo and an alternating current dynamo? In what way does a dynamo differ from an electric motor? Can a dynamo be run as a motor, or the motor as a dynamo?

20. If you were in charge of a steam plant where there was boiler power to spare, but the engine in its present condition was fully loaded, what would you do to increase the power of the engine in order to run extra machinery, assuming that the boiler pressure can not be raised, and that all parts of the engine are strong enough to carry the extra load?

21. Explain some type of ammoniac compressor, giving details of operation. How would you naturalize ammoniac fumes escaping from a leaky pipe in an enclosed room, and after this is done how would you locate the leak?

22. What is the safety head of an ammoniac compressor? What purpose does it serve, and how is it constructed? What precautions are necessary in taking compressor cylinder apart in order to prevent injury from inhaling ammoniac gas, if this gas should be inhaled to such an extent that a person becomes unconscious, what action would you take to save him?

23. What is the position of the eccentric related to that of the crank for engine running, either over or under (a) with direct motion; (b) with indirect motion; (c) with indirect valve and direct motion; (e) with expansion valve (righting cut off) direct motion, with indirect motion for some?

E. V. M., Lardo, B.C.

Answers to Questions In Last Issue

13. In the case of a safety valve blowing off at 80 lbs. when it has been operating at 100 lbs., the first thing to do would be to test the steam gauge and see if it was indicating correctly. If the gauge was found to be correct, and your safety valve was of the spring-loaded type, attention would be called to the spring. If the change had occurred suddenly, it would indicate a sudden failure of the spring, or if of gradual occurrence it might be due to a softening of the temper. If you had any reason to doubt the spring, it would be unwise to try and interfere with the compression while under pressure, as a sudden collapse of the spring, accompanied with a violent and large opening of the valve, would, perhaps, cause an explosion. It might be due to the easing gear becoming held up in some way. The safest thing to do is to shut the boiler down and examine the valve and gear. A safety valve not operating correctly ceases to be a safety valve. Sometimes a spring becomes fatigued when annealing, and re-hardening will remedy the trouble. However, do not run the boiler till you have found the cause.

In the case of the valve not lifting till the gauge showed 120 lbs., it would probably be a case of the valve spindle jamming, or the valve itself jamming in the seat. Note if the valve allows steam to go back to normal before closing, or if it blows down far below the working pressure. In either case, after the valve closes, try the easing gear, when steam is at or approaching the normal blowing off point. You can tell if it is sticking. If so, the only course again is to close down, and remedy whatever defect you find. Use your judgment, but don't take chances.

14. In setting the water column, arrange it so that when water is in the bottom nut, there will still be from four to six inches of water over the highest heating surface in the boiler.

If you had no means of testing the steam gauge with a standard gauge, you could still set your safety valve approximately. If a lever valve, you can arrange it by the principle of levers. If your valve is, say, 3 inches diameter, and the ball weighs 50 lbs., distance from fulcrum to valve spindle, 4 inches, required pressure, 100 lbs. per square inch. Then total load on valve will be $3 \times 3 \times .7854 \times 100 = 706$ lbs. The load on the valve multiplied by its leverage must equal the weight of the ball multiplied by its leverage. The steam pressure acting on the valve is the force. and the ball is the weight to be moved. We have F:W::2:L or $706 \times 4 = X \times 50 = 56.48$. The ball must be placed 4 ft. 8½ in. from fulcrum. This neglects weight of lever and valve, but is near enough.

If you have a spring-loaded valve, you can proceed in two ways. Suppose again your valve is 3 in. diameter, and pressure 100 lbs., your total load will be 706 lbs. Suppose your spring is 2 inches mean diameter, and ½ inch square steel, and there are 12 effective coils. By the formula

$$\frac{D^3 \times S \times n}{t^4 \times C} = f$$

where

D = mean dia. of spring.
S = load on valve.

n = number of coils.
t = thickness or dia. of spring steel.
C = 1,400,000 for round spring.
2,000,000 for square spring.
f = compression.

$$\frac{2^3 \times 706 \times 12}{\frac{1}{2}^4 \times 2{,}000{,}000} = .545$$

Therefore a compression of ½ in. on the spring will give the desired lifting point.

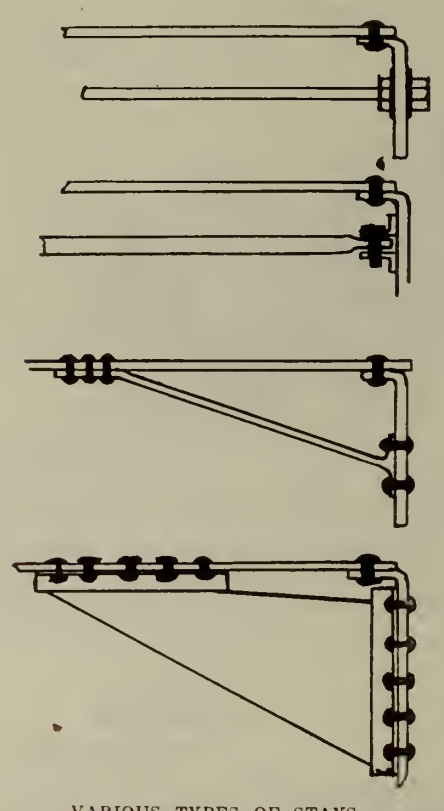
15. An expansion joint, as its name implies, is to take up the expansion in a length of steam pipe. On the end of one length a stuffing box is formed, and the end of the adjoining length fits into this loosely, a gland being fitted to ensure steam tightness. It is most important that guard bolts be fitted to prevent the pipe drawing out, as it is quite free to do so. A ring is fitted on each length of pipe, and suitable bolts are fitted, connecting the rings, with double nuts on the movable end of the pipe. Sufficient play is left between the double nuts to allow the pipe free movement, while preventing it by any chance drawing out of the gland.

16. A spring-loaded safety valve of the pop type is usually made with the spring enclosed within the body of the valve. The pop valve is made with a large lip on the valve, so that immediately it moves from the face an extra large area is exposed to the action of the steam, causing it to lift quickly. The same arrangement tends to keep the valve open till the pressure has dropped a little below normal. The ordinary valve is fitted with a lip, but not so large as the pop type, the effect in the ordinary valve being merely to overcome the extra compression of the spring, when the valve lifts.

The action of the safety valve is simple. The valve is connected to the steam space of the boiler, and the load on the valve is proportional to area X steam pressure. The size of the valve is governed by the grate area, being for low pressure ½ square inch valve area to 1 foot sq. of grate area, and for high pressures .3 sq. inch to one square foot. The load on the valve, due to the steam, is exactly balanced by the compression of a steel spring, thus holding the valve shut. When steam rises above the predetermined pressure, the load on the valve is greater than the resistance of the spring, and the valve rises, compressing the spring still more. It is to take care of this extra compression that the lip is formed on the ordinary spring-loaded valve, and the larger lip on the pop valve to ensure a rapid overcoming of the same. Provision is made in both types of valve to raise the spindle by hand, by fitting a lever which engages a cotter passed through the valve spindle end.

17. The breaking or ultimate strength of a boiler plate is from 60,000 to 65,000 lbs. per square inch of section, under a direct tensile stress. About half of that stress is the elastic limit of the material, that is, when stressed above 30,000 lbs., the strain becomes permanent. It is therefore necessary to make provision for the limiting of the working stresses below this point. Furthermore, such factors as workmanship, fluctuating loads, etc., have to be considered. Therefore, to make ample provision, when calculating the working pressure, a factor must be used that will leave an ample margin of safety. For a boiler of good material and workmanship, a factor of safety of 4 is taken, which means that the highest allowable stress will not be more than ¼ the ultimate strength of the material. This may be reduced to 1-5, or even less, by raising the factor of safety.

Frequent variations of pressure produce frequent variations of temperature, and different conditions of stress in the material. The result of this is a gradual



VARIOUS TYPES OF STAYS.

crystallization of the material, or fatigue, which reduces the elastic limit, and ultimate strength of the material.

The segments of boiler heads above the tubes are stayed by direct or diagonal stays, and by gusset stays. Direct stays are those which pass direct through the boiler from head to head, and are sometimes passed through the heads and secured by nuts and washers on each side of the plate. Sometimes a plate is fitted over the head, and called a doubling plate, which acts as a stiffener. In other cases the stays are formed with an eye, which fits between channel irons riveted to the head, a pin being passed through to hold them.

Diagonal stays are made either out of round or flat stock. When of round stock they are flattened out at each end to form a foot, which receives the rivets. The end attached to the head is sometimes turned to right and left, in which case the foot is welded to the stay. The head end may be formed into an eye and fastened between channels, as in the case of the direct stay.

There is also the Hewson diagonal stay formed by pressed steel, and made in such a way as to allow a certain amount of spring.

The gusset stay is a triangular piece of plate, fastened to shell and head with angle irons on each side.

The direct stay is the strongest and most simple. The only disadvantage it possesses, though in a small boiler it may be a serious one, is that it makes getting into the boiler difficult, and moving round after getting in also hard. The diagonal stay to be as strong as the direct stay must be of larger diameter, as owing to its inclination part of its pull is lost. That is, if H represents the height from shell to stay on head, and L length from head to point of connection of stay on shell; then, if area of direct stay equals 1, area of diagonal stay must equal

$$1 \times \frac{L}{H}$$

or strength of diagonal stay is equal to

$$1 \times \frac{H}{L}$$

Stays fastened to head by channel or angle irons have the disadvantage that the channels form a nest for the reception of scale, and unless care is exercised, the connecting pins corrode rapidly. The diagonal stay allows ample room to move about inside the boiler.

19. If the engine is equipped with a governor, the pulley can be altered to allow the engine to speed up. If a shaft governor is fitted increasing the tension on the spring will have the same effect.

If your engine has a pulley on crank shaft 10 in. diam. and on governor shaft 8 inches, engine revolutions being 100, the governor will run at

$$\frac{100 \times 10}{8} = 125 \text{ revolutions}$$

It is required to increase the engine to 110 revolutions, keeping cut-off the same. Therefore you must arrange so that governor will run the same speed with the engine at 110 revs., as at 100, in order to keep the balls in the same plane.

110 : 125 : : x : 10 = 8.8.

The pulley on governor shaft must be replaced by one 8.8, or, say, 9 inches, which will give

125 : x : : 10 : 9 = 112.5 revolutions.

In the case of the shaft governor, increasing the tension of the spring, or in some types increasing the weight must be tried till the result is as required.

The illustration herewith shows a section of a Linde compressor, double acting. The piston is made of the circular design shown in order to obtain

the minimum of clearance. There is a suction and discharge valve at each end of the cylinder. This type of compressor has no water jacket, the heat of compression being taken up by the evaporation of a small quantity of liquid ammonia injected at each stroke. The action is as follows:

Ammonia gas from the evaporation is drawn in by the piston at one end, while the charge previously drawn in is being compressed to a liquid at the opposite end When the compression has been completed, the pressure is sufficient to overcome the spring, and the liquid is forced over to the condenser. The same events occur on the return stroke.

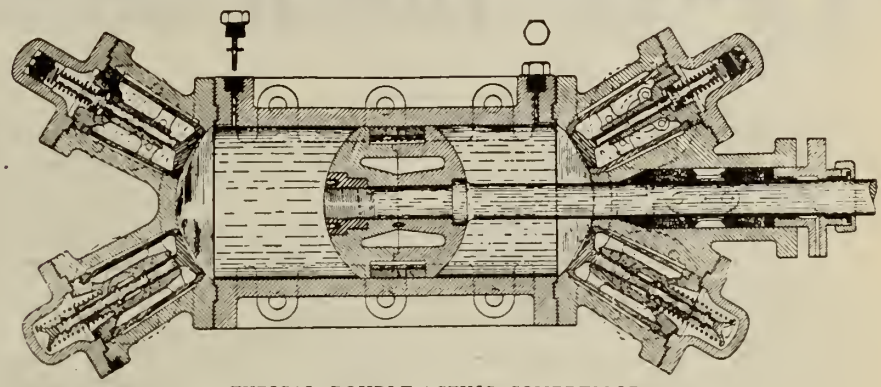
The way to neutralize the fumes of escaping ammonia is to saturate the fumes with water. Ammonia is readily absorbed by water, and a hose should be always handy.

If a man has become unconscious, get him in the open air, and give him warm milk up to a pint. If he is not unconscious, sucking a lemon, or drinking a solution of good cider vinegar will be of great value.

22. The safety head of a compressor is a false head, fitted with heavy springs to hold it in place, as shown in the illustration. The construction is such that in the event of an abnormal pressure, the head will lift exactly as a safety valve would do.

In taking a compressor cylinder apart be sure to drain all the gas away before opening up. This can be done by the by-pass arrangement fitted on many machines. Keep a hose handy to drown any fumes that may escape.

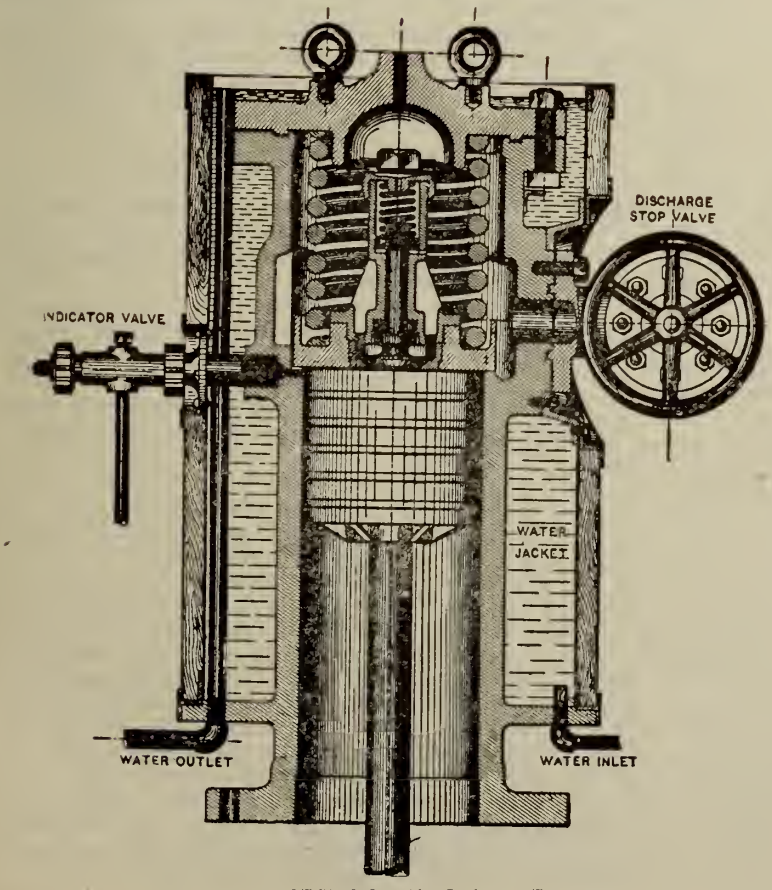
23. The position of the eccentric to the crank for a direct acting motion is that the centre line of eccentric is in advance of the centre line of crank by 90 degrees, plus the amount of cap and lead of the valve.



TYPICAL DOUBLE-ACTING COMPRESSOR.

With indirect valve and direct motion the eccentric will be behind the crank, instead of leading it, or with indirect motion and direct valve it will be behind the crank.

An expansion valve is usually operated by its own eccentric, and the position of this will be governed by the position of the main eccentric, and is usually about 180° from the crank.



SECTION SHOWING SAFETY HEAD.

THE USE OF BALL BEARINGS FOR ELECTRICAL MACHINERY

(Continued from page 224)

circulation of the lubricant in the ball paths: Oil rings, chains, or similar rotating oiling devices are done away with entirely and positive, thorough and uniform lubrication is assured.

It will be readily appreciated from the use of ball bearings on motors that:

1. They eliminate the frequent troublesome inspection of plain bearings—the user need not concern himself as heretofore about the possibility of oil rings sticking.

2. Motors equipped with ball bearings are free from the nuisance and dirty conditions caused by creeping oil and dust around the bearing heads. Frozen bearings due to oil or lint or draining of the oil reservoirs are practically eliminated. Security against such conditions in many instances is worth the cost of the motor and is particularly valuable in textile mills, flour mills, woodworking plants, or other paces where dripping oil adds to the fire hazard or is ruinous to stock in process.

Briefly summarizing the economies offered by ball bearings:

(a) Smaller air gaps permissible, because ball bearings will not wear down as plain bearings do. This gives an improved power-factor for induction motors.

(b) Danger of armature touching the pole pieces is eliminated.

(c) Leakage of oil is prevented. Thus oil cannot drip on to the commutator or oily dirt collect, causing flashovers.

(d) Over-all length decreased from 10 to 20 per cent, resulting in a more compact motor.

(e) Longer period between motor inspection and lubrication required—once in six months against once in two weeks with plain bearings.

(f) Fewer repairs and decreased maintenance cost.

(g) Improved motor commutation.

(h) Improved efficiency, because of reduction in bearing losses

J. B. O. Kemp has been appointed manager of the Toronto Branch, at 208 Kent Bldg., of the Herbert Morris Crane & Hoist Company, Limited.

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A New Fuel For the Power Plant

IMPROVEMENTS are constantly being effected in power plant design and operation. The turbine room having reached a high state of efficiency it is only natural that engineers should be devoting their attention more and more to the boiler room and to combustion problems.

New fuels are being developed, and one of them, powdered coal, has reached the commercial stage. A more recent development, colloidal fuel, makes use of powdered coal and fuel oil in a combined fuel having a very high heat value.

Colloidal fuel is an American invention, primarily due to the war and developed for the conservation of the oil wells. It is merely a mixture of coal dust and oil, the coal dust being held in suspension in the oil by the use of some agent. Graphite and many other substances if reduced to a fine enough state of division may be suspended in a liquid indefinitely; such solutions are known as colloids. The coal dust used with fuel oil is not necessarily so fine as to remain suspended in fuel oil by itself and the inventor, Lindon W. Bates, has been able to effect the permanent suspension of relatively large particles in oil.

This new fuel has the advantage over plain coal dust, in that it can be fired through oil jets with quite a moderate air pressure, whereas powdered coal requires burners of a special kind. Colloidal fuel also overcomes the explosive characteristics of powdered coal.

In practice it is possible to use two parts of coal to one of oil and to obtain a higher heat value than by the use of oil alone.

Pessimists Get Out And Stay Out

HE was sitting in his comfortable office, and everything was going fairly well with the business. But that did not make much difference.

Things in general, according to him, were bad. Our exchange rate abroad was putting a millstone around the national neck; strikes and threatened strikes were putting the finishing touches on the ruin; conditions in Europe were so uncertain that nothing could help them.

In fact, he was out to spray with pessimism every person with whom he came in contact.

There should be some recognized and legal method for dealing with the likes of this. He ought to be "canned," to use the rather pungent talk of the street.

He is living in a great country, better than which there is none. He is right in the midst of one of the greatest periods for usefulness and common-sense the world has ever seen.

And yet this chap, just at the period when the world, and Canada in particular, needs his shoulder at the wheel, is sitting at the side of the road, hoping that the cart will start and slip down hill to jibe with his silly little notions.

It would be too much to expect that a world, which had been churned and shaken from centre to circumference for four years, would, at a day's or a week's notice, slide back and jog along just as though nothing had happened.

This country needs the sane optimism of clean-thinking, courageous men. It does not need the whines of the pessimist nor the groans of the blue-ruin brigade.

A Risky Occupation

THE Toronto *Globe* man has been figuring out the capacity of electric furnaces. Simple thing, too—just as simple as measuring snow with a stick, or stepping off a frontage with your feet.

The *Globe* goes on to say that Toronto has "the largest single electric steel plant in the world as far as known." So far so good. Then the *Globe* goes on to tell its readers just how great this great furnace is:—

"The ten six-ton Heroult furnaces at the British Forgings plant are capable of turning out sixty tons of high-grade steel per day."

Quite so, but why stop at sixty? The *Globe's* man has proceeded on the good old plan that two and two make four. Therefore, ten six-ton furnaces equal ten times six, which makes sixty! Splendid!

But the *Globe* might be surprised to know that this plant has turned out as high as 350 tons per 24 hours, even with its "sixty tons per day" capacity. As a matter of fact, these furnaces can take a heat every five hours, and if worked at anything near real capacity, can make five heats per day. Taking only sixty tons per day from such an outfit as the British Forgings have would be about the same as having a plant and staff equal to that of the *Globe* for the production of a weekly paper.

The *Globe* is quite right in stating that ten times six makes sixty, but it should also recognize that computing the capacity of electric furnaces is slightly different from painting the political situation at Ottawa.

Association and Personal

CANADIAN ELECTRICAL ASSOCIATION WILL HOLD ANNUAL CONVENTION

The Canadian Electrical Association will hold its annual convention at Alexandria Bay, N.Y., on June 27 and 28. Members of the association will leave by boat from Toronto and Montreal on Wednesday, June 25. The cessation of war activities and the return to normal conditions promise a most successful convention, with a number of very interesting papers.

TORONTO LODGE ELECTS OFFICERS

Toronto No. 1 Lodge of the Canadian Association of Stationary Engineers, held a well attended meeting at their rooms in the Temple Building, on Wednesday, May 28th last, for the purpose of electing officers for the coming year, and also electing delegates to the annual convention to be held in Brantford, on June 24, 25, 26th.

The following officers were elected for the ensuing year: President, S. Balmfirth; vice-president, Mr. Adam Taylor; treasurer, John Brown; financial secretary, Ross Leach; recording secretary, Thomas Clews; conductor, J. MacLaren; doorkeeper, Mr. Beach.

The following members were selected to represent the lodge at the convention: Messrs Brown, Balmfirth and Beach.

Business being concluded, the officers and members adjourned to Young's banqueting hall, Yonge Street, where a tasty cold collation had been prepared. The supper being disposed of, the president called the members to order, and the toast of "The King" was honored in foaming ginger ale. The toast of the city of Toronto, was proposed, and replied to by Mr. MacRae, of the Board of Education. In course of his remarks, Mr. MacRae alluded to the trouble in Winnipeg, and in moderate and well considered words showed how the sane and conservative members of the trades unions had been misled by irresponsible agitators. This was followed by the National Anthem, after which the gathering dispersed, well pleased with their evening's entertainment.

Mr. Balmfirth gives notice of a picnic to be held in the near future at which he hopes to see a large attendance.

Henry Engineering Co.—The Henry Engineering Co. announce the formation of a company of three well-known gentlemen, experts in their various lines. Their offices are at 71 Bay Street, Toronto, where they are prepared to act as consulting engineers on general engineering lines. They will also specialize in the purchase and sale of power equipment, steam, electrical and hydraulic, both new and used. The company is composed of Thomas Henry, James A. Rumgay, and Edwin B. McBryde. Mr. Henry was for many years chief engineer of the Interurban Co., and the Erindale Power Co. Later he was associated with the sales department of the Toronto Electric Light Co. Mr. Rumgay was for some years with the Canadian Allis-Chalmers Co. as draftsman and estimating engineer. More recently Mr. Rumgay has been designing engineer and manager of the boiler department of the Polson Iron Works, Toronto. Mr. McBryde has been, since coming to this country, assistant distributing engineer of Toronto Electric Light, and later assistant sales manager. For the past two years he has been manager of the Fisher Electric Co., Toronto.

GETTING OIL IN ENGLAND

By L. P.

The Government has decided to explore Great Britain for oil. There is no reason why our battleships should not be steaming on oil fuel got from beneath our own soil, nor is there any reason why some of our motor cars should not be driven by petrol from under the roads they run upon.

In the past we have been too careless of the wealth that lies under our feet, petrol, lamp oil, fuel oil from overseas were sold here so cheaply that no one was prepared to risk money in drilling for oil in England. But the war has changed the entire position, and petroleum has become so precious that if it exists under England, it must be searched for and got.

That it does so exist has been proved on many occasions during the last century or two. At Clowne, near Chesterfield, there was a flow of 700 to 1,000 gallons daily. Dr. James Young, the founder of the Scottish shale industry, manufactured products 70 years ago from a flow of oil at Alfreton, Derbyshire. A flow at Coalport, mentioned in 1836 by Dr. Prestwich, is stated to have formerly yielded 1,000 gallons a week.

But the most important discovery of recent years was made at Kelham, near Newark in August, 1911. A bore hole was put down there and obtained true petroleum at a depth of about 2,440 feet. The oil sand or rock that gave the oil, was about 13 feet thick, and the bore holes passed right through it. From this bore hole, five to eight gallons of oil flowed to the surface for many months, and was described by our principal authority, Sir Boverton Redwood, as a true petroleum.

Any qualified person who has examined a sample of the oil will agree with him. Provided enough of this oil could be obtained there is no reason why it should not be piped straight away to say, Hull, where a warship could take it on board as oil fuel, just in the state it came from the well.

But there is one remarkable thing about the Kelham oil. Nearly all crude petroleum in its virgin state contains petrol. The Kelham oil contains none. It is incomplete. There is reason to believe it did once contain petrol, if so where has that petrol gone?

The answer is the petrol has become separated from the heavier part of the oil. Where shall we find the complete natural oil with its petrol intact, as contrasted with the Kelham oil? Obviously not above the Kelham oil or the bore holes would have passed through it. Therefort it is said we ought to find it below the Kelham oil—possibly a thousand feet lower. This is a surmise and cannot be said to be a certainty.

Some of us have for years past been urging the Government to drill for oil. We have not predicted with absolute certainty that they will get oil here or get it there. What we have said is that it is worth while making the experiment and finding out whether in these critical times we can depend upon a supply of petrol or lubricating oils, and of liquid fuel, without bringing these from overseas.

The Government has wisely determined to search for oil in England. They have a good chance of being successful.

The Automatic Gas Regulator Company, capital $50,000, head office Vancouver, plans to manufacture and deal in gas regulators.

Hydro Buys Thorold Plant. — Mr. James Battle of Thorold has disposed of his electric power and transformer plant to the Hydro-Electric Power Commission. The price was $100,000 in four per cent. bonds. It is likely that the town will take over the plant. Mr. Battle had a 26-year contract with the Ontario Power Company.

Progress in New Equipment

NEW VULCAN SOOT CLEANER SWIVEL HEAD

FIG. 1 shows the new swivel head for the Vulcan soot cleaner, just put on the market by the Vulcan Soot Cleaner Co., Du Bois, Pa.

To be successful, a swivel head must provide for four things: (1) It must permit easy turning of the soot cleaner element by simply pulling the chain shown in either direction; (2) It must take care of expansion and contraction of the connecting pipe line; (3) It must not leak steam; (4) It must not permit air infiltration.

Steam from the boiler passes into the swivel head from the bottom through the vertical pipe shown, and thence into the horizontal element which extends from the swivel head through the brick wall and into the setting. Fig. 2 shows an interior view of the cleaner element as applied to a Stirling boiler.

After the steam is turned on, the operator rotates the element slowly from one extreme to the other. Steam turbine nozzles inserted in the element and correctly spaced discharge the steam between the tubes in high velocity jets, and in the course of rotation the tubes are thoroughly freed from soot. The limitations of rotation are easily regulated by stops attached to the link chain. These stops are stopped by the horizontal cast fingers shown. A pointer from one arm of the sprocket plainly indicates to the operator the direction in which the steam jets are discharging. This pointer is plainly shown in Fig. 1.

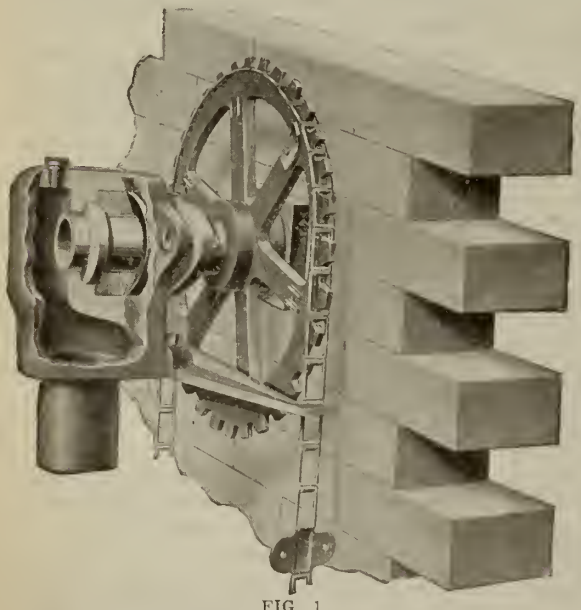


FIG. 1.

The method of packing the stuffing box in the swivel head is clearly illustrated. The visible end of the element, Fig. 1, is made of bronze composition on which is turned a collar that fits against metal on one side and packing on the other. It is designed in such a way that when steam is turned on friction is relieved and turning the element by hand becomes easy. In their broad experience at soot cleaning the manufacturers have learned that the operator is less liable to shirk his duty where manual labor is eliminated or reduced to the minimum.

To take care of expansion and contraction, a gas tight, sliding joint is provided between the sprocket wheel and the metal housing that is mortared into the brickwork. Hence the ample clearance shown in Fig. 2. As the vertical riser expands or contracts, the swivel head moves up or down and the attached end of the element must, of course, follow. This is nicely cared for in the new Vulcan sliding, rotation swivel head, which is so designed that air inleakage becomes impossible because of an air-tight plate used in the sliding joint.

As is well known, in ordinary settings, where the hand lance is used for cleaning, air inleakage is enormous and much fuel is lost, due to that cause alone. The effective sealing up of all cracks with the installation of a mechanical soot cleaner is in itself an important coal-saving item.

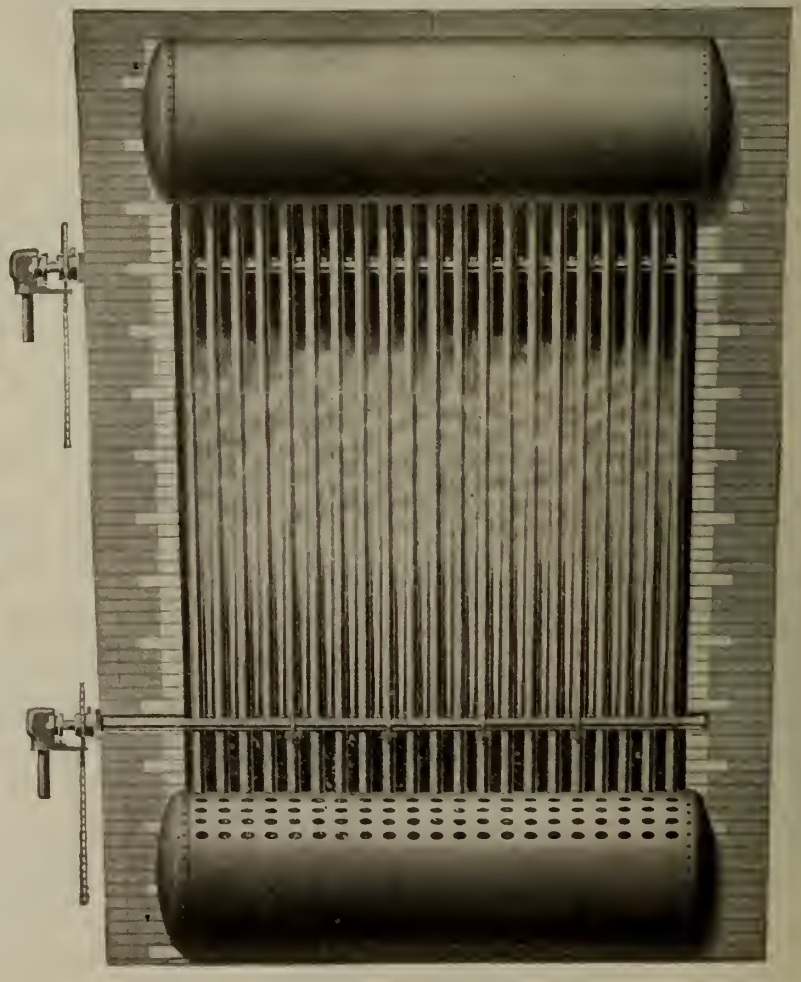
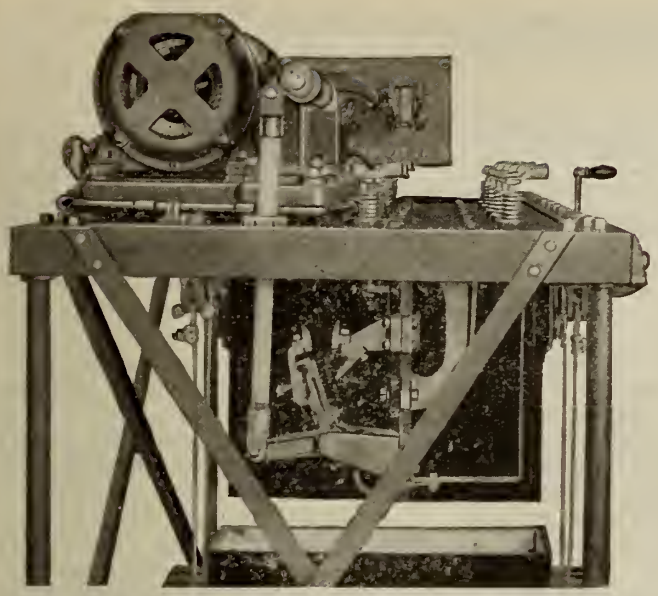
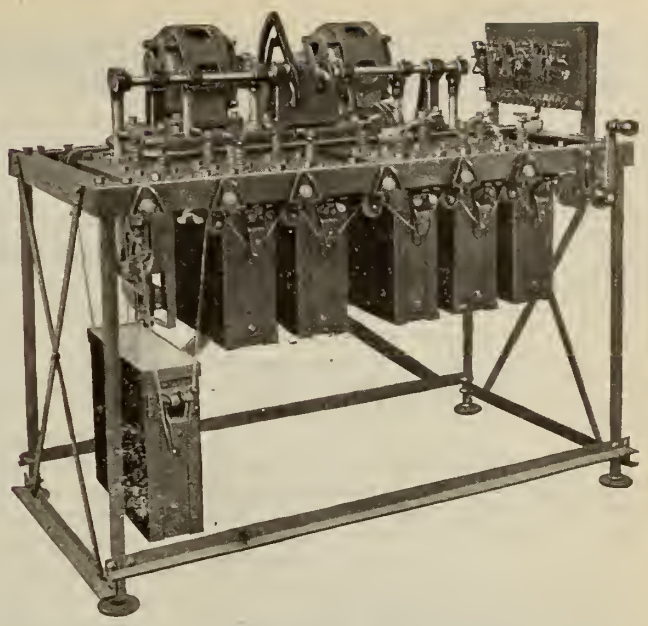


FIG. 2.



THIS END VIEW SHOWS THE CONSTRUCTION OF THE CONTACT-MAKING MEMBERS; THE ARC BEING BROKEN HORIZONTALLY RATHER THAN VERTICALLY.



NEW PRIMARY OIL REVERSING SWITCH WHICH IS VERY QUIET IN OPERATION, BEING OPERATED BY TWO HIGH TORQUE MOTORS.

NEW OIL REVERSING SWITCH FOR LARGE MOTORS

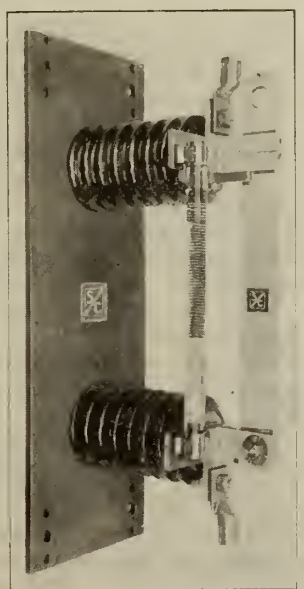
High voltage slip ring motors built for steel mills, mine hoists and similar duty, require some form of switch to connect the primary winding to the lines, especially so when the motor is used for reversing service. The accompanying illustrations show a new primary oil reverse switch that has several new and interesting features. It consists principally of two 3-pole switch units each operated by a high torque motor.

Among the unique features of this switch are the unit tank construction and the means of lowering the tanks for inspection, repairs and renewal of oil. Unit tank construction is used because it increases accessibility and saves time and labor in locating trouble and making repairs. A double windlass with cables and pulleys permits easy lowering of one or more tanks. In the end view one of the tanks is lowered and shows the simple construction of the stationary and moving members. It will be noted that the arc is broken horizontally, rather than vertically. This construction allows the arc to rise to the point of rupture without burning parts not designed for such duty; and since the rupture takes place near the top of the oil, it is well away from all sediment; hence frequent inspections and renewals are unnecessary. The support for the stationary and moving members is bolted to a channel iron, which in turn is bolted to the main frame, consequently in case of serious damage to any single pole unit the complete unit may be removed without disturbing any of the others. The tanks are lined with a heavy asbestos material to prevent groundings of any live parts in case the tank is pushed out of place, and also as an additional safeguard in case of sludging of the oil.

The contractor panel shown at the extreme right is controlled from a master switch or push buttons and handles the motor currents. Very little current is required, as the motors used have high resistance motors. This particular reversing switch was made by the Cutler-Hammer Mfg. Co. of Milwaukee for a 1,200 h.p. 220 volt mine hoist motor. It may be used for two motors on non-reversing service, or where only one non-reversing motor is required the switch is made with only one 3-pole unit and one motor.

S. & C. SAFETY DISCONNECTING SWITCHES

The hazard attending the opening of disconnecting switches that are alive but which are not supposed to be carrying current, is only too well known to operating engineers. The disastrous results have taken a heavy toll in lives, besides the enormous damage done to apparatus and to the morale of operators wherever these accidents have occurred. These accidents are by no means necessarily the result of carelessness on the part of operators, as there have been many cases where oil switches have failed to operate properly, and, since the contacts are enclosed in the oil pots, there was no way of knowing that the contacts had not separated and that the disconnects were still carrying current. After the disconnecting blade has been opened and the resulting arc has flared into the surrounding structural iron, it is too late to rectify the error.



SAFETY DISCONNECTING SWITCH.

In addition to the desirability of making the operation of disconnecting switches safer, there also exists a large field for an inexpensive method of interrupting load currents at moderate and high voltages without the use of expensive oil circuit breakers. This is especially true in those cases where the opening of the circuit is necessary only at rare intervals.

There have been many attempts to provide devices to insure the safety of the operator and to make possible the interruption of high voltage currents, but the adaptation of the S. & C. fuse to this purpose, is, without any doubt, the simplest and most reliable of all such devices. The arrangement of the S. & C. fuse for this purpose is shown in the accompanying illustration. It will be noted that it consists essentially of a disconnect shunted by a low amperage S. & C. fuse, and provided with a lock, so that the disconnect cannot be opened unless the fuse is in place. If the disconnect is opened when it is carrying current, the current is shunted through the fuse where it is interrupted when the fuse blows due to the current being above the rated current of the fuse.

A very noteworthy fact is that in interrupting currents at 9,000 volts, it was not necessary to open the disconnect with any unusual rapidity. The ordinary rate of opening the blade was

quite sufficient to shunt the current through the fuses and prevent the arc from being reestablished at the contact. In regular service it is, however, desirable to open the disconnect with as quick a movement as possible.

In order to be positive as to the possibilities of the safety disconnecting switch, a great variety of loads were interrupted, covering everything from an exciting current of compensators and transformers, to the breaking of single and three phase load currents. The results were the same in each case, in that there was scarcely any visible evidence that any current had been interrupted.

The adaptability and utility of such an arrangement is at once apparent. It represents a very small additional cost to the equipment, and at the same time, provides positive insurance against the inevitable damage, and perhaps loss of life, whenever a blade disconnect is opened while carrying current. Such insurance is especially desirable in the case of oil switch disconnects, regulator transfer switches, etc., where the space around the blade is very limited, and where, therefore, an arc would result disastrously.

It should be remembered that the fuse only blows in case the disconnect is carrying current when it is opened, and there is no expense involved unless current is interrupted. On the other hand the cost of refilling an S.&C. fuse is quite infinitesimal when compared with the cost of repairs after an accident of this nature, for it must be remembered that when once an arc is started between a live contact and grounded framework, such as surrounds all installations of this kind, only the opening of the oil switch controlling the source of supply can stop the flow of current. The expense of occasionally filling an S. & C. fuse is, of course, negligible when compared to the advantage of the S. & C. safety disconnect idea. carrying load. and therefore avoid the installation of costly oil circuit breakers.

If safety disconnecting switches are used it is not necessary to provide ordinary positive locks to keep the switch from opening, due to magnetic forces when short circuits occur. The safety lock performs its regular function and this function also. Ordinarily the safety fuse would not be in place. and. therefore, the switch would be locked. It might be well to emphasize that although there might be many safety disconnecting switches in a station, only a comparatively small number of fuses need be kept on hand, as they are only inserted when it is desired to open the disconnect.

Another invaluable feature of this adaptation of the S. & C. fuse is the effect upon the morale of the operating force when they know this danger in opening disconnects has been removed. Particularly is this so on systems where such accidents have happened. Experience has shown that length of service does not afford immunity, for quite often the trouble lies in other people and in apparatus beyond the control of the operator.

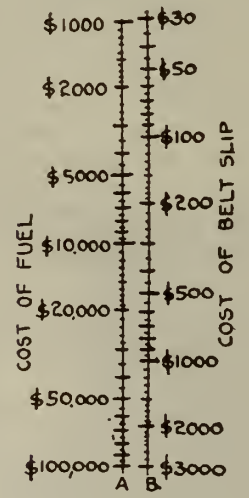
These safety disconnecting switches and fuses are manufactured by Schweitzer and Conrad, Ravenswood Ave., Chicago.

THE COST OF BELT SLIP

The Cling-Surface Co., Buffalo, N.Y., in its more than 20 years of existence, has done much toward conserving fuel and saving belts by eliminating belt slip. It has made belt slip and its attendant costs and troubles a special study. Readers will therefore be interested in the small and handy accompanying chart and the "Cling-Surface Formula" for more accurately figuring costs.

Referring first to the chart, column B shows roughly how much money Cling-Surface will save.

For example, if you spend $10,000 per year for fuel (see column A) and if all the power developed is sooner or later transmitted through belting. Column B



COST OF BELT SLIP IN TERMS OF FUEL CONSUMPTION

(opposite the $10,000) shows that $300 can be saved by stopping slip.

In the above scale 5 per cent. total slip, including creep, is assumed, which is a very low assumption.

If all the power is transmitted through a main belt and the main belt slips 5 per cent., the annual preventable loss in that one belt is $300.

Power is often transmitted from the main shaft to the second shaft, from the second shaft to the third shaft, and so on. This loss multiplies until the total often amounts to 10, 15, or 20 per cent. of the yearly cost of the fuel.

In the face of these facts it is evident that the cost of Cling-Surface is practically "zero" when compared with the money it saves through elimination of slip.

To assist the reader still further in correctly and simultaneously computing slip and costs this formula has been developed:

$$C\left(0.98 \frac{dn}{Dn}\right) = \$ \text{ wasted per year}$$

where—C = cost of power per year for the given drive, dollars:
d = diameter of driven pulley plus belt thickness, inches
n = r. p. m. of driven pulley
D = diameter of driving pulley plus belt thickness, inches
N = r. p. m. of driving pulley

If the reader doesn't like formulas, it can be done by following these simple rules.

(1) add diameter of pulley to belt thickness, inches, and multiply by r.p.m. of driven pulley.

(2) add diameter of driving pulley to belt thickness, inches, and multiply by r. p. m. of driving pulley.

(3) divide (1) by (2)

(4) substract (3) from 0.98

(5) multiply (4) by the cost of power in dollars per year for the drive.

The result is the dollars wasted per year because of unnecessary belt slip. The function of belt treatment is to save these dollars, an accomplishment that is possible by proper study, care and application.

A FILE IS A FINE TOOL

The Ingersoll File Company, Ltd., is sending out the following notice with its shipments of files:

The point of each tooth on it is as beautifully sharp as the edge of a good chisel. If carelessly handled some of these teeth are broken, with the result that the next time the file is used it seems dull and makes furrows or ridges in the work.

DON'T throw files carelessly into the drawer with cold chisels, hammers, etc.

DON'T leave files lying around on the bench or lathe where they are liable to be swept on to the floor and broken. Hardened steel is necessarily brittle, and we take a pride in making our product as highly tempered as we know how.

DON'T keep files in a damp place. Rust will ruin the best tooth ever cut on a file.

DON'T use a file for any other job than that for which it was made. Because it is "only a file" is no reason why it should be made the "Handy Man" of the shop.

May we suggest that you provide a rack for your files as you do for your drills, etc, so that they may be properly stored when not in use.

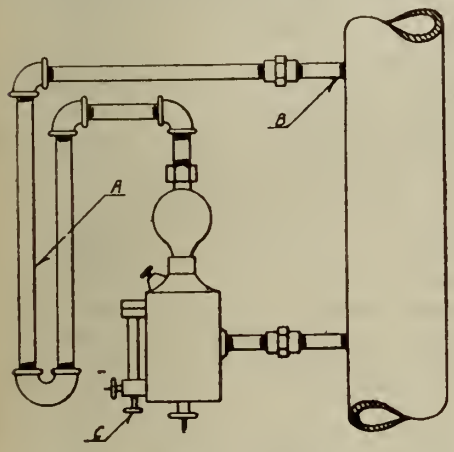
If these suggestions are acted on we think you will find the life of your files materially lengthened, and that they will keep their cutting edge, in which case you will be better satisfied as users and we as producers.

Always remember, a file is a fine tool.

The Operators' Point of View

LUBRICATION ATTACHMENT

The following idea may or may not be a new one. An engineer informed me that he connected his lubricators as shown and he found the regulation much easier than when he had the connection B several feet above the lubricator, his idea being that the pressure head in a long pipe requires a nearly closed feed valve, that when filling the lubricator the condensing pipe might be emptied and the feed valve would be opened enough to give a desired feed; gradually the long pipe would fill up, the pressure



LUBRICATOR CONNECTION.

would thus increase, and the oil would feed faster and the feed valve at C would have to be closed until the desired feed was secured; if it was neglected the lubricator would soon empty. With the trapped connections there is very little hydrostatic head, and the trap will hold the water when the lubricator is being emptied before refilling with oil, and the regulation is much easier, usually the first setting being right.

JOHN JAMES.

THE OLD HAND-FIREMAN TALKS

Oh, mister, what of the night,
Fresh air I seldom see,
I tell you I'm nearly tired to death,
Don't talk of the busy bee.
Just look in that hole, so black and grim,
So full of dust and grit,
I spend my life with my mates down here
With nary a chance to sit.
It's shovel and drag and poke the coke,
And slice and shovel and draw,
Is it any wonder I am a grouch
And say I am treated raw?
Sure I am a fireman, sir,
A hand-firing man at that;
I don't give a cuss for any machine,
I'll beat the best ones flat.
You say I could sit and read and eat,
And take things kind o' slow,
If I had your stoker machine
Attached right where my fires do glow,
There's nary machine on earth can stay
In this old game with me,
I hope the boss won't fall for it,
I'll put him wise, begee.
I love this darned old cheery dump,
I've been here half my life;
I know every danged old brick in the wall
As well as I do the wife.
The units of heat in the coal I fire
Come out and work for me,
Although a few run up the stack
They're as white as you or me.
The fires are level as mill-planed boards,
With nary a hole to see;
The grates I use have been here for years,
In fact since ninety three.
You ask me why I sometimes grouch,
And why do I raise a howl,
Well, mister, I'm getting old,
And an old man likes a growl.
I guess your mechanical stoker is fine,
But it can't compete with me,
For the human machine with a pride in its work
Beats the iron machine, you see.

THE OLD FIREMAN.

WHICH ARE BEST—PLUGS OR CAPS?

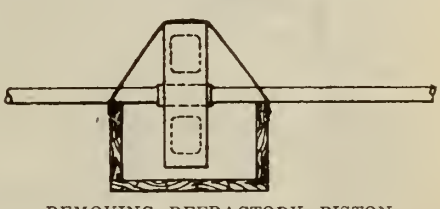
Around steam plants one often finds discharge pipe ends closed by putting on a coupling and inserting a plug. In high-pressure lines this is sometimes done where a leaky valve is on; the plug stops the drip. I prefer to use a pipe cap for the purpose because the hot water or steam does not fly out around one's fingers. One is only inconvenienced by the heat conducted through the metal of the cap and only one fitting is used instead of two. Every plant uses plugs, but one comparatively seldom finds caps on hand, and even some dealers fail to stock them, probably because they are

seldom asked for. The sketches indicate the difference of direction of flow of the hot water or steam in the two methods.

J. E. McCORMACK.

REMOVING A STUBBORN PISTON

A 16-inch piston on a 10-foot rod refused to yield to the influence of a 25-pound sledge. Not caring to apply fire to the piston and perhaps figure in the casualty list, we laid the rod across a box as per sketch and covered the piston



REMOVING REFRACTORY PISTON

and box with canvas. After heating the piston by means of a steam jet discharging into the box, and then cooling the rod with water, a little more persuasion from the sledge induced the piston to yield. It was safer than the fire method as the piston was cored and might have contained water.

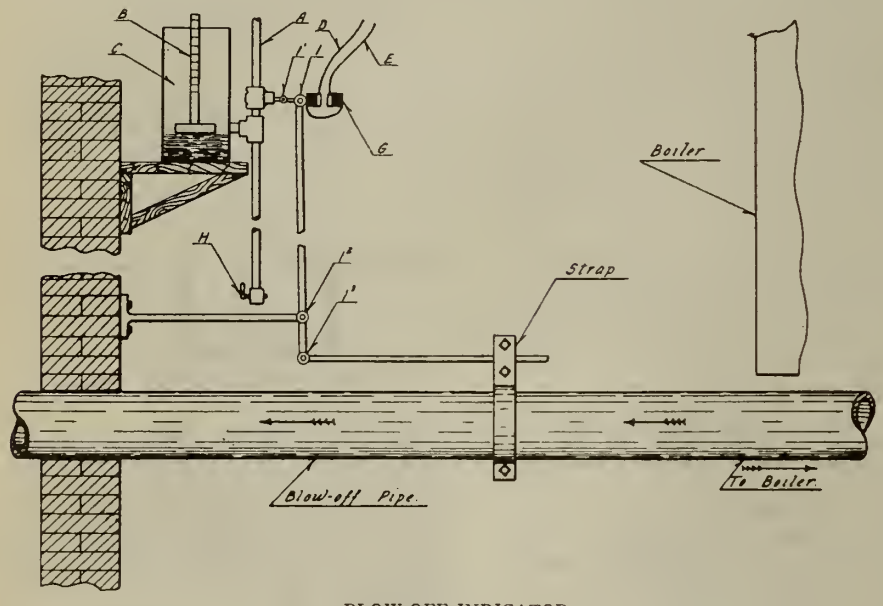
R. McLAREN.

STEAM BOILER BLOW-DOWN RECORDER

By Wm. Beecher

I have described several of these recorders in the past; the one herein shown is more simple and easier made than any of the others. It will do good work. Any man with ordinary ability can put it together. A strap is fastened around the blow-off pipe to hold a ⅜-inch iron rod with movable joints at 1, 1^2 and 1^3. A brace is attached from the wall to the rod as shown. If there is a night-watch clock in the building the wires D and E can be run to it; the two square pieces at G are attached together with a fine piece of spring wire, the piece at side, G, being fastened so that it will not move. The other piece is left loose, the spring allowing it to be moved to come in contact with the other one. The dark part is insulating material, the light part brass or copper, to which the wires are soldered. When the boiler is blown the pipe expands in the direction of the heavy arrows. This will force the two squares together at G and the time clock will record the hour and duration of the blow-down. If a pen record is used no change need be made; if a punching check is used the punching pin will have to be filed so that it will slit the paper disc should the blow-down be prolonged.

If no clock is used an ordinary outfit with the bell or buzzer in the office can be attached, and to show the duration of the blow-down a water tank as shown can be put up. The tank is a piece of 2-inch or larger iron pipe closed at the bottom and open at the top, a ⅛-inch water pipe is at A, a threadless spindle globe valve being at 1', a loose joint being there also. Inside the tank is a float with an indicating rod attached. When the blow-off pipe expands it opens the water valve and forces the electric connections together. By experiment the amount of rise of water in the tank per minute, or per inch of fall of water in the boiler can be noted, and the spaces marked on the rod B. This same rod should have as a guide a piece of sheet iron with a hole in it laid across the top of the pipe. If a piece of 2-inch pipe is used the float could be made the full size of the pipe, the markings being put on the float.



BLOW-OFF INDICATOR.

I feel sure that recorders of this style will be fairly accurate as the temperature in the blow-off pipe will drop very rapidly for the first 100 degrees or so, after the blow-off cock is closed. With a fairly long upright rod an expansion of 1-16th of an inch at the pipe will give a movement of ½ an inch or more at the valve. That is all, the sketch shows the idea very distinctly.

OBSERVATIONS OF A GREENHORN IN THE ENGINE ROOM

By WM. WEBB

ONE evening recently the boss called on me, and asked me if I would take charge of the engine and boiler next day, as the engineer was sick. I told him that nothing was easier. He had probably noticed that my bump of intelligence was abnormally large, and thought that I was capable of running his plant for a day or two. I am a woodworker by trade, but in my visits to the engine room I had taken particular notice of the duties of the engineer. All I ever saw him do was to throw a few shovelfuls of coal on the fire, cast a wise look on that clock thing up on the boiler, look at his engine, then sit down and read the POWER HOUSE. Anybody could do that. I hardly slept that night. I could fancy the fellows coming in, and saying, "Hello, Chief." Well, I got up, good and early, and went to work. My hat was a tight fit that morning. The night watchman had steam up, ready to start the engine. I told him to go home, and I would look after the rest. Our engine is a Wheelock, and I had noticed the engineer take hold of a handle, rock it back and forth a few times, and away she would go. As easy as falling off a log. Well, I turned on the steam, seized the handle, rocked it back and forth, but the engine refused to run the right way. It gave two or three revolutions backwards, and put half the belts in the shop off the pulleys Well, by great good luck she took a notion to run right, and away she went. And, by jimmy, she did go. I had never seen that engine go so fast. I was the boy to speed her up. But one of those know-it-all's came running in and shut off the steam. I said. "What did you do that for?" He said. "She was running too fast, and shaking everything to pieces." I suppose that is the reason that engines are always called "she." The engineer had taken a piece out of the belt that drives the governor, and had not put it on again. You could hardly blame me for that. Well, we put the belt on and turned on the steam. Not a move. One of those blamed pots would not work. Our engineer is not given to strong language, but I have heard him call those things, "dashed pots." Well, this same fellow moved some little lever under the governor, and the blamed dashed pots worked alright, and the engine started up once more. I thought my troubles were over. Well, I threw some coal on the fire, and I thought I would attend to the dynamo. The dynamo is driven by a belt connected with the engine. Our engineer claims that a dynamo should be driven by a little engine all by itself. And by this time I was beginning to have some little respect for the engineer and his job. Well, I started the dynamo, and pulled the switch from the city lights to our own lights. Result: Complete darkness. Back I switched to the city lights. In came Mr. Know-it-all. "What's the matter, Bill?" I told him the governor of the dynamo wasn't working, or else some blamed dashed pots were out of order. Well, he told me to turn a little wheel, then move the switch. I did so, and, by jimmy, the lights were on. I discovered that by turning that wheel that I could make the lights brighter, and so I turned till the clock thing was up to one hundred and forty, which was as high as the dashed thing would go. I tell you, our engineer never gave us such good lights as I got from that old dynamo. I then went to see to the fire, well pleased with the way I was progressing. I think I will take out engineer's papers. The fire was nearly out, so I threw in enough coal to last about an hour. I wanted to sit down and read for awhile. Pon my word, in came that Mr. Know-it-all again. Says he. "Where's your water" Says I, "In the tap, Smarty, and there's a cup, drink all you want." He says, "I mean where's the water in the boiler, I don't see any in the glass?" Well, 'pon my word. I had forgotten to start the pump. Well, we soon had the pump going, and I began to think that he did know a little about engineering. While we were attending to the water, the lights began to grow dim, till finally they went out. I made a rush and switched on the city lights. And that dynamo, instead of sending the light out to the shop, was keeping it all on the armature. There was enough light flying off the brushes to light three factories our size. Mr. Know-it-all says that the dynamo wanted a cleaning, and to get a piece of waste and clean it off. I remembered that the engineer put coal oil on the waste, so I got a piece, soaked it well, and applied it to the armature. Well, it blazed up in my hand, and burned my fingers. This gave me an excuse to go to the doctor, so I gave Mr. Know-it-all full instructions regarding the running of the plant, and beat it to the doctor. I got my hand bound up with about ten yards of bandage, and took dashed good care not to go back to work till the engineer was on the job again. I have decided not to apply for engineer's papers.

F. D. Still, vice-president and secretary of the Canadian Sirocco Company, has left on an extended trip for the far East, where he will investigate trade conditions in connection with export work. Mr. Still's itinerary includes Japan, China, Australia and most of the European countries and he expects to cover approximately 36,000 miles before

The Lubrication of Refrigerating Machinery

Special Attention Must be Paid to the Proper Lubrication of Compressors to Secure Highest Efficiency—The Proper Oils to Use Depend Upon the System Used

WHILE at first glance the lubrication of refrigeration machinery would appear to be little different from the lubrication of other apparatus of a similar type, a little thought will show that the refrigerating medium employed and the effects of the lubricant on the operation of the system will have to be taken into consideration.

In the absorption system where aqua ammonia is used as the refrigerant the only moving part is the pump, which does not present any difficulty in its lubrication unless where, in the case of a steam driven pump, the exhaust steam is required for ice making.

In ammonia compression systems the ammonia vapor is compressed from a pressure of 150 to 180 lbs., and from the compressor goes to the condenser, where the heat resulting from its compression is extracted and the gas liquefied. The anhydrous ammonia is now in a liquid state and still under pressure is expanded in the expansion coils. In its expansion it absorbs heat and returns to the compressor. An oil extractor is usually inserted in the line between the compressor and the condenser and any lubricating oil carried over thus entrapped.

In an article in "Southern Engineer" the Lubricating Engineers' Association of the Texas Co. make the following recommendations concerning the lubricating of ammonia compressors:

Lubrication of Compressor Cylinders

The characteristics of a suitable oil are such as any high grade air compressor oil would possess. The temperature during compression is comparatively low,probably not over 250 degrees, and as practically all of the oils that would ever be used have a flash point of over 300 degrees, this feature may be entirely disregarded in the selection of the lubricants.

The mechanical condition of the cylinder wall, piston, piston rings and valves determines the viscosity of the oil that should be used, as the oil must assist the piston rings in maintaining perfect compression. If the cylinder and moving parts are in first-class condition, a light bodied oil will give satisfactory results, but if the cylinders are worn out of round through usage or are scored because of improper lubrication or by the presence of foreign matter, a medium or heavy bodied oil should be used. An oil of medium body will greatly improve the seal of the piston rings and cylinder and will increase the efficiency of the compressor.

While an oil having the above-mentioned characteristics will satisfactorily lubricate the compressor cylinder, there are a number of other operating factors to be considered which frequently make necessary the selection of an oil of other physical characteristics. Regardless of how high the flash point may be, some vaporization will always take place under the high temperatures of compression, and this vapor will be carried out of the cylinder with the ammonia gas. As the compressor cylinder, the condenser, receiver, and expansion coils constitute a closed system, any oil vapor taken out of the compressor cylinder necessarily remains in the system, and, unless condensed and removed at some point, will gradually cover the internal surfaces of all parts of the system.

All oils, as they become cooler, thicken, until, at a certain temperature, they cease to flow and congeal into a thick, heavy bodied mass. In the event that the oil vapor reaches the condenser and expansion coils it is cooled and liquefied and unless it has a pour test lower than the temperature in the expansion coils it will congeal on the inner surface of the tubes. This congealed oil in addition to obstructing the passage of ammonia forms a very effective insulator, preventing the transfer of heat to the ammonia and seriously affecting the efficiency and capacity of the refrigeration system. To reduce as far as possible the loss due to the congealing of oil on these surfaces, the lubricant should have a pour test not above zero F., and lower if possible, so that any oil passing the traps and reaching the expansion coils will remain fluid enough to be carried along in the usual cycle of expansion and compression of gases.

Paraffine oils can be made suitable for ammonia compressor lubrication only after careful extraction of the paraffin by refining, a process which lowers the cold test.

To reduce the possibility of oil reaching the coils, all refrigerating machines and their accessories are equipped with oil extractors placed between the compressor and the condenser. These oil trapping devices should be carefully located and constantly watched to see that they are working properly, and are drained at regular intervals. Common practice in connection with determining the efficiency of such devices is to check up the amount of oil removed from them with the amount fed to the compressor cylinder. Any great difference is immediately investigated as it would indicate that the oil is not being entirely trapped. In any case the oil supplied to the compresspr cylinder should be reduced to a minimum. A surprisingly small amount of oil is required to lubricate the cylinder, and any excess amounts fed are likely to cause trouble.

The location of the oil extractor between the compressor and the condenser, and its efficiency, have a great influence on the viscosity of the oil which may be used in the cylinder. If the oil extractor is located close to the cylinder, a relatively high viscosity oil should be used, as the higher viscosity oils have less tendency to vaporize and be carried over with the ammonia gas. On the other hand, if the extractor is placed at some distance from the compressor, a lower viscosity oil may be used, as the oil vapor has a greater length of time in which to condense out of the ammonia gas before it enters the condenser. Consideration of the location of extractors is of vital importance in the selection of the compressor lubricating oil.

Medium bodied paraffine oils which might be suitable in viscosity for the lubrication of worn cylinders or piston rings have a high cold test which renders them unfit for refrigerating work.

Compressors are made in many types and forms and are lubricated in many ways. The cylinders of machines like the Remington, the Brecht and the Brunswick are lubricated by the splash system, the oil being carried in the crank case at a predetermined level indicated by a gauge glass and splashed on the parts to be lubricated by the rotating crank. The Brunswick and Remington machines are single acting with one end of the cylinder open so that the splashing of the oil on the inner surface of the cylinder lubricates it in a similar manner to the lubrication of automobile cylinders. The Brunswick machine has two piston rings below the suction inlet, which serve to wipe off excessive oil and prevent its being drawn into the cylinder.

There is a possibility with this method of lubrication that, in the event of the operator neglecting the machine and allowing the back pressure to drop below atmospheric pressure in the cylinder the low pressure in the cylinder may cause a considerable quantity of oil to be spashed up on the lower part of the cylinder to be drawn in. Such an occurrence, however, is almost always the fault of the operator, and with proper attention may be prevented. Oil losses may be reduced by blowing back into the crank case under pressure the oil carried over from the cylinder and deposited in the oil extractor.

Some compressor cylinders are lubricated by circulating oil through the piston rod stuffing box, which is especially arranged with an oil lantern. A

small amount of oil works into the cylinder through the packing and affords lubrication. The oil in the stuffing box lantern also protects the packing from the action of the hot ammonia gas which would have a very bad effect on the packing if it were not for the efficient protection afforded by the oil. Some compressors are equipped with mechanical force feed lubricators or lubricators connected between the intake line and the discharge line, the difference in pressure serving to force the oil through the regulating valve into the intake line.

As a point of interest to operating engineers, who may have had trouble with oil passing the oil extractors and congealing in the condenser, experience has shown that this accumulation may be removed by cutting off the water from part of the coils at a time and allowing them to become hot. This thins down the oil and it may be drained off at the oil trap. If the expansion coils have become coated, the oil may be removed by running the system backwards; that is, bp passing the hot ammonia gas back through the coils, warming them up, and melting down the congealed oil. Sometimes these coils are cleaned by pumping out all of the gas and blowing out the coils with steam and finally with air to remove the moisture. This is dangerous, as some water may remain in the system and have a bad effect on the ammonia.

Steam Cylinder Lubrication

Unless the exhaust steam is used in making ice. the lubrication of the steam cylinders of steam driven refrigeration machinery and steam pumps presents no unusually difficult lubricating problem. A high grade steam cylinder oil should be selected to meet the operating conditions, bearing in mind the principles involved in the lubrication of ordinary types of steam cylinders. However, if the exhaust steam is condensed and used in making ice, very careful arrangements must be made for the removal of practically all of the oil. For this purpose, oil separators are placed in the exhaust line, and upon their efficiency hinges, to a considerable extent, the selection of a proper oil to be used in the steam cylinders. When the live steam contains moisture, a mineral cylinder oil containing a percentage of fatty oil will give the best results, and is, in some instances, absolutely necessary to prevent cutting of the cylinder. On such installations a highly filtered oil should be used as sparingly as possible, and the oil separator should be blown out frequently. Where the steam is reasonably dry, a filtered straight mineral steam cylinder oil may be used if care is taken in the selection of the oil and the method of application. The oil should be introduced into the steam line far enough back from the throttle to insure complete atomization before it reaches the cylinder, as such atomization will permit of the use of minimum quantities of oil.

The discoloration of ice is the most frequent source of complaint from the engineers and operators and in practically all cases it is at once blamed on the oil. If the oil is not completely removed from exhaust steam used in making ice, a fan shaped discoloration appears in the block of ice. Rust formed by condensed water left in the cans is often the cause of ice discoloration, which can easily be distinguished from oil discoloration, as it appears all through the block and is without definite formation.

The carbon dioxide machine presents practically the same lubricating conditions as the ammonia machine except that the working pressures are from 900 to 1,000 pounds. The compressor cylinder temperatures are a little higher than those found in ammonia cylinders, but when properly cooled and arranged with inter-coolers, no lubricating difficulties will be experienced.

The Allen dense air machine, however, presents a very interesting lubricating problem because of the extremely low temperatures encountered in this system. Air is compressed to a pressure of from 250 to 300 pounds, the cylinder being water cooled to carry away a part of the heat of compression. The compressed air then goes to a cooler, where the temperature is lowered as much as possible by water, and then passed into the air expander, which consists of a cylinder on the same shaft as the compressor cylinder. The air is expanded in this cylinder until the temperature drops to a very low point, sometimes reaching 60 degrees below zero. The lubrication of the cylinder under such low temperatures is a very difficult problem, as even most of the natural cold test oils congeal at a few degrees below zero. and to meet these requirements. it is necessary to make an oil from specially selected natural cold test stock. From the expander cylinder the cold air is sent through the refrigeration coils, where the temperature may be as low as 45 degrees below zero.

Efficient oil trapping devices should be installed in all cases, and the oil frequently blown out. If this is done no trouble should be experienced from clogging of the expansion coils. In all expander installations, as in ammonia compression machines, the oil consumption should be cut down as low as possible and still afford proper cylinder lubrication.

PROTECTING IRON FROM CORROSION

In a paper read before the Iron and Steel Institute, Mr. J. N. Friend summarized as follows the results of his researches on the usefulness of paint for protecting ironwork from atmospheric corrosion: 1. The practical value of acceleration tests is very small in the present state of the knowledge on the subject. Reliable results can only be obtained from tests carried out under conditions closely resembling those prevailing in practice. 2. Addition of pigment to oil increases the efficiency of the latter as a protective paint until a maximum is reached. After this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered. 3. Linseed oil, on setting, expands by some 3.3 per cent. This is the primary cause of crinkling. Further oxidation causes a decrease in volume, which in time leads to cracking. 4. Linixyn is permeable to moisture. The permeability is reduced by heating in absence of air, the oil increasing in density, viscosity and molecular weight. 5. Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle. 6. The functions of a pigment are to toughen the film and render it less permeable to water vapour and oxygen. It also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle. 7. A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place. 8. The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight. 9. Thinners enable thin coats of paint to be applied. Turpentine leaves a very slight residue behind upon evaporation, but its effect on the efficiency of the paint is small. 10. Other things being equal, the most permanent paints are those containing black or red pigments, since these absorb the shorter rays of light and prevent them from hastening the destructive oxidation of the linoyn by the air. 11. Finer pigments afford more efficient protection than coarse pigments, since they are more thoroughly in contact with the oil. 12. Iron structures should be painted whilst their scale is still on, after loosely-adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved. 13. Experiments with rusty plates are not conclusive but suggest that the rust need not be so carefully removed as is usually thought to be necessary.

IRON CEMENT OR FILLER

By T. H.

In workshops where there is filing and drilling there is usually a lot of fine cast iron in powder to be thrown away, the stuff being a nuisance generally, yet when a joint has to be made or a hole in a casting stopped. filings are conspicuous by their absence. Sufficient finely-sifted stuff passing a 32-in. gauze sieve should be secured. thoroughly dried and kept in an air-tight tin or bottle, and when wanted for use, 80 parts of filings, 2 parts sal-ammoniac, and 1 part flower of sulphur should be very intimately mixed, being careful to finely powder the sal-ammoniac. Immediately before use this mixture should be made into a stiff paste with water and pressed into the cavities, ramming with a piece of wood. In two or three days the material will be hard, and can be filed down level if desired, but it has a slightly brown appearance caused by the formation of oxide or rust.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$4 50
Tank plates, 3-16 in.	5 50	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	26 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard	Lapweld	
2 in.	38 81	35 34
2½ in.	42 12	62 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 25
Steel bars, base, Toronto ...	4 25
Steel bars, 2" to 4" base...	5 50
Iron bars, base, Montreal ..	3 75
Steel bars, base, Montreal..	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 55	$ 6 00
Sheets, Black, No. 10.	5 15	5 45
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 95
Premier, 10¾ oz.	....	8 25

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 60
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 60
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	60
Kearney & Foot, Arcade	60
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Flles	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	60

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	65
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 76
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	60
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D." per lb.	0 03
Rosin "G." per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ⅛ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned, 14x60 in.. 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 30
Sheets, 24 oz. and heavier base	0 38
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	26
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	26
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus	10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	66
Patch bolts .....add	40, 10
Cold pressed nuts to 1½ in.	add $4 60
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper	17 25	19 00
Tin	58 00	55 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 60
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided	$0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

CATALOGUES

The Ingersoll-Rand Company, have issued a catalogue descriptive of their Imperial type 14 air compressors for belt drives. These compressors are of small size and excellently adapted to many uses around the machine shop and other industrial plants.

"Billy-Isms" is the title of a little booklet recently brough out by the Ingersoll-Rand Company, and is descriptive of the "Little-Tugger" Compact Hoisting Engine, which can be shifted around from place to place and hung anywhere. The hoist is operated by compressed air and is very portable.

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 243 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

The Buffalo Forge Company, have issued section No. 100 of their catalogues, descriptive of fans, blowers, and exhausters. This publication takes up the types of fans made, and in addition to giving the various sizes and types manufactured, goes into their manufacture.

The Defender Automatic Regulator Co., St. Louis, Mo., have issued catalog No. 11, descriptive ofthe various lines of power plant regulating apparatus which they manufacture. The publication is unusually complete and is of high value to the power plant operator from the standpoint of efficient operation.

The American Steam Gauge and Valve Manufacturing Company, Boston, have issued booklet descriptive of the American Thompson Improved Indicator. In addition to the descriptive matter on the Indicator itself, a large amount of useful information is contained in this publication relative to the indicating of engines in general.

The Homestead Valve Manufacturing Company. of Homestead, Pa., has added Mr. Charles Nagle to their New York office. Mr. Nagle will call upon the trade within New York and Brooklyn. It has also placed an additional man in their Pittsburg office, in the person of Mr. F. H. Thorn, who has had several years of broad experience in the mechanical engineering field. Mr. Thorn will devote his time exclusively to the plants within the Pittsburgh district.

Wanted representing agents and merchants to sell and represent firm manufacturing Milling Cutters, Twist Drills, Reamers, Lathe Tools, Planer Tools, High Speed Steel and Alloy Tools, and Merchants' Tools. Good terms and discounts for selling or representing offered. Apply Lawton Bros., Woodseats Engineering Works, Sheffield, England.

Western Association of Mechanical and Electrical Engineers

Edmonton District Loop No. 5

This Association would be pleased to receive correspondence from any engineers who would like to associate with us with a view of getting better conditions for the craft in general. We would also be pleased to have communications from any other society or societies of engineers who are endeavoring to secure these conditions. Address all communications to

The Secretary,
Western Association of Mechanical and Electrical Engineers.
P.O. Box 991, Edmonton, Alberta, Canada

The radical but logical departures from standard practice introduced in the steam turbine put on the market some time ago by the Steam Motors Co., of Springfield, Mass., have proven very popular. The Steam Motor, which is the name that the manufacturers decided upon for this machine, differs from the other types of steam turbines in that it is not a complete machine in itself. It is manufactured with one bearing only and when connected to the driven apparatus becomes an integral part of the complete set, making a unit of the two bearing over-all type.

The various advantageous points of the design and particulars of, as well as illustrations covering different applications, are shown in bulletin No. 5, recently issued by the Steam Motors Co.

NEW ELECTRICAL METHODS IN MEDICINE

Electricity, as is well known, plays a large part in the treatment of disease, but its usefulness in diagnosing faults and breakdowns in the human machine is less familiar, except in the case of X-Rays for the detection of fractures and foreign bodies. Several ingenious electrical instruments have been invented and manufactured in Great Britain for giving accurate records of the heart's action and of the temperature of the body. When a current of electricity is passed through the body between the extremities of the limbs, the contraction of the heart alters the strength of the current; by an ingenious arrangement this alteration is made to record itself on a photographic plate. A "cardiogram" is thus secured which gives a diagrammatic account of the heart's action and enables the physician to detect conditions which might escape other means of detection. In taking temperatures, the usual method is to insert a thermometer at intervals and to "chart" the record, drawing straight lines between the points ascertained. With the up-to-date electric method, the record is continuous, showing the slightest variation from minute to minute. Much new light has been thrown on the course of fevers and other diseases by this electrical record, which represents yet another contribution of British scientific and engineering skill to the advancement of the healing art.

MONCRIEFF'S "UNIFIC"
WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
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WE-FU-GO AND SCAIFE
PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

AT LEAST TEN CONVERSATIONS NOW PLACED ON A SINGLE WIRE

BY means of Multiplex Telephony apparatus at least ten simultaneous conversations and several telegraph messages may be transmitted over a single copper wire for practically unlimited distances. Demonstrations of the wonders of the new invention were given a party of civic officials and newspaper men at the Strachan avenue Hydro plant at Toronto.

The demonstration is being carried on by the Canadian Independent Telephone Co. of Toronto, which has brought to Canada Dr. Lee DeForest, with a corps of DeForest Radio engineers and Prof. Charles A. Culvert of Beloit College. Major-General George O. Squier, Chief of Staff of the United States Army Signal Corps, is the inventor of "Wired Wireless," and Dr. Lee DeForest the inventor of the appurtenances which made its commercialization possible.

Four on One Wire

Over a single Hydro telephone wire to Dundas four newspapermen carried on conversations at yesterday's demonstration. Every word came clearly and distinctly, and there was no wire noise, such as is encountered on standard connections. On the Bell system there are thirty circuits from Toronto to Hamilton.

According to demonstrators of the "Multiplex Telephony and Telegraphy," with their apparatus nine hundred telephone connections can be made in addition to scores of telegraph connections. It would cost $1,000, they said, to install the apparatus from Toronto to Hamilton—much less when it is manufactured in commercial quantities.

"Viewed from the standpoint of public ownership," say the men in charge at the Hydro plant, "the Province of Ontario now owns several hundred miles of long-distance copper telephone circuits which are used only by the Provincial Hydro-electric officials and employees in the operation of the system.

"These inventions of Squier and DeForest, without interfering with the present use of the line by the Hydro-electric System, can be used to increase the use of these long-distance lines to many times their present capacity and the extra telephone circuits used for public telephone service.

"The Dominion of Canada has recently become owner of the G.N.W. telegraph system and of the Transcontinental telegraph system. These telegraph systems combined represent a very large expenditure of money, and at least part of the Transcontinental is equipped for both telephone and telegraph use. The invention would multiply the possibilities of these lines by at least ten times their present capacity."

BRITISH AUTOMATIC TELEPHONES

Great Britain has shown conspicuous activity in developing the automatic telephone exchange; and the announcement that a sum of £7,000,000 is to be spent on converting the telephone system of London from "manual" to automatic working is proof that the enterprising trials at Leeds and other English towns have been successful. In the automatic telephone the instrument is provided with a rotating dial having numbered depressions near its circumference. To effect a "call" the user places a finger in a certain depression and pulls the dial around to a mechanical stop; this operation is repeated for each figure in the telephone number required. Thereafter the mechanism at the exchange does all the work. It "selects" the line required, rings the bell of the called subscriber and continues ringing it until the receiver is lifted; "holds" the line clear until the conversation is finished and both receivers are hung up; and then disconnects the line. If the called number is engaged a clear signal is given in the calling telephone. The advantage of replacing the fallible exchange operator by almost infallible machinery is so great that the British example is likely to be widely followed, especially in countries where skilled labor is not cheap and plentiful.

Eight real advantages

in equipping water tube boilers, oil stills and superheaters with Key Boiler Equipment Company's

KEY SAFETY HAND-HOLE CAPS

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

No gaskets required. Over 1,500,000 now in service. Let us send you our descriptive literature.

Power Plant Equipment Co.

Canadian Selling Agents

310 Dominion Bank Bldg., Toronto, Can.

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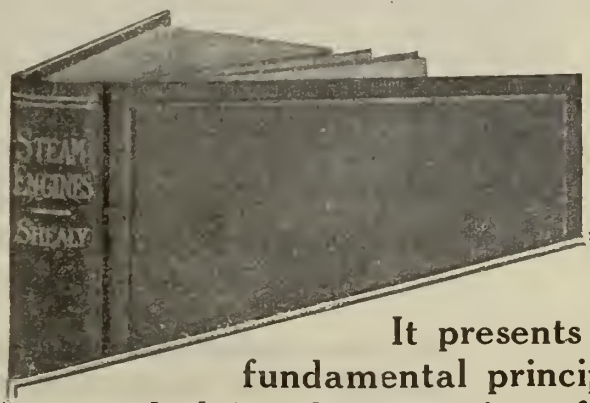


It presents the fundamental principles underlying the operation of the

STEAM ENGINE

The parts dealing with thermodynamic principles are particularly clear and practical.

The treatment of valve gears is especially complete because operating engineers find information on valve gear mechanism so valuable.

Tells about steam engine indicators and indicator diagrams and the proper way to use them.

Gives laws of heat engineering—a plain, straightforward, non-mathematical explanation of the laws of force, work, energy and heat.

And gives other special features too numerous to mention.

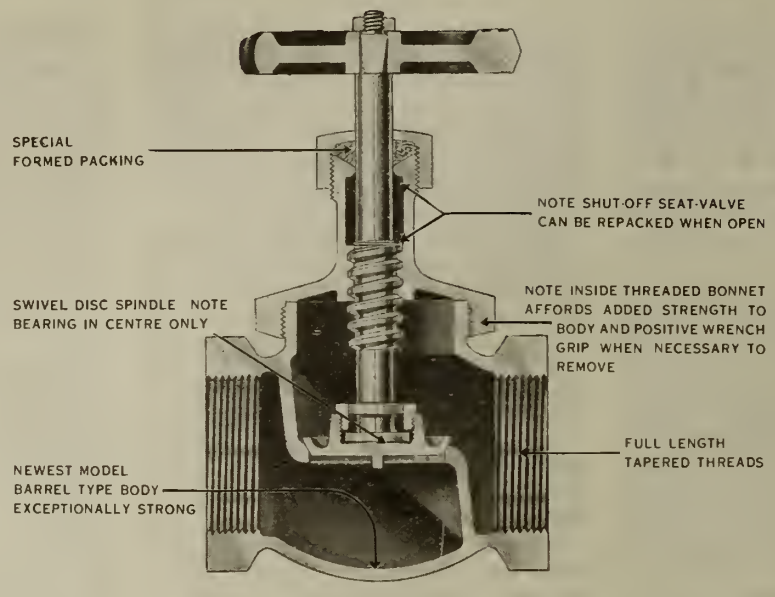
A complete text book on the Steam Engine

By E. M. SHEALY,

Associate Professor of Steam Engineering, University of Wisconsin.

290 pages, 6 x 9, 173 illustrations *$2.50 net, postpaid*

Order from Technical Book Department of "POWER HOUSE," 153 University Ave., Toronto



The Globe Valve Supreme

MUELLER Globe and Angle Valves are standard valves with all of the desirable features of high grade valves. The sectional view above will give you a fair idea of a few of the advantages it offers.

Look at the packing feature—a double seat enables you to re-pack the valve without removing it from the line.

The packing is a feature in itself; a specially formed, properly lubricated braided packing of flax reinforced with a lead core and copper wire strands; filled with graphite, absolutely sure in action; long-wearing and positively leak-proof.

Note the outside threaded bonnet with large hex, giving an added strength to the latest improved barrel type body and a positive wrench grip when necessary to remove.

We will gladly send you a sample valve for trial. Provincial Authorities have passed this valve—allowing a pressure of 175 lbs. We will be especially glad to receive requests from engineers for full particulars and samples of this valve.

Have you received a copy of our new 1919 Catalog "A"—just off the press?

H. MUELLER MFG. CO., LIMITED
SARNIA - CANADA

MORSE DRIVES

Money Earners
Greater Output

Money Savers
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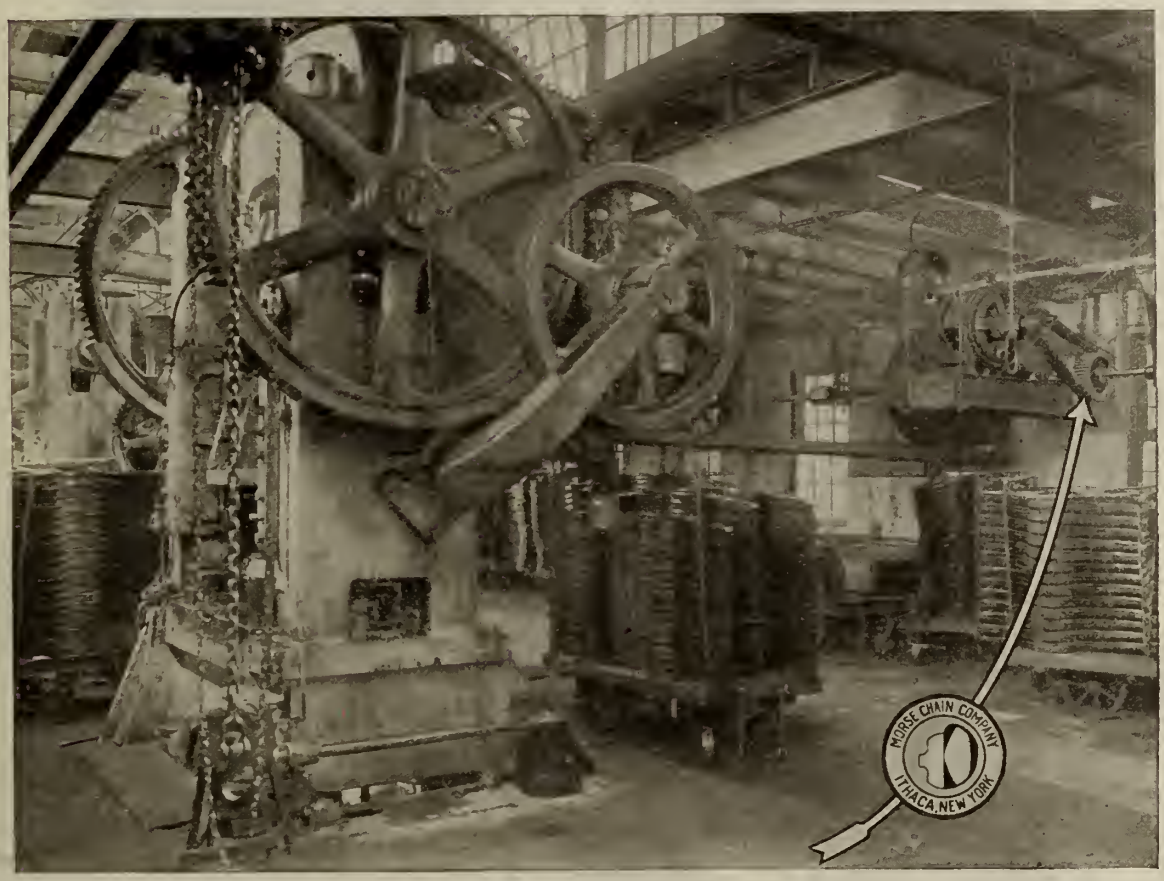

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The Bossert Co., Utica, N.Y.

The more severe the duty, the more need of "Morse"—The perfect, durable, positive, transmission, with 99% efficiency.

Before buying belts, gears, rope, investig ate the drive that is writing history in increasing production, low maintenance and low depreciation.

If you have a drive that is now giving trouble or need one for service in Dust, Gases, Acid Fumes, Steam, or may require speeding up or increase power, tell Morse Engineering Service. We feel we can help you.

MORSE CHAIN CO., LARGEST MANUFACTURER OF SILENT CHAINS IN THE WORLD **ITHACA, N. Y.**

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CANADA.....Jones & Glasco, Regis'd.
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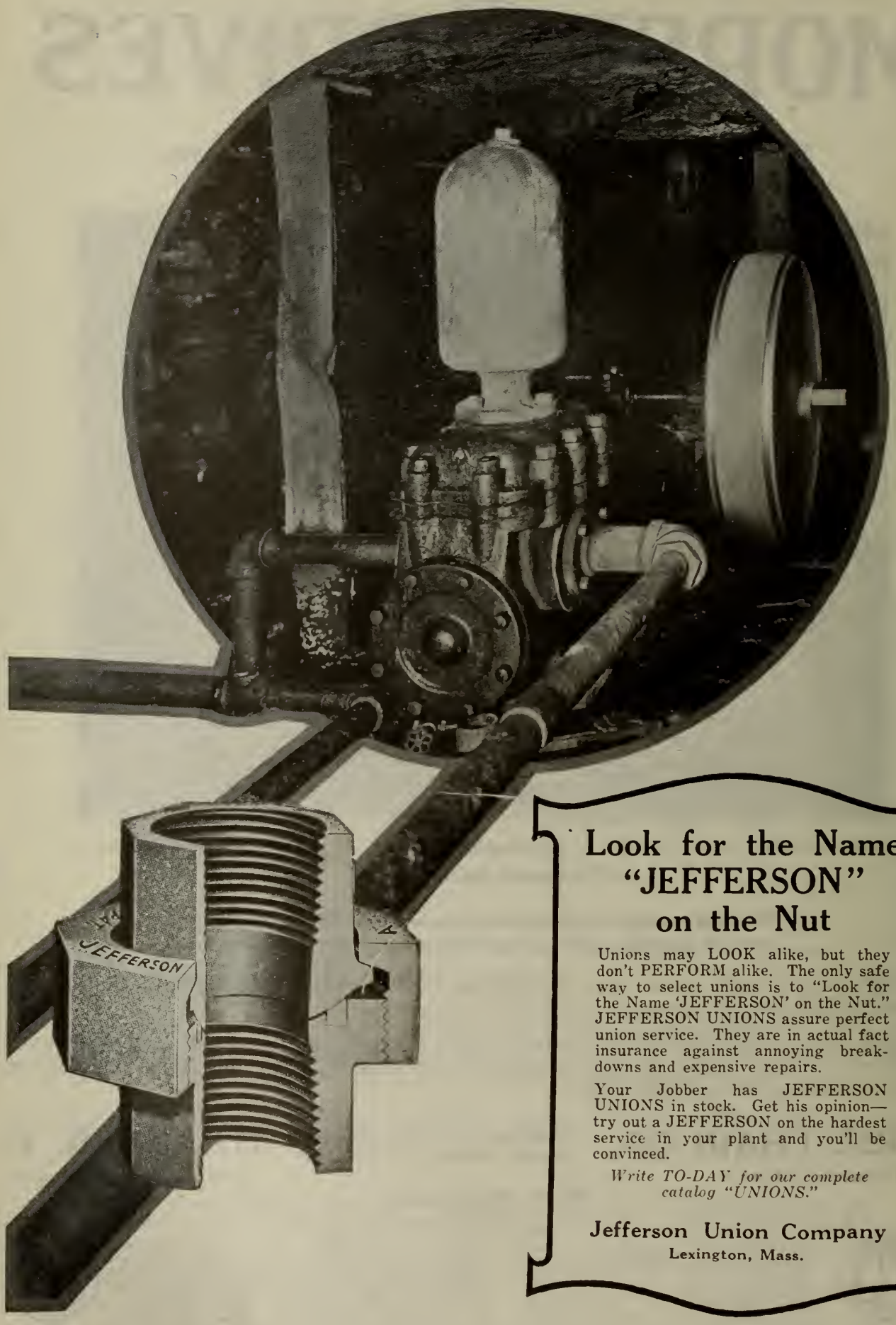


Look for the Name "JEFFERSON" on the Nut

Unions may LOOK alike, but they don't PERFORM alike. The only safe way to select unions is to "Look for the Name 'JEFFERSON' on the Nut." JEFFERSON UNIONS assure perfect union service. They are in actual fact insurance against annoying breakdowns and expensive repairs.

Your Jobber has JEFFERSON UNIONS in stock. Get his opinion—try out a JEFFERSON on the hardest service in your plant and you'll be convinced.

Write TO-DAY for our complete catalog "UNIONS."

Jefferson Union Company
Lexington, Mass.

Small Power House Equipment

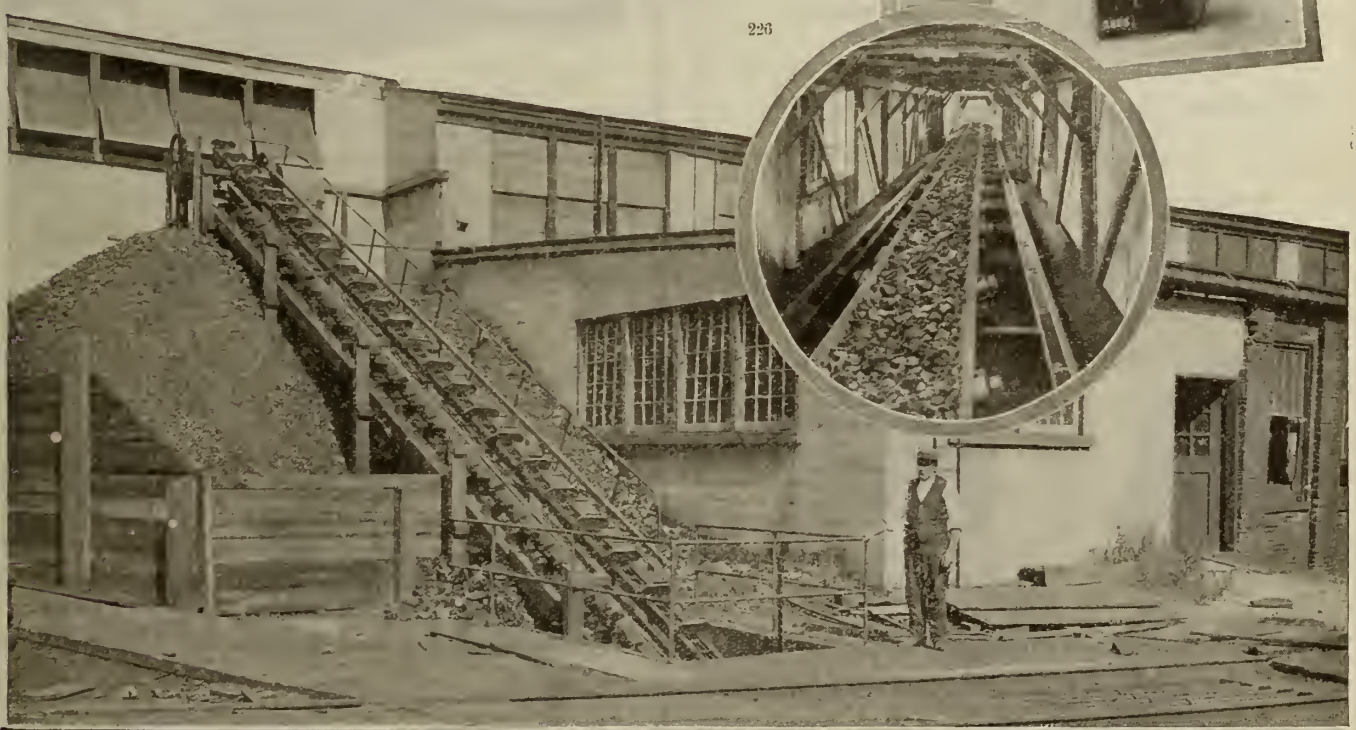
BECAUSE many of Canada's largest power houses are Link-Belt equipped, some officials of small power plants have gained the impression that we welcome only larger installations.

This is not true. We have equipped hundreds of small plants. But every small installation—every piece of Link-Belt equipment—is backed by the same engineering skill and is of the same high standard which characterize all Link-Belt products.

We furnish a complete line of power house equipment including: Belt Conveyors, Bucket Carriers, Feeders, Crushers, Track Hoppers, Coal Bins, Ashes Pockets, Stoker Spouts, Bin and Hopper Gates, Cars, Locomotive Cranes, Grab Buckets, Unloaders, Electric Hoists, Water Intake Screens, Transmission Machinery, etc. Write us—no matter how small your requirements.

CANADIAN LINK-BELT CO., LTD.

WELLINGTON & PETER STS., TORONTO



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- ☐ Link-Belt and Sprockets
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Place X in Square

LINK-BELT

Elevators and Conveyors

Cast Iron Screwed Fittings

Standard Weight

These fittings are of good design and weight, and are suitable for steam working pressures up to 125 lbs., or water working pressures to 175 lbs.

Straight Elbow

Straight Tee

All sizes, ¾″ to 6″ inclusive, carried in stock.

EXTRA HEAVY
CAST IRON SCREW FITTINGS

Straight Elbow

Straight Tee

250 pounds working pressure.
All sizes, ¾″ to 6″ inclusive.

T. McAVITY & SONS
LIMITED

St. John, N.B., Canada

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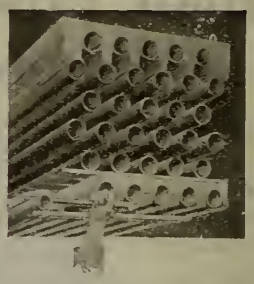
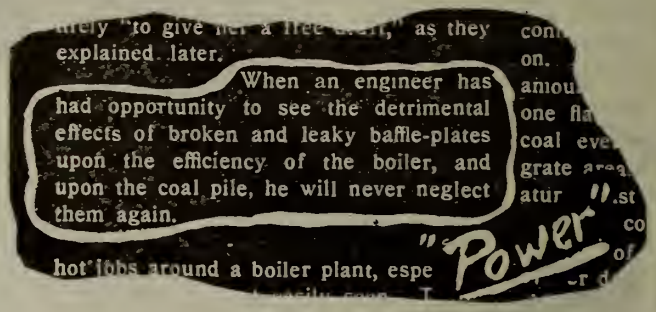
MONTREAL WINNIPEG EDMONTON CALGARY

PATENTED, another view of a horizontal water tube boiler, both baffles being made of Betson's Plastic Fire Brick.



How Betson's Plastic Fire Brick is put in place to form horizontal or lengthwise baffles in water tube boilers where it is desired to blow soot from the sides.

MAKE YOUR BAFFLES LEAKLESS
IT IS EASY


explained later.
When an engineer has had opportunity to see the detrimental effects of broken and leaky baffle-plates upon the efficiency of the boiler, and upon the coal pile, he will never neglect them again.
hot lobs around a boiler plant, espe
"Power"

With Betson's Plastic Fire Brick you can make gas-tight permanent baffles, in one piece without joints, so that there is no mortar to crumble away and no bricks or tiles to crack or fall down. Betson's is the only Plastic Fire Brick, and it has made the monolithic baffle-wall practicable.

Gas-tight baffles help you to maintain highest boiler efficiency. They prevent those short circuits that waste coal unnecessarily.

No matter how much the tubes have warped or sprung out of place, baffles of Betson's Plastic Fire Brick will fit exactly,—will be gas-tight,—and remain gas-tight. You can give the baffles any slope or angle desired to meet the conditions of your B & W, Heine, Stirling or any other type of boiler.

One man, without special tools, can make a Betson baffle in the shortest possible time. It will be a better baffle than can be made in any other way. Betson baffles are permanent baffles.

BETSON'S
REG. U.S. TRADE MARK PAT. OFF
PLASTIC FIRE BRICK

Is the ideal refractory for boilers. It has 20 years of practical experience behind it. Beside baffle walls it is used for making solid one-piece furnace linings, front arches, rear arches, etc., in all kinds of boilers and settings. **IT COMES IN YELLOW HEAD BARRELS** in a moist plastic condition ready for use.

Let us quote you on your requirements. Also, ask for our practical catalog,—it will interest you.

BETSON PLASTIC FIRE BRICK CO.
Rome, N.Y.

Canadian Distributors

International Chemical Company
44-46 Lombard Street
TORONTO, ONT.

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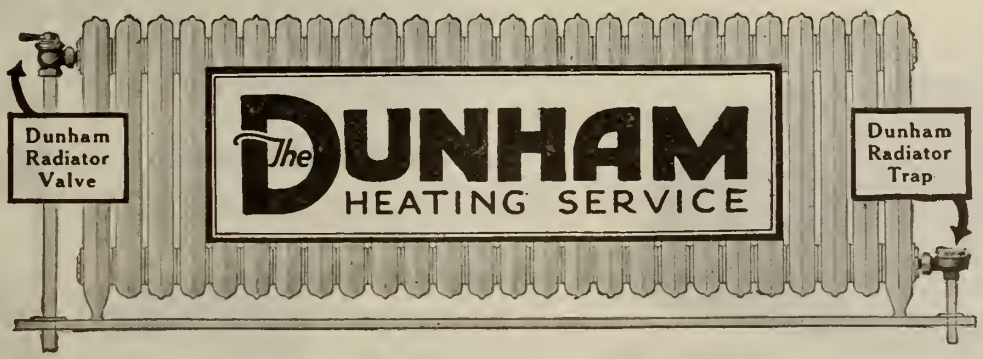


A Timely Service --- and the Company behind it

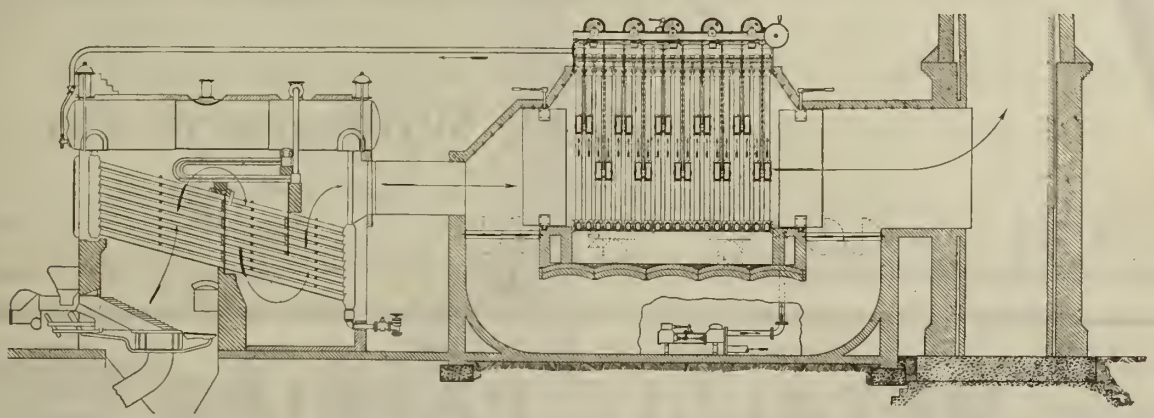
The public wants better steam heating service—more comfort per ton of coal. This Company is in a most favorable position to meet this demand through its co-workers—the architects, heating and ventilating engineers, heating contractors and builders—to whom it offers practical co-operation that will increase their prestige as well as their volume of business.

Any man who uses, specifies or installs steam heating equipment will find it advantageous to learn more about Dunham Heating Service—the product of 15 years' knowledge of steam heating in all its phases.

C. A. DUNHAM COMPANY, LTD., Toronto, Ont.

Halifax Ottawa Vancouver Montreal Winnipeg Calgary

GREEN'S ECONOMISERS



Showing Typical Economiser Installation which will

1. Save 10 to 15% of your fuel bill.
2. Increase your boiler capacity.
3. Lengthen the life of your boiler.

GREEN'S ECONOMISER, LTD.
TORONTO

SAVE COAL

By making your furnace air and gas-proof.

PLIBRICO

can be installed by inexperienced labour.

A High Grade Refractory

Write for free copy of 36-page book of useful information on furnace building & maintenance

Manufactured exclusively by

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Williams "Agrippa" Chain Pipe and Fittings Wrench

THEIR narrow, single jaw, with saw-tempered teeth for file sharpening when worn, gives these wrenches unequaled facility for holding and turning cramped and irregular fittings, flanges, short nipples, etc., etc., because:—

They grip upon surfaces where ordinary tools cannot—"Their grip does not slip."
They do work which tools with broader jaw will not.
They give more and better service than any screw-adjusted wrench made.
They "start" rusted fittings when all else fails—just the service to be logically expected of a fully warranted tool.

Remember, each Chain, like those in our well-known "Vulcan" Wrenches, is "proof-tested" in a standard tension machine to two-thirds of its catalog strength, and is certified. We guarantee absolutely every tool that leaves our factories. 7 sizes for ⅛ to 12″ pipe and fittings.

Your dealer will serve you. Ask for Booklet.

J. H. Williams & Co.

"The Drop-Forging People"

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Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

In Cotton Tubes

HOMESTEAD
Quarter-Turn Valves

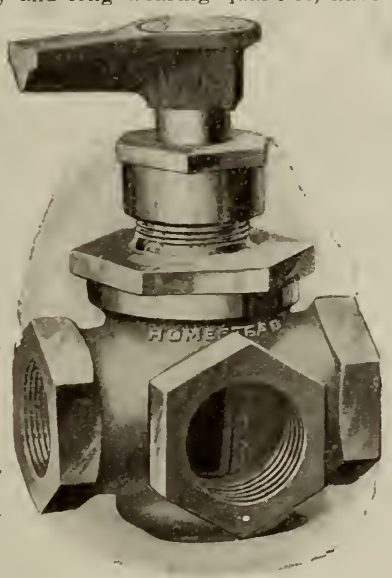
The Valves for Hard Service

Expert workmanship and the quality of material used in the manufacture of Homestead Valves, together with their practical utility and long wearing qualities, have brought insistent demands from all fields.

The harder the service the more you need the Homestead Valve.

They are made for all pressures, in Straightway, Three-way and Four-way styles. They are made to suit all classes of material to be handled, and are, therefore, of brass, semi-steel and semi-steel with brass plugs.

Instal a Homestead Valve on your most troublesome line and note satisfactory results.



Homestead Three-Way Type

Homestead Valve Manufacturing Co.
HOMESTEAD, PENN.

Get The Most Out Of It

"In every business club you will usually find two classes of members, those who get nothing out of their membership and those who find it the best investment they ever made." (Class).

But the man who gets nothing out usually puts nothing in but his application and fee.

Are you getting all you can out of your investment in POWER HOUSE?

Here's an engineer who is: **"I consider POWER HOUSE the best paper in Canada, as it touches on local power plant equipment and problems as no other paper does for the engineers."**

Another engineer writes that by studying the editorial pages he gets great help and by reading the advertising pages he learns all about the latest equipment. He says: "The circulars about new equipment usually are kept in the offices, but POWER HOUSE reaches the engineer straight."

Get the most out of Power House by reading it from cover to cover.

Starrett Hack Saws

A saw for every metal cutting requirement. Our Chart CD enables you to select the proper blade for your particular work. Consult our chart to reduce cutting costs and increase the efficiency of your cutting-off department.

The L. S. Starrett Company
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
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ENGINEERS

who *study* the Advertising Pages of

POWER HOUSE

naturally learn a lot about modern POWER PLANT EQUIPMENT which they really ought to know.

Why Did We Let Trotzky Go?

THERE was a time when Canada had it in her power to end the war. In the early days of the Russian Revolution a bushy-haired German was taken off a boat at Halifax and interned at Amherst, N.S. He pretended to be a Russian but was known to be in German pay—on his way to push the revolution—British and American Intelligence Officers so informed our authorities. But pressure was brought to bear and the man was finally released. He got to Europe and became the most sinister figure among the Bolsheviki. Largely as a result of his work, Russia dropped out of the war and Germany was able to fight on for eighteen months. That man was Leon Trotzky. His real name was Braunstein.

Why was Trotzky allowed to leave Canada?

Colonel MacLean discusses this question in the June issue of MACLEAN'S MAGAZINE. He tells the story of Trotzky's activities, of his arrest and subsequent release in full detail, tracing the threads of a strange intrigue from Germany to Washington, and Washington to Ottawa. It is a gripping story, the most important inside story of the war.

Other National Features of This Issue

"Victory Stuff" By Robert W. Service.

"Solving the Problem of the Arctic" By Vilhjalmur Stefansson.

"The Gold Wolf" By W. A. Fraser.

"Hobson's Hard Start" By William Byron.

"The Menace in the South" By Agnes C. Laut.

"The Undercurrents" By J. K. Munro.

And a score of other interesting articles.

Secure YOUR Copy EARLY--While Supply Last

Over a Quarter of a Million Canadians Will Read

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

20c. — June — 20c.

ON SALE AT ALL NEWSDEALERS

CAMOUFLAGE!

Camouflage in war saved lives, money and material. But camouflage in packing is cheap for the maker and costly for the user. A little red coloring doesn't make packing—but it may cover a multitude of sins.

VULCABESTON

Red Fibre Sheet Packing

is honest packing—all the way through. It is made from long-fibre asbestos by a special process which gives it unusual resiliency and pliability. Unlike rubber it will not squeeze out or stretch.

On shipboard, in power plants and refrigeration plants, in chemical factories, or on locomotives — wherever a gasket is used — Vulcabeston will insure dependability. It is "the universal packing"—serving everywhere, regardless of temperature or pressure, corrosion or moisture.

"'Vulcabestonize" *your* packing problems.

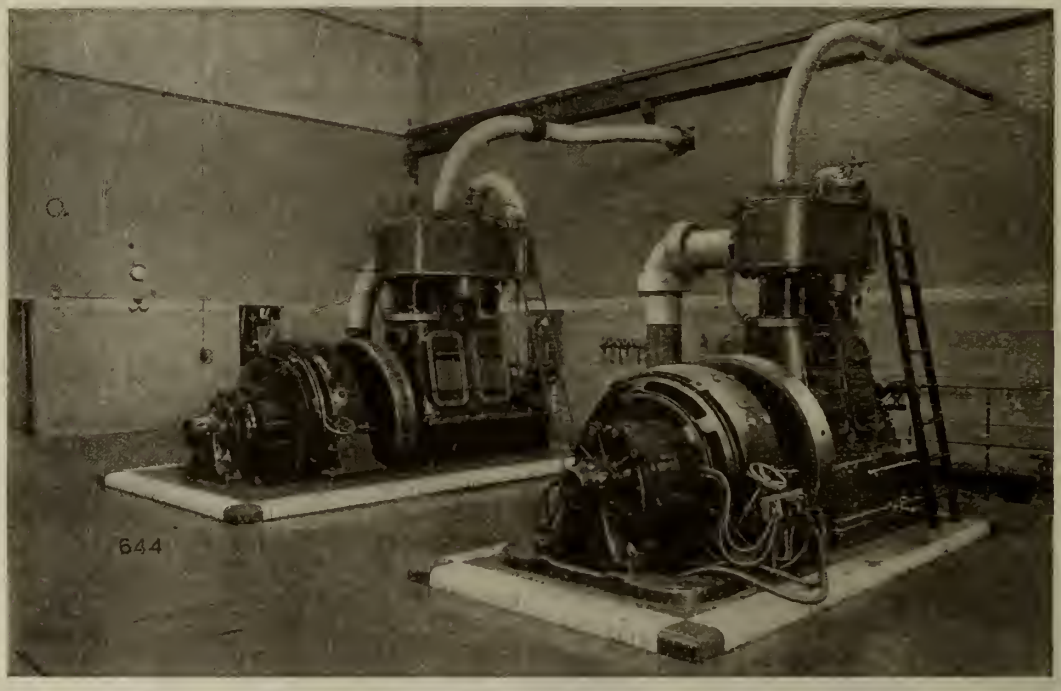
If your regular dealer cannot supply you, write us direct

The Johns-Pratt Company
Hartford, Conn., U. S. A. 19-5

VULCABESTON

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss Engines at McGill University Power House

Steam and Exhaust Turbines
Diesel Engines, Air Compressors
Condensing Plants, Steam Engines

Heanan Refuse Destructors
Air and Water Coolers
Dynamometers

Paterson Water Softening Plants

Centrifugal Pumps

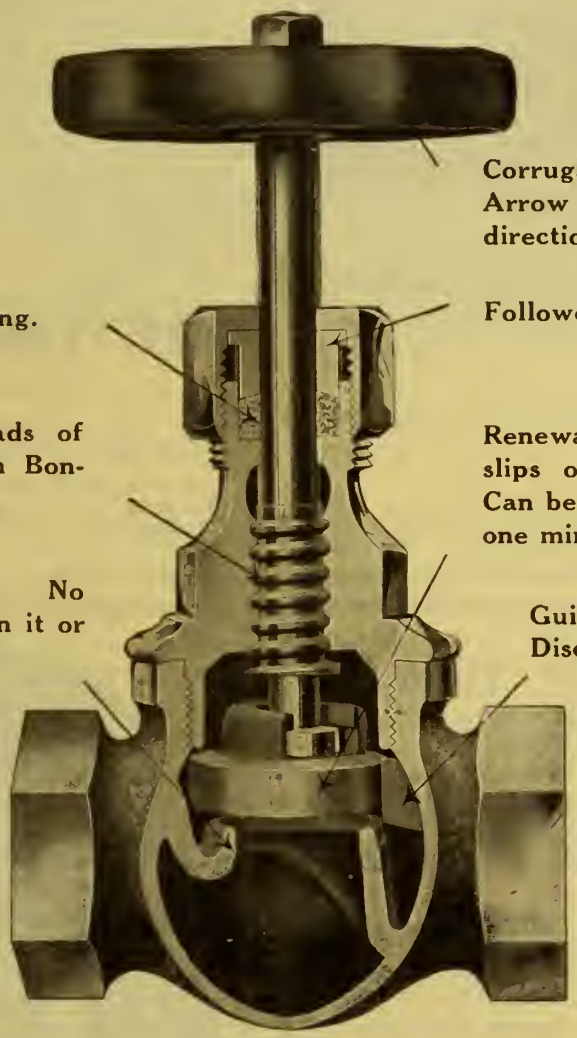
LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Follower in Stuffing Box.

Palmetto Twist Packing.

At least Four Threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised Round Seat. No sediment can lodge on it or injure disc.

Guide cast on Body holds Disc centrally over seat.

Globe or Angle

Screwed or Flanged

The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

Everything in Mechanical Goods

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Clean Tubes mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

Scale in Your Boilers

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, But EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

METLSKIN CO., Inc.
Rochester, N.Y.

Canadian Representatives:
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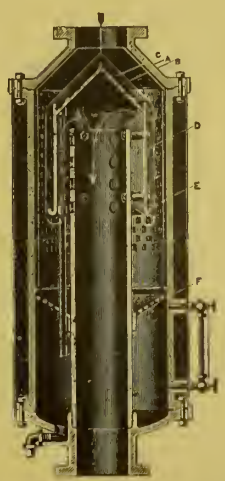
III IMPORTANT THINGS
TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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SWING JOINTS
Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.
New York City
General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
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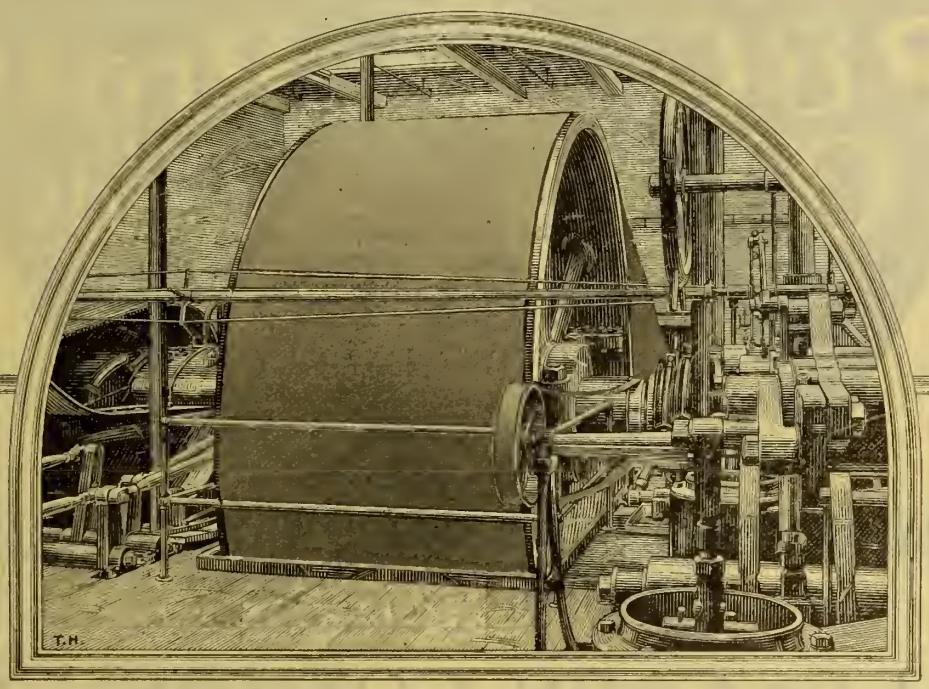

This is an 80-inch 3-ply Heart Brand Belt in a Massachusetts paper mill. It began its service in 1911. It carries 1,100 horse-power. The cost of transmitting a horse-power a week is $.0045.

The Test of Adaptability

For some materials there is no substitute. Such, for instance, is leather for belting. Its superiority for all the major requirements is recognized by transmission experts. The belt shown above, for instance, was transferred from one drive to another—lengthened by splicing, and cut down 2 inches in width—an adaptation that is possible only with leather.

The advantages of leather for transmission are developed to their maximum in Graton & Knight Standardized Series Leather Belts. They are that rare thing in business—a highest-quality line enjoying the largest sales. Do you know of any other brand in any highly competitive field that combines highest grade with biggest sale? Talk that over in your transmission conferences.

Write for booklet on standardization as applied to belting

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Standardized Series
LEATHER BELTING
Tanned by us for belting use

1851 G&K

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EVERYTHING MECHANICAL

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VALVES
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STRENGTH—GOODNESS—QUALITY
STEAM

A central power station operating at approximately 275 to 300 pounds pressure and an equal degree of superheat produces unusually severe conditions for a gasket material. The fact that DURABLA Gasket Material makes permanently tight joints under these conditions is one of the reasons why it has been accepted by others as a standard for all steam work.

Pack your next steam joints with DURABLA and it will prove its worth to you. It is guaranteed to make a tight joint at all temperatures and pressures.

DURABLA Gasket Material is also guaranteed for air, water, oil, ammonia, gasoline and acids.

One Standard Material for All Gasket Work. Sold on a Service Basis.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada
The Canadian Fairbanks-Morse Company, Limited

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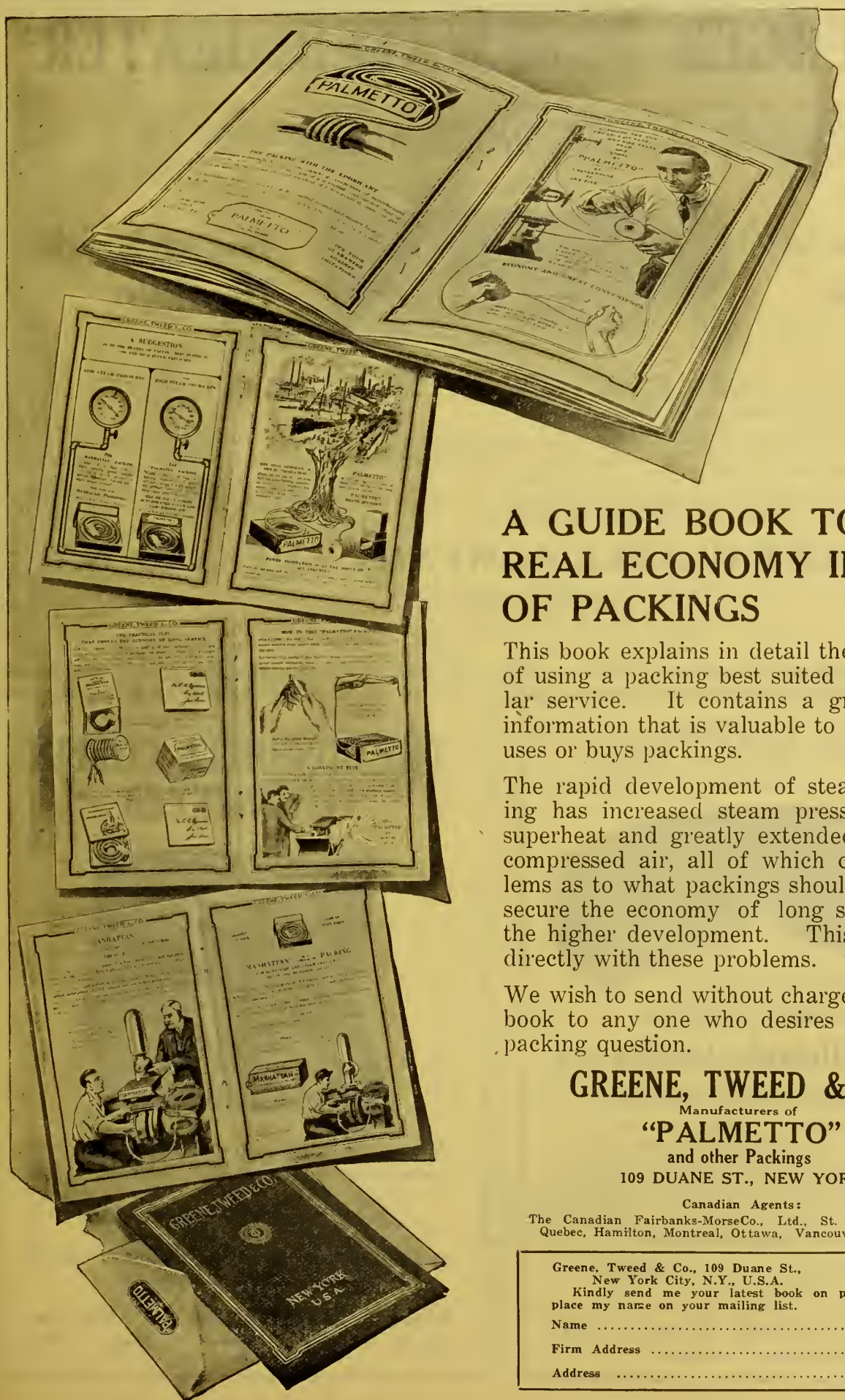

May we send you a copy?

A GUIDE BOOK TO REAL ECONOMY IN USE OF PACKINGS

This book explains in detail the importance of using a packing best suited to a particular service. It contains a great deal of information that is valuable to any one who uses or buys packings.

The rapid development of steam engineering has increased steam pressures, added superheat and greatly extended the use of compressed air, all of which creates problems as to what packings should be used to secure the economy of long service under the higher development. This book deals directly with these problems.

We wish to send without charge this helpful book to any one who desires light on the packing question.

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Manufacturers of

"PALMETTO"

and other Packings

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Kindly send me your latest book on packings and place my name on your mailing list.

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ALBERGER MULTI-HEAD WATER HEATER

This is the "ideal heater," because the water is heated as fast as it is drawn. It is the "perfected heater," because an absolute stranger to the costly troubles ordinary heaters so frequently develop.

Transmits 50% More Heat

Than Any Straight Tube Heater

The small, corrugated, pure copper tubes in this Alberger Heater expand into a floating head independent of the cast iron shell, which means that there cannot be trouble from expansion or contraction strain.

An Alberger Multi-Head Heater with corrugated tubes will remain free from scale longer than a heater with plain tubes, because the corrugations promote a scouring effect on the tubes.

You need an Alberger Heater. Therefore ask for catalogue describing both Horizontal and Vertical Types. No obligation whatever.

ALBERGER HEATER COMPANY, BUFFALO, N.Y.

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Voorhees Rub-Steel Valves

"The Valve with a backbone"

Are without an Equal for

Deane of Holyoke Condensers

or Suctions on Paper Machines

Softest high-grade rubber as seating, supported by an inseparable **steel core.** Spring guides and brass bushed stud-holes as above, if desired, or plain faces.

Not a cheap valve, but positively smoothest in action and longest lasting.

This construction in Four Grades for **every** known pumping service.

The Canadian Fairbanks-Morse Co., Ltd.
Sole Distributors for Canada

THE BUSHNELL-COFFIN PLANIMETER

A thoroughly improved and up-to-date planimeter of the direct reading type.

Send for descriptive folder.

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO. LIMITED
Montreal, Toronto, St. John, Winnipeg

American Steam Gauge & Valve Mfg. Co.
New York Chicago BOSTON Atlanta Pitts.

For LOCOMOTIVES

HOFIUS STEEL & EQUIPMENT CO.
Seattle, Wash.

Magnolia Metal Co., August 29, 1918.

Gentlemen:—

We have, for sometime now, been using MAGNOLIA METAL for general work in our shops.

We have from time to time various railroad equipment that comes up for rebabbitting. This equipment includes Shay and Climax Locomotives. Much of this work requires a high grade babbitt. In this connection we have found your MAGNOLIA METAL, from every angle, an entirely satisfactory babbitt.

HOFIUS STEEL & EQUIPMENT CO.
James L. Souter, Supt.
Yours very truly

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A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
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Present an exceptional opportunity to secure **Water Tube, Return Tubular** and **Robb Type Boilers,** as follows:—

BOILERS—WATER TUBE.

No. for Sale	H.P.	Make	Headers	Steam Pressure Lbs.
1	100	Babcock & Wilcox		150
1	120	Earl C. Bacon		125
2	204	Babcock & Wilcox	Vertical-C.I.	160
1	212	Babcock & Wilcox	Inclined-C.I.	143
8	250	Sterling		160
2	250	Sterling		150
12	264	Babcock & Wilcox	Steel	175
6	290	Babcock & Wilcox		160
6	308	Heine		140
4	350	Babcock & Wilcox	Steel	200
2	360	Erie City	Steel	160
1	380	Sterling		153
4	400	Sterling		150
1	450	Heine		180
1	460	Heine	Forged Steel	150
1	500	Robb	Forged Steel	175

BOILERS—ROBB TYPE

No. for Sale	Size	H.P.	Make	Steam Pressure Lbs.	Kind
1		70	Robb	100	Return Tubular
1		85	Robb	125	Return Tubular
1	60" x 18'	100	Robb Monarch	80	Locomotive
1		115	Robb Mumford	125	Return Tubular
1		150	Robb Economic	125	Locomotive

BOILERS—RETURN TUBULAR.

No. for Sale	Size	H.P.	Make.	Steam Pressure Lbs.
1	48" x 12'	38	Leonard	100
1	54" x 11'	6-70	Leonard	125
1	60" x 14'	70	John Inglis	85
1	60" x 16'	85	Goldie & McCulloch	120
2	66" x 16'		Murray Iron Works	125
2	66" x 15'	100		100
3	72" x 18'	96		100
3	72" x 18'			135
1	72" x 18'		Leonard	145
2	72" x 18'		Goldie & McCulloch	145
2	48" x 35'	250	Keeler	105
2		350	Keeler	180

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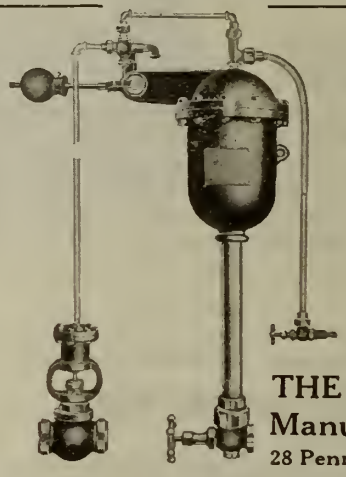

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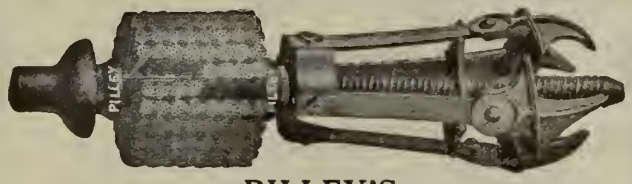

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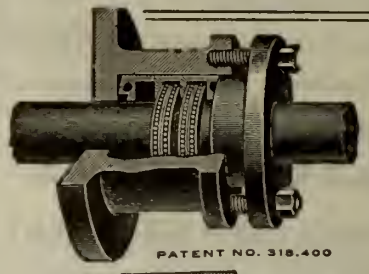

PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	876,238
" "	654,542	" "	894,537
" "	725,388	" "	895,791
" "	774,490	" "	896,066
" "	775,193	" "	905,103
" "	775,194	" "	934,629
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" "	805,669	" "	1000,76

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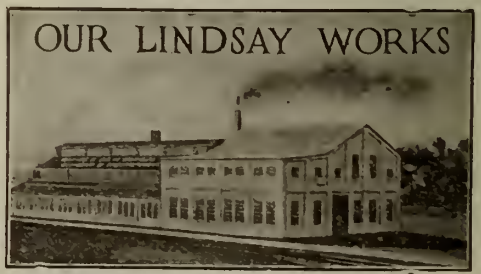

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TO

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Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

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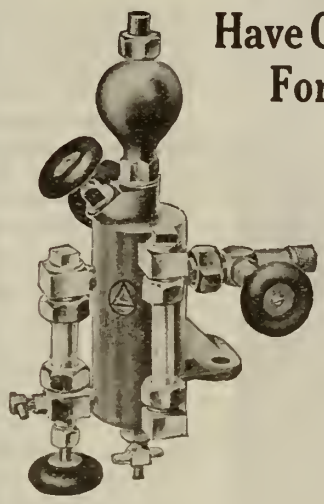

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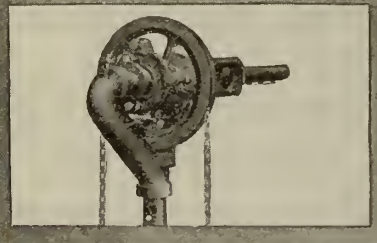

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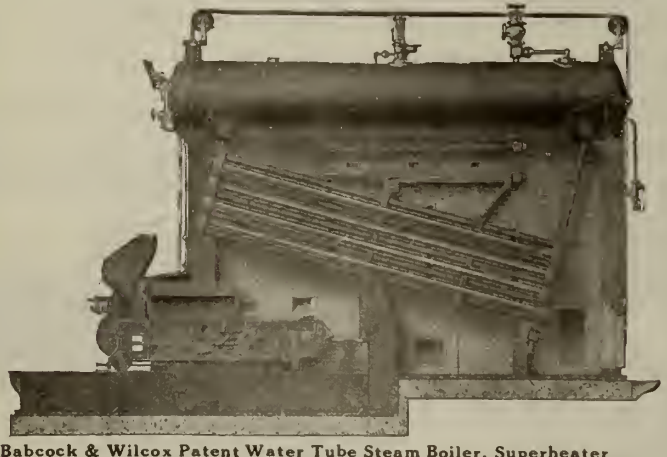

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Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Royles, Ltd., Irlam, Manchester, England.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. I. Philip & Sons, Toronto.

CONDUITS
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CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.

CONDENSER AND SMOKESTACK PAINTS
Beveridge Paper Co., Montreal, Que.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONTRACTORS' STRUCTURAL STEEL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, PORTABLE
Portable Machinery Co., Inc., Passaic, N.J.

CONVEYORS, BELT
Portable Machinery Co., Inc., Passaic, N.J.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

COPPER TUBE
Empire Mfg. Co., Ltd., London, Ont.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canadian Corkboard Co., Toronto.

CORKBOARD
Canadian Corkboard Co., Toronto.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Canadian Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd. Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Can. Link-Belt Co., Toronto, Ont.

CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK AND CROSSHEAD PIN OILERS
Lunkenheimer Co., Cincinnati, O.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Canada.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

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Bowser, S. F., & Co., Inc., Fort Wayne, Ind.

CYLINDER OIL
E. H. Kellogg & Co., New York.

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
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York Manufacturing Co., York, Pa.

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Green's Economiser, Ltd., Toronto.

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DRAFT GAUGES
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Defender Automatic Regulator Co., St. Louis, Mo.

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Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithica, N.Y.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.

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Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

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Penberthy Injector Co., Windsor, Ont.

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Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

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Can. H. W. Johns-Manville Co., Toronto, Ont.

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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.

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Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
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Laurie & Lamb, Montreal.
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Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
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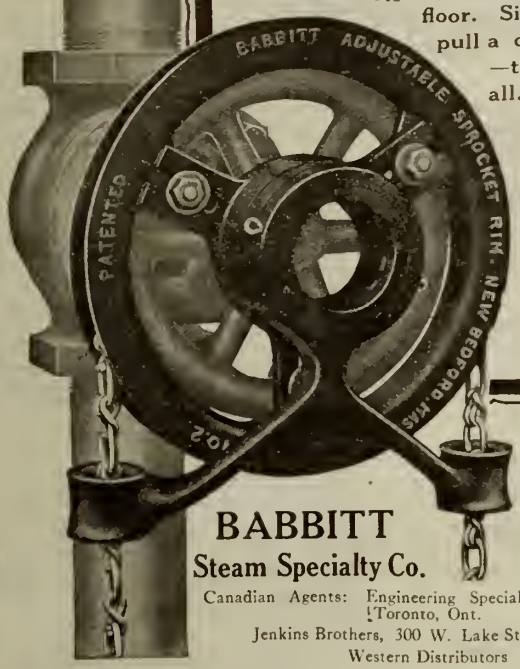

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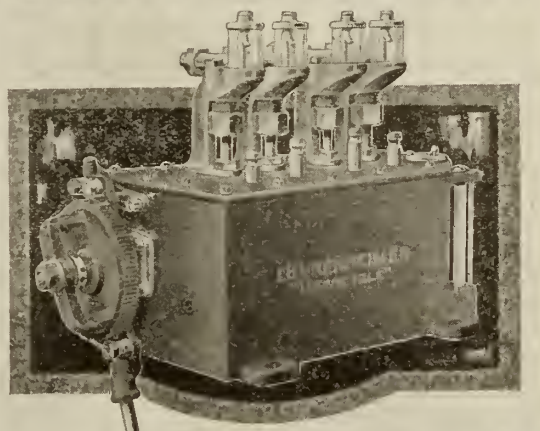

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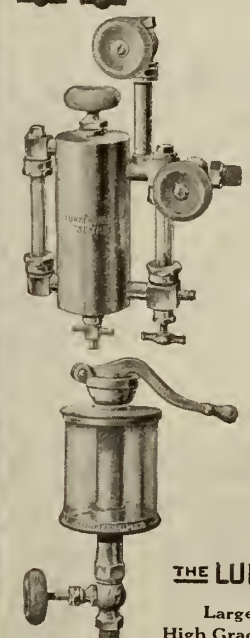

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Jointless Fire Brick Co., Chicago, Ill.

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Babcock & Wilcox, Montreal.
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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
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Green's Economiser, Ltd., Toronto.

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Imperial Oil, Ltd., Toronto.

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Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

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Lunkenheimer Co., Cincinnati, O.
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Taylor Instrument Co., Rochester, N.Y.
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Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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GEARS, CUT, WORM, MORTISE
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Smart-Turner Machine Co., Ltd., Hamilton.

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Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

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Jas. Morrison Brass Mfg. Co., Toronto.
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Laurie & Lamb, Montreal.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.

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Jas W. Hays Corp., Michigan City, Ind.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

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The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, STEAM, SUCTION AND WATER
Canadian Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Vorhees Rubber Co., Ltd., Montreal.

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Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
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Frick Co., Waynesboro, Franklin Co., Pa.

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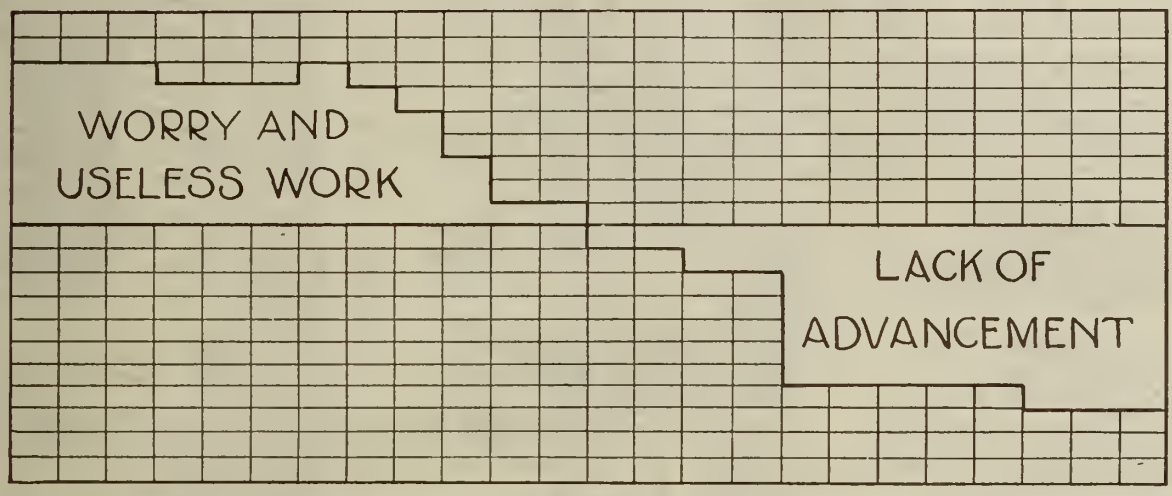

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The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

MacGovern & Co., Inc., Montreal, Que.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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Uehling Instrument Co., New York, N.Y.

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Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.

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Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.

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Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

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Royles, Ltd., Irlam, Manchester, England.

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Bowser & Co., Inc., S. F., Toronto, Ont.

KEROSENE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

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R. G. Long & Co., Toronto, Ont.

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Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
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LOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, CYLINDER

CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

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Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

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Armstrong Cork & Insulation Co., Montreal, Que
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Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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E. I. Philip & Sons, Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. I. Philip & Sons, Toronto.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. I. Philip & Sons, Toronto.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. I. Philip & Sons, Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

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Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd.
St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

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Bowser & Co., Inc., S. F., Toronto, Ont.

MOTORS
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Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
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Bowser & Co., Inc., S. F., Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

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Lunkenheimer Co., Cincinnati, O.

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Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
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Babcock & Wilcox, Ltd., Montreal.
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Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

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Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
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Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

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Defender Automatic Regulator Co., St. Louis, Mo

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Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesharre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Vorhees Ruhher Co., Ltd., Montreal.

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Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

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Beveridge Paper Co., Montreal, Que.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
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York Mfg. Co., York, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
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Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
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Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

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Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
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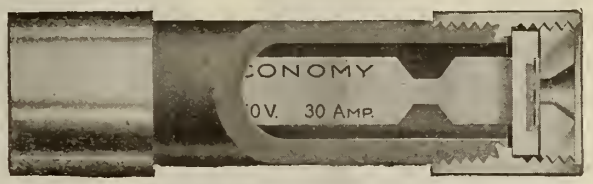

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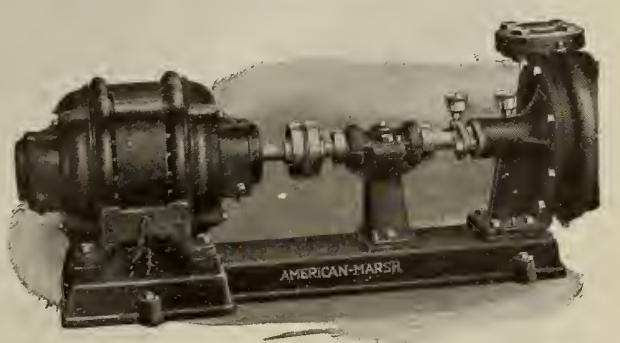
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.



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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
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Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
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Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
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Coppus Eng. & Equipment Co., Worcester, Mass.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
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Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
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Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
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American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
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Graton & Knight Mfg. Co., Montreal.
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American Steam Pump Co., Battle Creek, Mich.
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
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American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
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Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
RAGS
Shell Bar Boico Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
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Bowser & Co., Inc., S. F., Toronto, Ont.
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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
REGISTERING MEASURES
Bowser & Co., Inc., S. F., Toronto, Ont.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.
RECORDING INSTRUMENTS
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Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
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The Jos. W. Hays Corp., Michigan City., Ind.
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REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
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The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
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Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
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ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que
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Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
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Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
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Yarnall-Waring Co., Philadelphia, Pa.
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National Boiler Protector Co. of Canada, Montreal, Que.
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Waterous Engine Works Co., Brantford.
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Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
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Beveridge Paper Co., Montreal, Que.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
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Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
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L. S. Starrett Co., Athol, Mass.
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Waterous Engine Works Co., Brantford.
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Babbitt Steam Specialty Co., New Bedford, Mass.
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SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y
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Morse Chain Co., Ithica, N.Y.
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Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
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Goldie & McCulloch Co., Galt.
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Watson & McDaniel Co., Philadelphia.
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Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
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Watson & McDaniel Co., Philadelphia.
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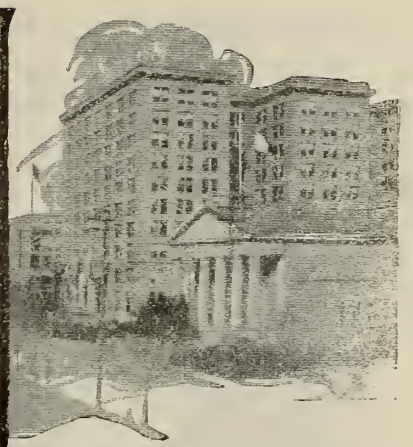
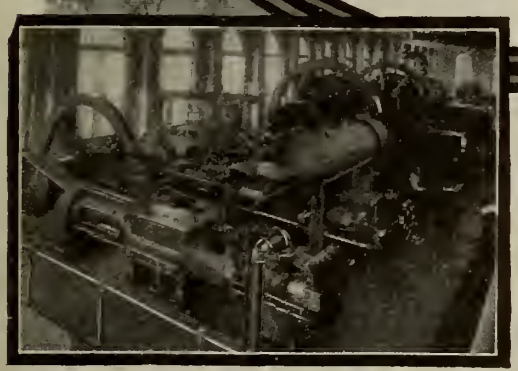


National Cash Register Company, Dayton, Ohio

Bowser Oil Filtration and Circulating System takes care of their Power Plant.



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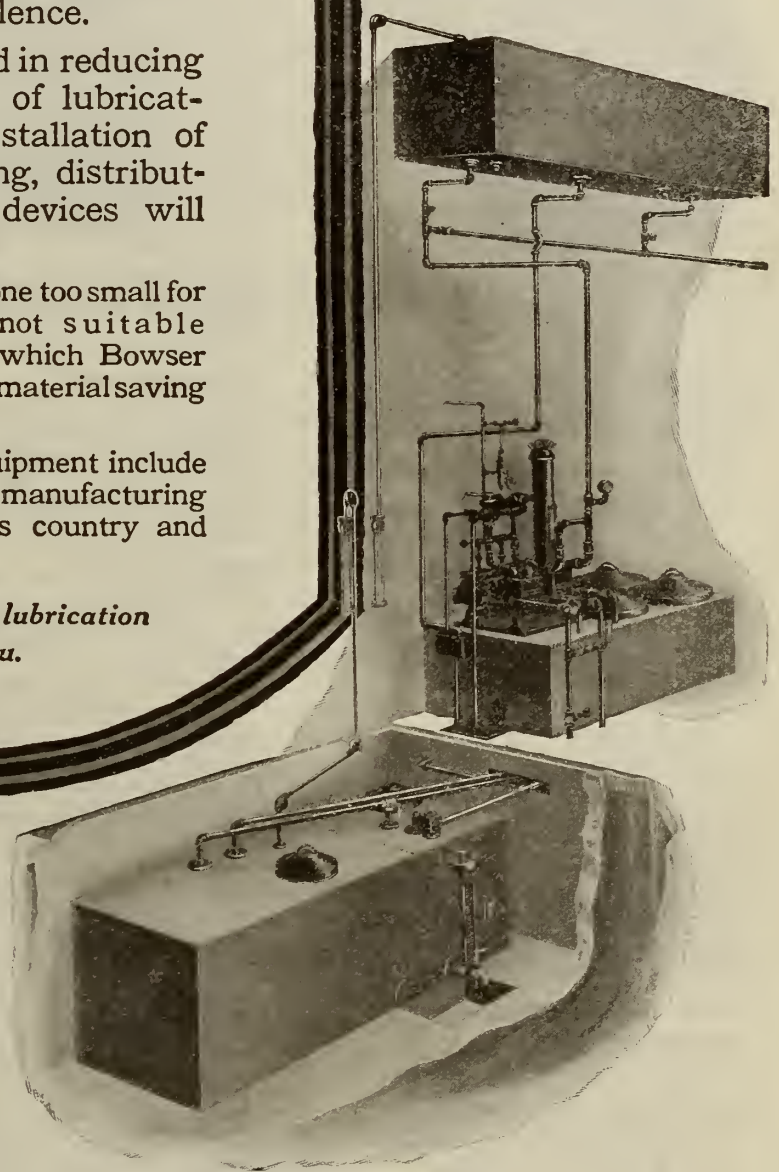

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Mason Regulator & Engineering Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

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Green's Economiser, Ltd., Toronto.

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St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt, Ont.
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Canadian Fairbanks-Morse Co., Montreal.

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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

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TUBES, BOILER
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Coppus Eng. & Equipt. Co., Worcester, Mass.

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Engineering and Machine Works of Canada, Ltd.,
St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TURBINES, STEAM
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Engr. & Equip. Co., Worcester, Mass.
Escher Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

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Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

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Portable Machinery Co., Inc., Passaic, N.J.

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Canadian Steam Boiler Equipment Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
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Cole, Ltd., Geo. W., Toronto.

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Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
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Graton & Knight Mfg. Co., Montreal.

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VALVES, CONDENSER, PUMP, RUBBER
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Canadian Fairbanks-Morse Co., Ltd., Montreal.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Darling Brothers, Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.

AIR VALVES
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Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Engineering Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.

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Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, BRASS
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Penberthy Injector Co., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa

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Shell Bar Boico Supply, Ltd., Toronto.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

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Lunkenheimer Co., Cincinnati, O.
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McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Yarnall-Waring Co., Philadelphia, Pa

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Beveridge Paper Co., Montreal, Que.
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D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VALVES, SAFETY THROTTLE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Detroit Luhricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, O.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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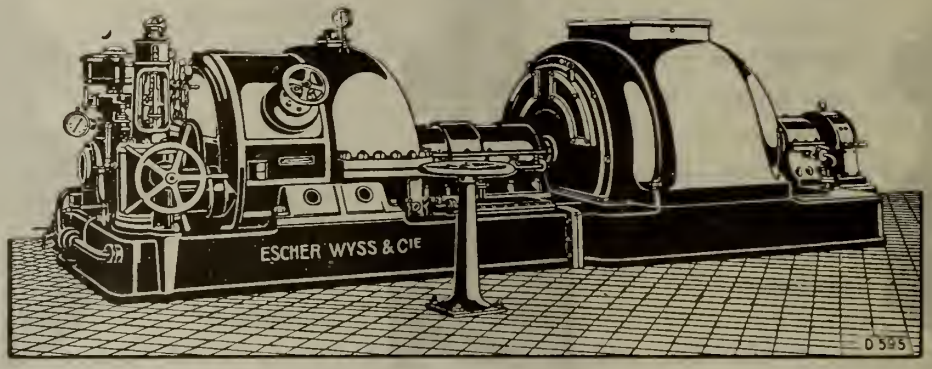

Zoelly-Rotary-Compressors

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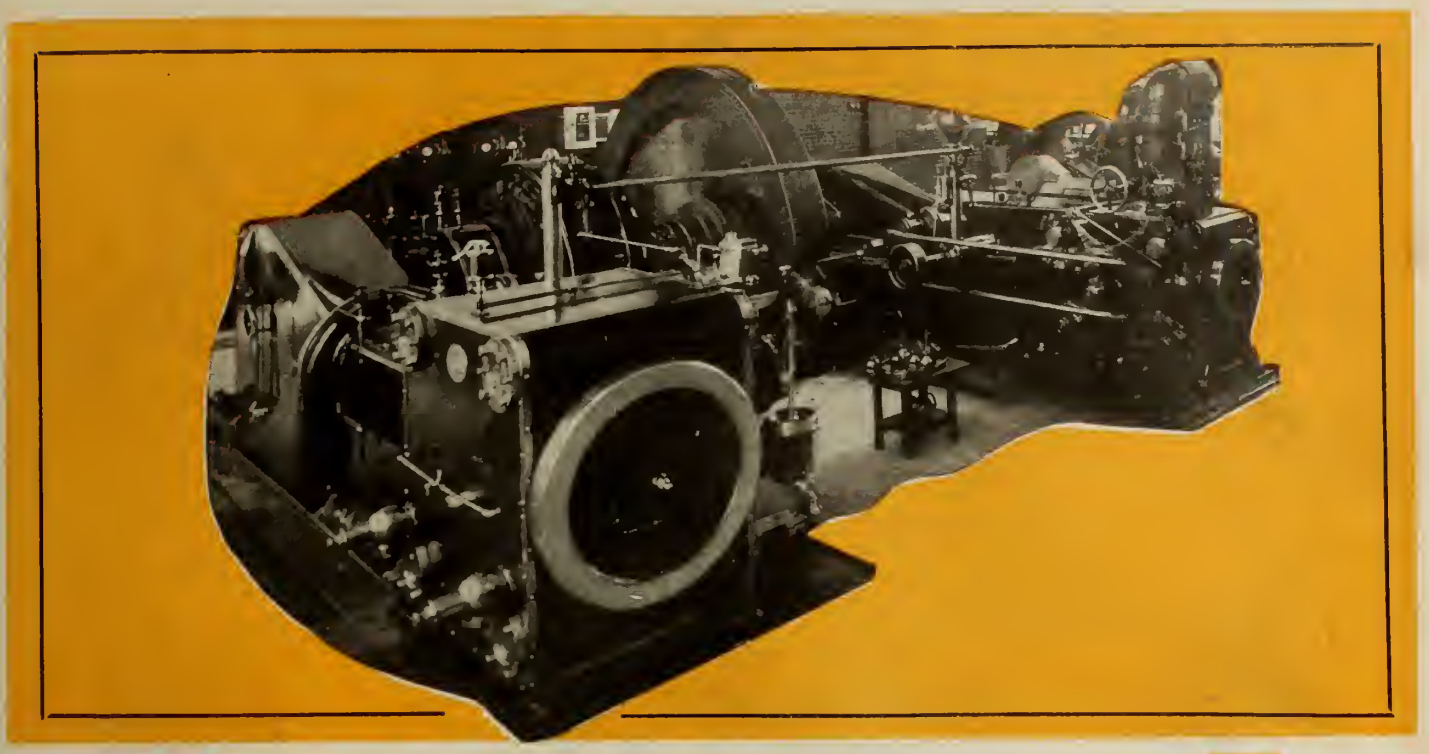

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Vol XII.—No. 9. Publication Office, Toronto—June 20, 1919 Published Semi-Monthly $1.00 per Year

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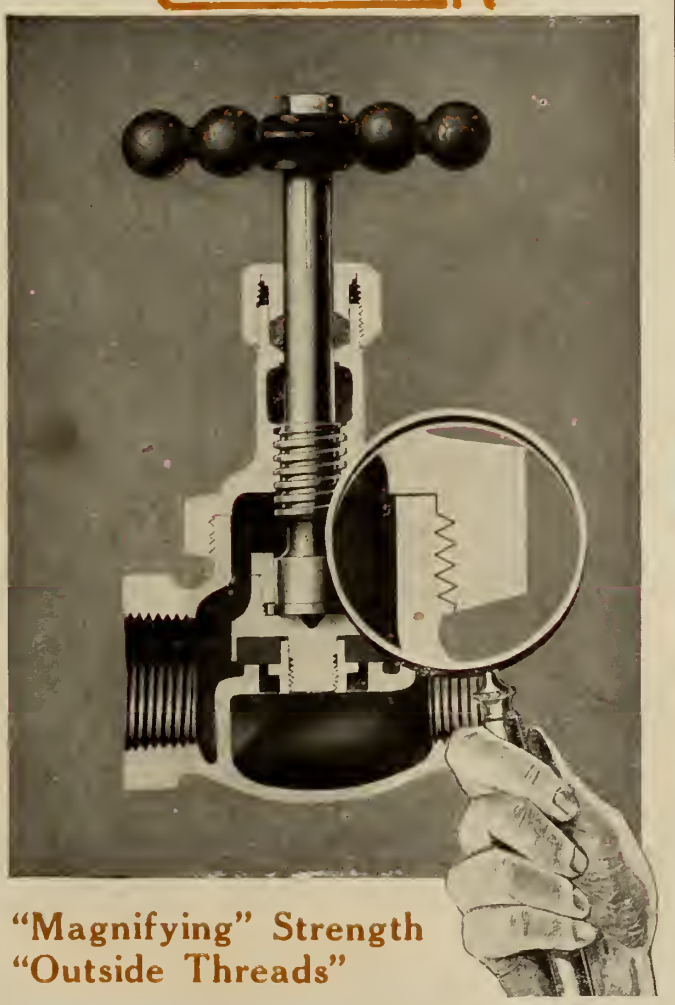

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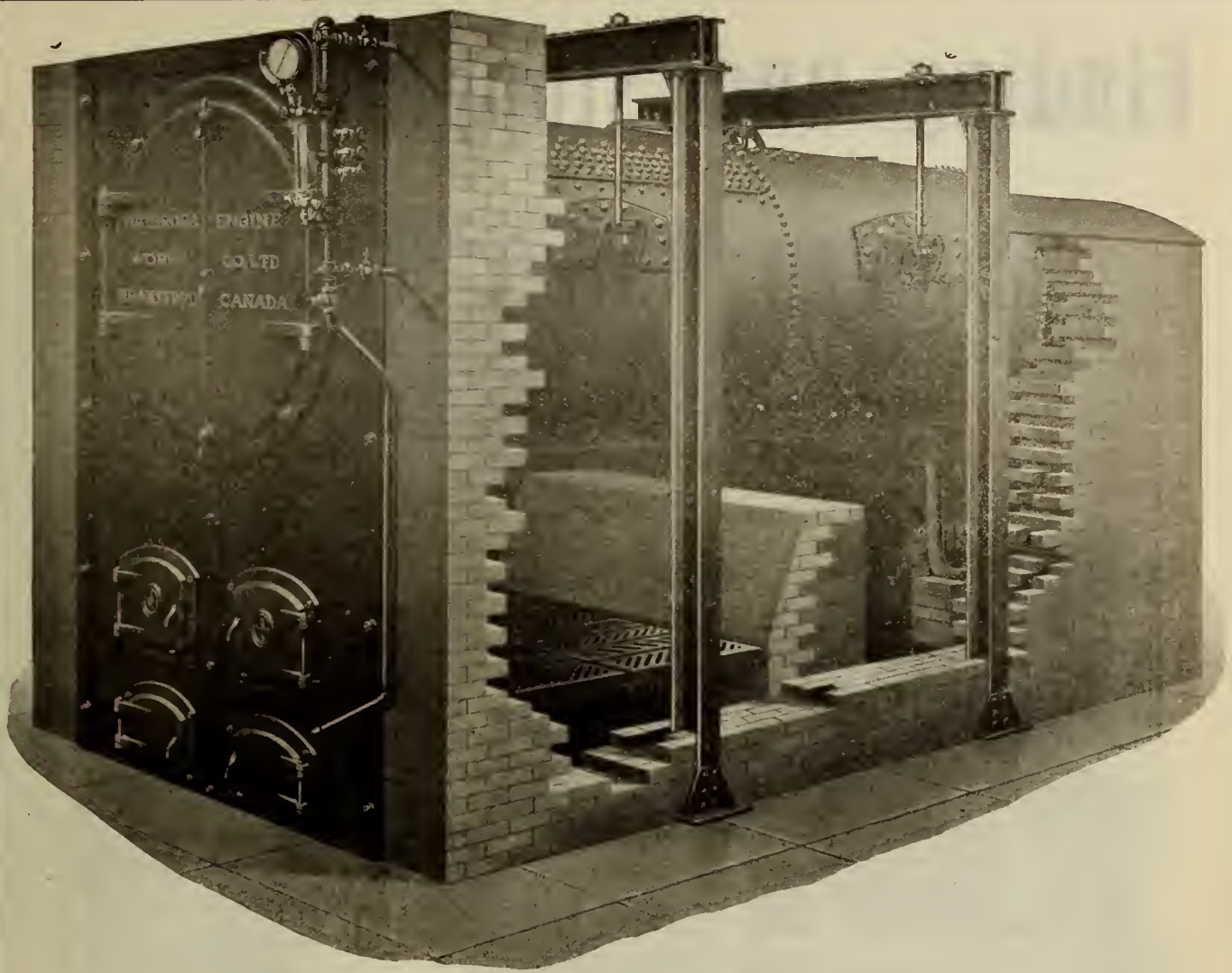
POWER HOUSE, June 20, 1919, Vol. XII., No. 9. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1.00; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.



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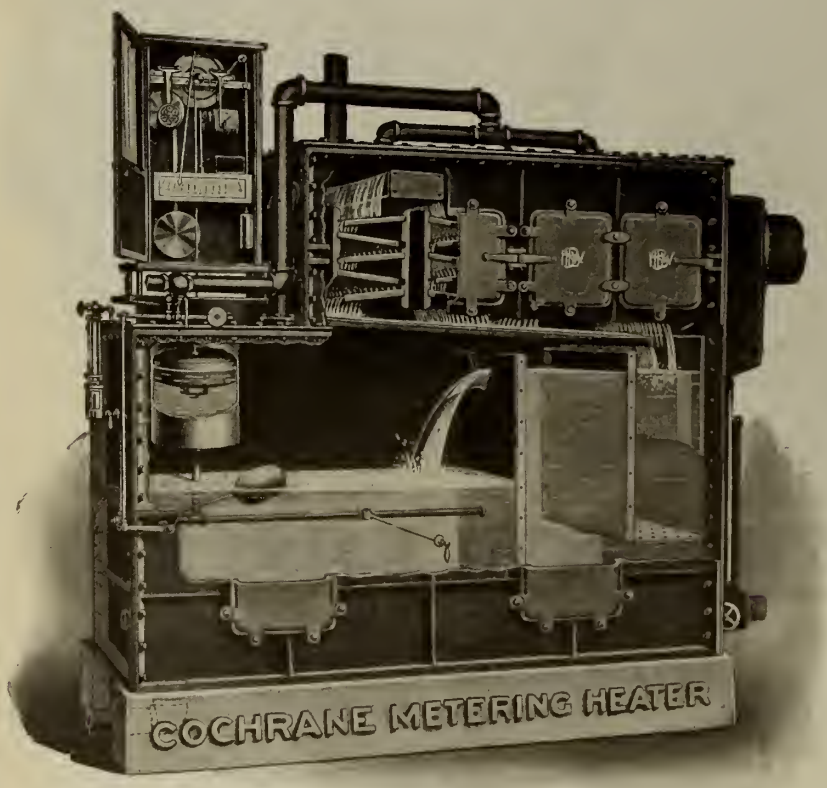

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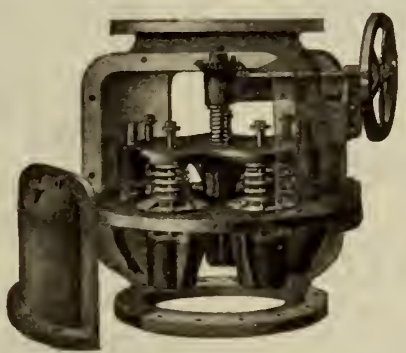

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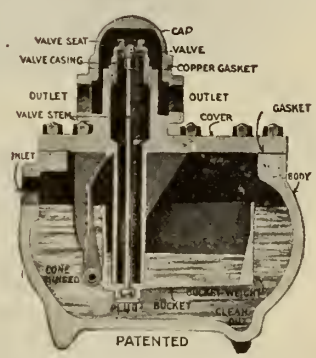

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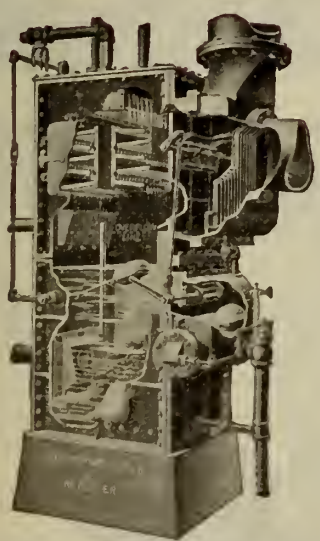

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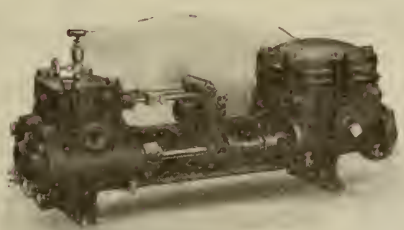

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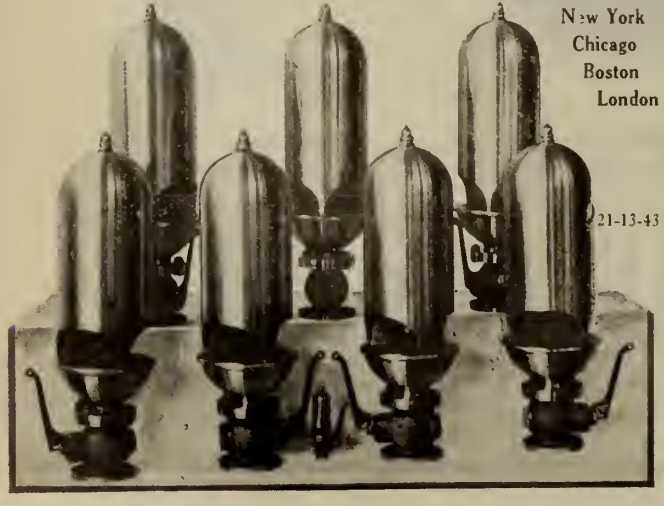

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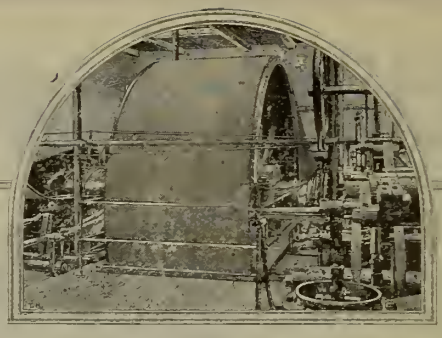

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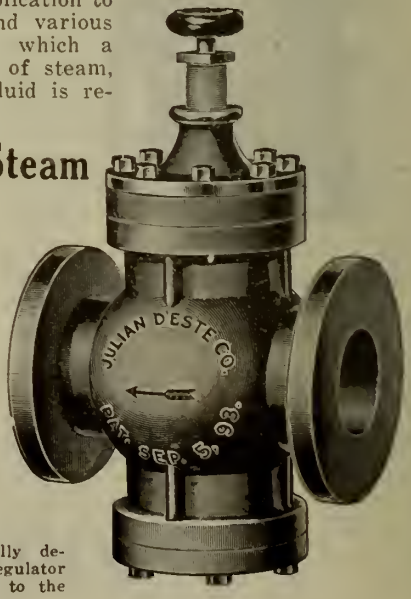

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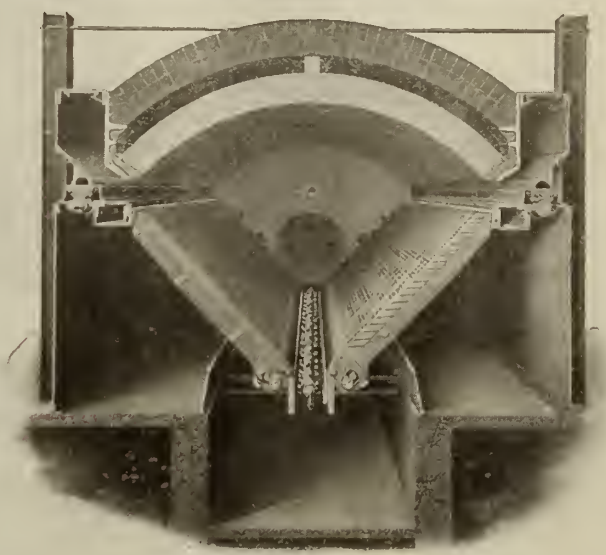

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50 h.p. and Up

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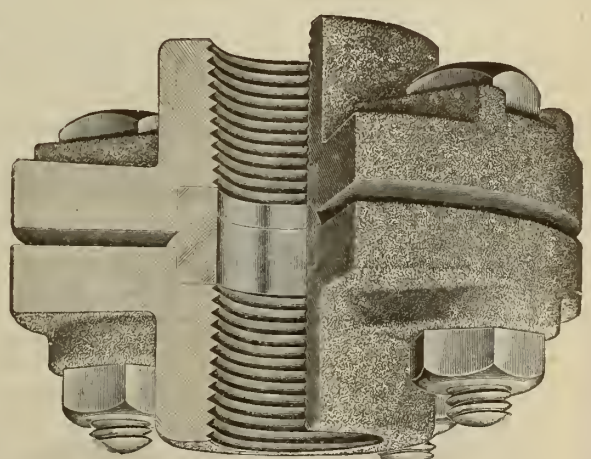

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Nonpareil Insulating Brick are composed principally of diatomaceous earth, a peculiar cellular material of high natural insulating value. Each of its minute cells contains "dead" air. The ground earth is mixed with granulated cork, molded into brick form, and then fired. The cork is thus burned out, thereby adding to the number of "dead" air spaces, and materially increasing the heat insulating efficiency of the finished Nonpareil Brick.

These Bricks are especially suitable for the insulation of high temperature equipment. They have an ultimate crushing strength of 10 ton per square foot. The finished brick form makes them easy to handle and install. Furthermore, Nonpareil Brick are so light, 1.6 pounds each for the 9 x 4½ x 2½ inch size, that when substituted for an equal amount of common brick, the total weight of the insulated structure is reduced materially.

It will interest you to know about the savings that Nonpareil Insulating Brick would effect in your own plant. Copies of the booklets, "Good Furnaces Made Better" and "Saving Fuel," together with a large sample will be sent, free of charge, on request.

Nonpareil High Pressure Covering not affected by water.

Nonpareil High Pressure Covering

For high pressure and superheated steam lines, underground heating systems, boilers, breechings and heated surfaces.

In these days of high fuel and labor prices, the question is not, "Shall I insulate my steam line?" but rather, "What covering will save the most coal?" The answer, as careful investigation will show, is Nonpareil High Pressure Covering.

This—"The Steam Covering That's Different"—is composed principally of diatomaceous earth (kieselguhr)—a light cellular substance that is practically pure silica and an excellent nonconductor of heat. The covering is not only an efficient heat insulator, but will withstand relatively high temperatures without calcining or disintegrating. Furthermore, it is not affected by water and will stand repeated wetting and drying without injury. It is furnished in sectional, block and plastic cement form, making it easy to apply. The bound book, "Nonpareil High Pressure Covering," is worth asking for. It shows how you can determine your radiation losses, also overcome same.

ARMSTRONG CORK & INSULATION COMPANY

LIMITED

903 McGill Building, Montreal .·. **10 Church Street, Toronto**

Also manufacturers of Nonpareil Corkboard Insulation for all cold storage rooms; Nonpareil Cork Covering for brine, ammonia and ice water lines; Nonpareil Cork Machinery Isolation for deadening the noise of machines; and Linotile and Nonpareil Cork Tile for flooring offices, halls, elevators, etc.

GATES REFRACTORIES, LIMITED

382 St. James Street **MONTREAL**

Manufacturing All Kinds of Special Shapes in Refractories

Remember, we are making all our own blocks and making a specialty of special shapes.

We are using a high grade fire clay, which is the factor of supreme importance in all processes of manufacture. Our burners are experts. When you are in the market be sure and write us as we know you will find our proposition interesting.

Our stoker arches are designed to promote combustion and give longer life.

Our door arches and jambs are made to withstand the strong-armed boy with the slice bar.

Our side wall blocks are made to eliminate the many joints that clinkers stick to, when ordinary fire brick is used. They give longer life and reduce air leaks to a minimum.

We designed these arches and blocks so that any handy man could replace same in half the time that it takes to repair a standard fire brick job.

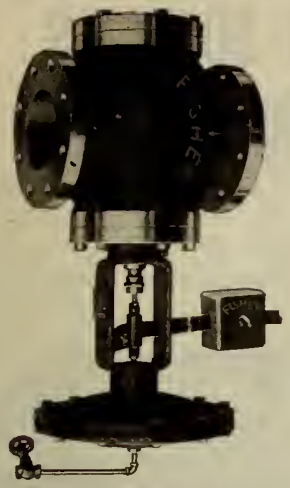
Remember, Gates' blocks means cutting your cost of upkeep and fuel bills.

We specialize in all kinds of POWER PLANT BRICK WORK

Call on our engineers at any time for information you may require; their services are offered to you without obligation.

GATES REFRACTORIES, LIMITED

382 St. James Street **MONTREAL**

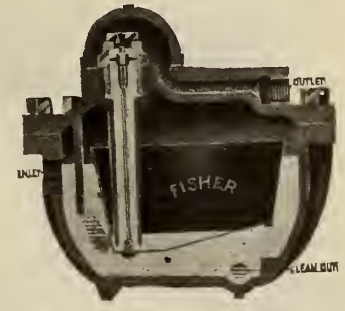


Fisher Reducing Pressure Valve.

FISHER

TRADE MARK REGISTERED

POWER PLANT SPECIALTIES



Fisher High Pressure Steam Traps For all Pressures up to 250 lbs.

Quality is excelled only by the Service they render. Fisher Valves are on the job 24 hours a day and with least attention.

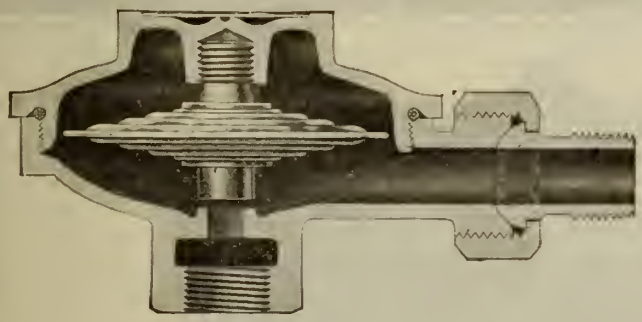
Fisher Reducing Valves can be depended on to maintain a constant reduced pressure.
Fisher Pump Governors for all services give accurate automatic control.

Get full information and Bulletins on

FISHER { REDUCING PRESSURE VALVES
HIGH PRESSURE STEAM TRAPS
PUMP GOVERNORS AND REGULATORS
BACK PRESSURE VALVES
FLOAT CONTROLLED VALVES

C. A. DUNHAM CO., LTD., TORONTO, ONT.

HALIFAX MONTREAL OTTAWA WINNIPEG CALGARY VANCOUVER



Inside Facts About the Dunham Radiator Trap

The Dunham Radiator Trap is distinctive in the simplicity of its construction. It consists of two major parts, a body and a cover. In the cover the operating member, the Dunham Thermostatic Disc, is securely placed. It has an exceptionally large valve opening, there are no loose parts in the path of flow, no sliding contacts, nothing to gum up, and no guide or pin to obstruct the valve opening.

The position and design of the valve is such that it is self-cleaning; the action of the disc is positive, and the valve seats squarely like a globe valve, the tightest of all types of valves. All of its working parts are made of non-corrosive material of the best quality, the workmanship is of the highest order, all parts being made to exacting standards and every finished article given individual working tests.

Complete details on request

The DUNHAM HEATING SERVICE

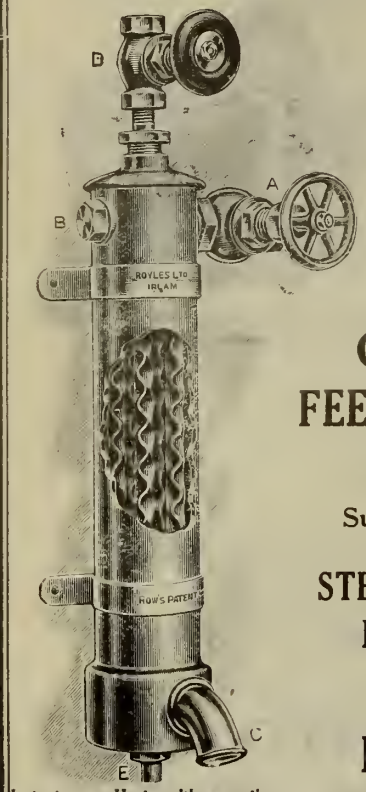
C. A. DUNHAM CO., LTD

Toronto, Ontario

Halifax Winnipeg Calgary
Ottawa Vancouver Montreal

HEATING BY HOT WATER & HOT WATER SUPPLIES

HIGHEST EFFICIENCY GUARANTEED



Instantaneous Heater, with connections for Fresh and Salt Water and Steam

ROW'S PATENT

CALORIFIERS

FEED WATER HEATERS

RADIATORS

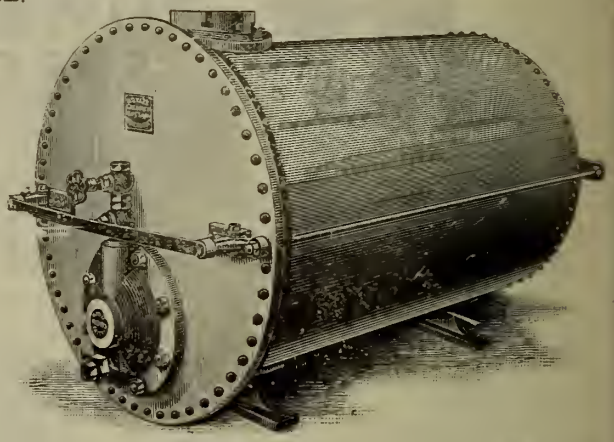
Suitable for Hot Water or High Pressure Steam

STEAM and GAS KETTLES

EVAPORATORS

CONDENSERS

ROWLE'S PATENT AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.


ROW'S PATENT CALORIFIER. STORAGE PATTERN.

ROYLES LIMITED, ENGINEERS AND SPECIALISTS **IRLAM, MANCHESTER** ENGLAND

STANDARD RETURN TUBULAR BOILER

Horizontal Tubular
Vertical Tubular
Locomotive Types

BOILERS

We have registered designs to conform with various provincial codes.

Our BOILERS Are Installed in the Largest Industrial Plants.

Write Us for Boiler Information and Prices.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Office: Hall Machinery Co., Sherbrooke, Que.

HITEMP FIRE BRICK

FOR USE IN

Boiler Furnaces mechanically stoked or where conditions are unusually severe. We make a specialty of difficult shapes and special blocks.

JAMES GARDNER, Jr. CO.
EBENSBURG, PA.

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY
OIL

Unusual conditions are found on pressure stills as it is necessary to break the joint after each run. In many cases DURABLA Gasket material has made a tight joint on pressure stills exceeding 160 runs. This performance has caused DURABLA to be accepted by others as a standard for all oil conditions.

Use DURABLA on the next oil joints you make and it will prove its worth to you. It is guaranteed to make a tight joint at all temperatures and pressures.

DURABLA Gasket Material is also guaranteed for air, water, steam, ammonia, gasoline and acids.

One Standard Material for All Gasket Work. Sold on a Service Basis.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada
The Canadian Fairbanks-Morse Company, Limited

DURABLA

D. K. McLaren, Limited

GENUINE OAK TANNED

Leather Belting

This trade-mark guarantee is on every piece of D. K. McLaren's Leather Belting.

Look for it.

D. K. McLaren's Belting represent Flawless Backs of the hides of the choicest steers tanned by the genuine British-Oak process; the best known for preparing belts for hard service. Every bit of the hide's natural strength is preserved. Minimum stretch, minimum slippage and fewer breaks are the results you can expect.

The Quality becomes more evident as time rolls on.

The Choice of Many of Canada's Largest and Most Efficient power plants

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Head Office and Factory: 351 St. James St., Montreal, P.Q.

Toronto, Ont., 194 King St. W.; St. John, N.B., 90 Germain St.; Vancouver, B.C., 849 Beatty Street

"We Install a Jenkins Bros.' Valve with a Feeling of Confidence"

THIS is the actual statement of a prominent engineer, just after he had installed a genuine Jenkins Bros'. Valve in a troublesome line.

"That extra metal that Jenkins puts in his valves is just where it's most needed and I've never known a 'Jenkins' to break down even on a line where the pressure and strain is greatest."

Over fifty years of valve making is behind genuine Jenkins Bros'. Valves. They are the result of a thorough understanding of valve requirements and valve uses.

Jenkins Bros.' Valves are of all types and sizes for all uses, made of brass, iron and cast steel. They are distinguished from their imitations by the "Diamond Mark" cast on the body.

Look for it—demand it.

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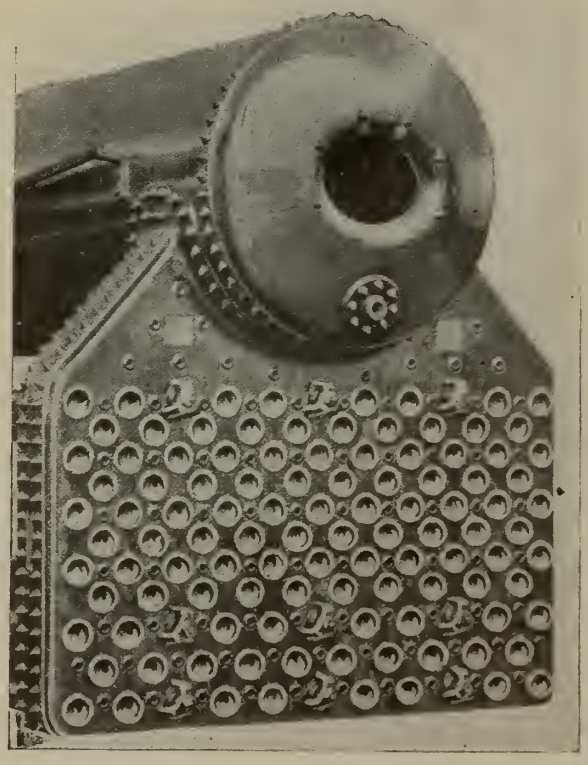
Eight real advantages

in equipping water tube boilers, oil stills and super-heaters with Key Boiler Equipment Co.'s



KEY SAFETY HAND-HOLE CAPS

viz:--

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

No gaskets required. Over 1,500,000 now in service.

LET US SEND YOU OUR DESCRIPTIVE LITERATURE

Power Plant Equipment Co.

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The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

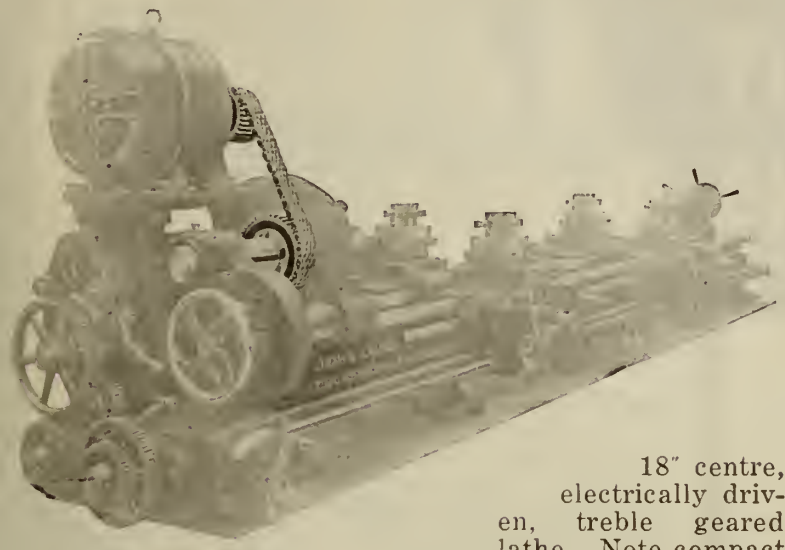
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Ltd. 376 Dufferin Street **Toronto**

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec

"THE COVENTRY" CHAINS



18" centre, electrically driven, treble geared lathe. Note compact arrangement of drive.

THE REASONS FOR
CHAIN TRANSMISSION

Will work at a high speed and in either direction. Positive, yet flexible, turning movement. Will work on centres too long for gears and too short for belts, so that drive can be arranged to suit either details of design.

Unaffected by heat or cold — give positive velocity ratio, — minimize journal friction. Will transmit considerable power with high efficiency, which is retained. Increase output, give uniform quality of product, consume minimum of power. Minimum attention required for repairs or adjustment.

The Coventry Chain Company, Limited, Coventry, England

Cables: CHAINS, COVENTRY. Codes: A.B.C., 3rd and 4th Editions
WESTERN UNION and MARCONI

ANNOUNCING

A New Emergency Power Plant

Medium and high speed Sterling gasoline engines (which have held world's marine speed records for eight years) have been adapted for driving centrifugal pumps and electric generators. They are being used by many prominent pump manufacturers, coupled to Underwriters fire pumps, and are installed in townships, villages, municipalities, department stores and manufacturing plants for fire protection. They are also utilized for emergency generator drives. The motors are admirable for either pump or generator operation as they develop rated power at 800, 1,000, 1,200 and 1,400 R.P.M. The construction is in 4, 6 and 8 cylinder units, 10 to 300 H.P.

Numerous units are employed in the United States and Canada. They are equipped for instantaneous starting for any emergency and will always furnish dependable power until the emergency will have passed.

CATALOG ON REQUEST.

STERLING ENGINE CO., Department C 4 Buffalo, N.Y.

DETROIT STOKERS

Furnish Dependable Power

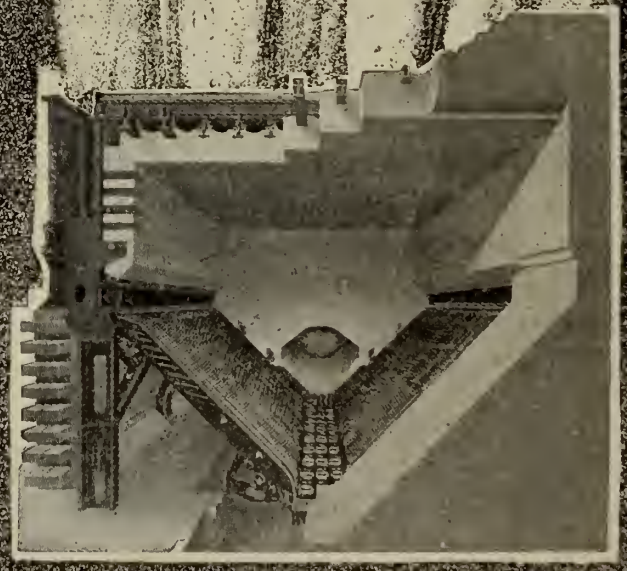
Fuel Economy. Saving in fuel costs from 10 to 20%.

Labor Saving. Labor costs reduced 50 to 75%.

Flexibility. Easily handles variable loads.

Capacity. Range of 75 to 200% of Boiler Capacity at high efficiency.

Smokelessness. Proper methods of combustion resulting in clean stacks.



Detroit Stoker Company
DETROIT, MICH.

Branches:
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Mason Service Means Something to You!

Mason No. 55 Pump Pressure Regulator

WE are not only able to supply you with power house specialties of well-known quality, but are prepared to give you real service in addition. Our engineering staff is composed of men of practical knowledge. They are continually coming in contact with problems such as yours and are prepared to give you the benefit of their wide experience.

New Bundy Return Trap

The "MASON" Line

"Mason" Reducing Valves (genuine)
"Mason" Pump Governors.
"Mason" Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Coppus Turbine-driven Boiler Feed Pumps.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Feed Water Filters.

Salesmen Who Know

Here's where MASON service counts to your benefit again—above everything our Sales Engineers know the practical application of our lines to actual condition. They sell from knowledge, not from Catalog. **Their advice is worth while!**

We are concerned with results — not merely with making a sale.

Mason Standard Bronze Reducing Valve

Full Informatian Gladly Furnished

Use "MASON" Service

The Mason Regulator & Engineering Co., Limited

Successor to H. L. PEILER & COMPANY

Toronto Representative:
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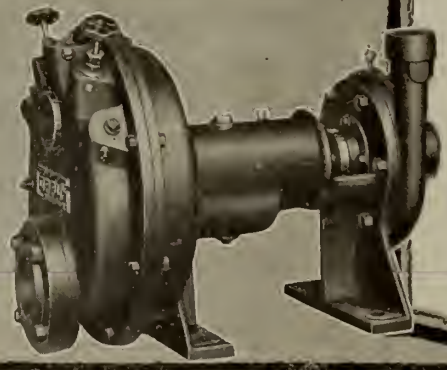
What Do You Want When You Buy A Feed Pump?

Do You Want—
low steam consumption
steady water pressure
absence of water hammer
easy regulation
great flexibility
minimum upkeep
freedom from repairs
dependable operation
behind every pump?

and—a guarantee that stands unqualifiedly Then you want the catalog which describes the COPPUS Turbo Feed Pump—a pump which will give you all of these things. Just write for Catalog H9—we'll do the rest.



THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

Manufacturers of COPPUS Turbo Blowers and COPPUS Power Turbines

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Agents for Montreal: Mason Regulator & Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Building.

COPPUS Centrifugal Turbo FEED PUMP

THE SCOOP CONVEYOR

The Scoop Conveyor Keeps Equipment Moving

Two or More Scoop Conveyors Make a Flexible Arrangement

Unloading Hopper Bottom Cars Direct Into Trucks with a Scoop Conveyor

DOES THE WORK OF FROM 6 TO 12 MEN

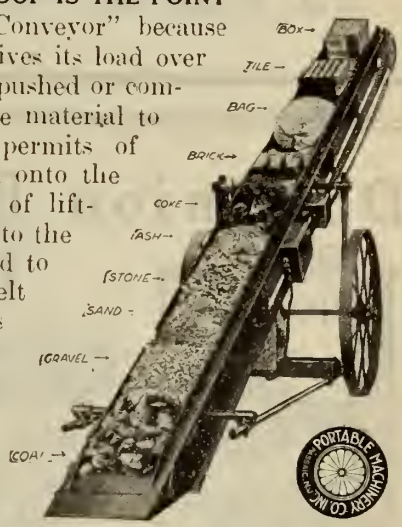
It has proven to be one of the greatest labor and time savers in storing and reclaiming, in loading and unloading cars, trucks and wagons. It keeps equipment moving. Enables men to work faster and easier. Eliminates much shovel and wheelbarrow work. Does three to five days' work in one.

OVER 1000 USERS

The Scoop Conveyor has been adopted by over 1,000 leading American manufacturers, contractors and coal dealers because it is durable, compact, easily moved around and low in cost. About one-half of our sales are "repeat orders."

THE SCOOP IS THE POINT

It is called "Scoop Conveyor" because the carrying belt receives its load over a scoop which can be pushed or completely buried into the material to be conveyed. This permits of scraping the material onto the carrying belt instead of lifting it by shovelfuls into the receiving hoppers fitted to ordinary portable belt conveyors and results in a saving of fifty per cent. of the labor in feeding.



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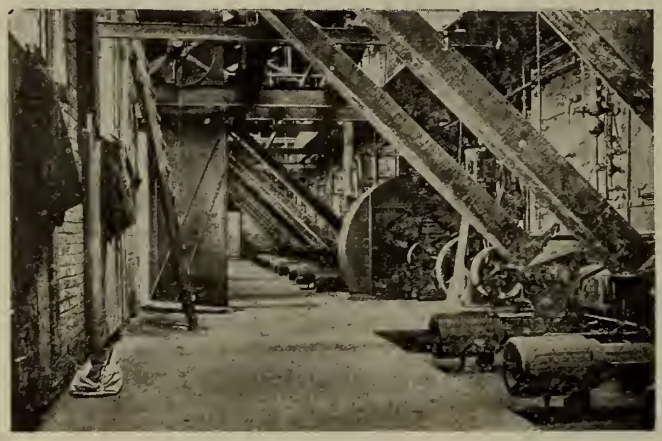
PORTABLE MACHINERY CO.
PASSAIC, N.J.

Sand, Gravel, Coal, etc., Easily Loaded with a Scoop Conveyor

Unloading Hopper Bottom Cars with a Scoop Conveyor. No Track Hopper or Pit Is Necessary

Down Goes Fuel Cost!

15 to 25 per cent



This is a result that is quickly noticed, following the installation of the

Jones Underfeed Automatic Stoker

The "Jones" feeds fuel better and more economically than the best of firemen. It maintains a uniform steam pressure and responds instantly to varying demands for steam.

The "Jones" construction means durability. No parts more in contact with the fire—and loss of fuel through grates is impossible because there are none.

May we send you full facts and figures re the saving effected by this modern way of stoking?

Jones Underfeed Stoker Co.
Limited
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Dominion Belting Company, Limited
Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

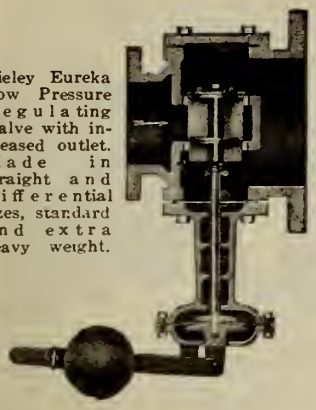
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal



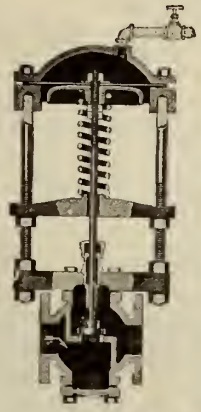
Kieley Eureka Low Pressure Regulating Valve with increased outlet. Made in straight and differential sizes, standard and extra heavy weight.

KIELEY

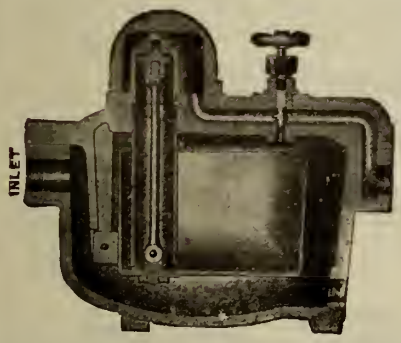
High Grade Steam Specialties

In the close competition of modern industry economies in the use of steam, water and air specialties bear closely upon the question of net profits. Modern devices are absolutely essential to the most profitable production. Antiquated appliances won't do. Kieley specialties are worthy of your attention in view of this fact. Kieley construction represents **quality.** All materials used in their construction are of the highest standard. Each casting is finished with care and every part is accurately assembled. Finally a thorough test is given each specialty before leaving the plant.

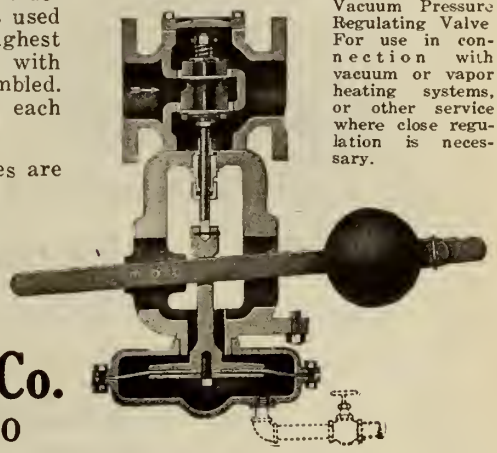
Kieley steam, water and air specialties are thoroughly reliable, advanced in design and economical. **Look carefully over designs illustrated here, then write for catalogue of the full Kieley & Mueller line.**



Kieley Rockaway Single Seated Pressure Regulating Valve. For regulating and controlling steam supply to domestic water heaters, thermostatically controlled Valves, cooking kettles, sterilizing apparatus and similar service.



Kieley Improved Steam Trap. Suitable for any and all service, either high or low pressure.



Kieley Special 98 Vacuum Pressure Regulating Valve For use in connection with vacuum or vapor heating systems, or other service where close regulation is necessary.

The

Arthur S. Leitch Co.

1002 Kent Building, TORONTO

GREEN'S

HI-EFFICIENCY HI-SPEED

RADIAL FLOW FANS

have the following advantages

1. They require approximately 20% less horsepower than any other fan.
2. They are so designed that the rotor and bearings may be easily inspected without changing the alignment or dismantling the flue work.
3. They run at speeds best suited for direct connection to turbines or motors and are also suitable for gear or belt drive.
4. Any blow back through the fan inlet or dead space on the fan wheel is impossible due to the design of the rotor and housing.

Our engineers will be glad to furnish more complete information in regard to these fans to cover your individual requirements.

GREEN'S ECONOMISER, LTD.

TORONTO

Booth No. 10 in the Convention Hall at Brantford will Contain Some Vital Information for Engineers

We have combined a few salient facts of vital interest to all visitors at the Brantford Convention. Our Mr. H. Wainwright and Mr. M. Schroder will be in attendance to convey these facts to you. Call at Booth No. 10. Use it as a meeting or resting place and in that way make the few moments you will spend there of material benefit to yourself.

H. MUELLER MFG. CO., LIMITED

SARNIA :-: CANADA

There's a Big Waste in Little Leaks

Do you know that a one-tenth inch pipe-joint leak at 150 lbs. pressure will waste steam in a year at a cost to-day of approximately $825? Figure it out for yourself. Leak one-tenth inch; pressure 150 lbs.; 9 lbs. steam per lb. coal; coal $5.50 ton; 10 hours per day; 300 days per year.

And it's such an unpatriotic waste in these days of coal conservation—such a needless and careless waste at any time—for the leak can be stopped in a few minutes' time with a

YARWAY PIPE-JOINT CLAMP

Formerly the SIMPLEX

More than 13,000 leaks have been stopped since this effective clamp was first placed on the market. Millions of dollars have been saved. The saving in coal can only be guessed.

The Yarway (formerly the Simplex) can be attached in a few minutes by any workman. The principle can be seen from the illustration shown here.

If there is a pipe-joint leak in any of your lines, tell us the size and we will send you a Yarway for 30 days' trial. Instead of returning it, you will probably be as enthusiastic over its success as the man who said of a Yarway Clamp, "It's worth its weight in gold."

Write to-day

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7604-20 Queen Street
Chestnut Hill - Philadelphia

Calgary, Alberta
GORMAN, CLANCY & GRINDLEY CO.

Montreal, Canada
JAS. ROBERTSON CO.

Montreal, Que., Canada
A. McLELLAN,
103 St. Francis Xavier Street

New Westminster, B.C.
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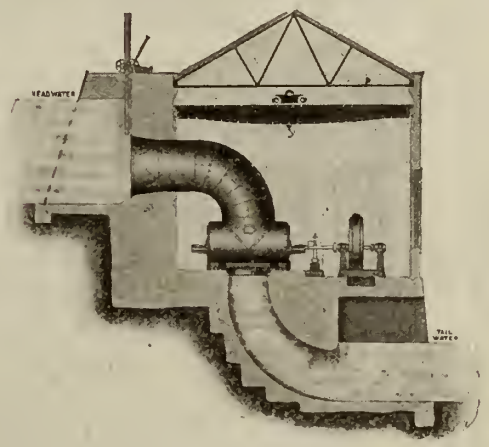
Water Wheels and Hydraulic Power Plant Equipment



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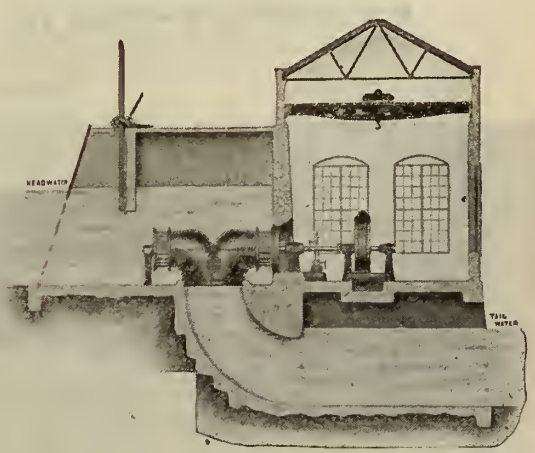

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THE ALLROUND BOILER ROOM INSTRUMENT

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These meters measure steam, water and air for all departments, also steam generated by each boiler.

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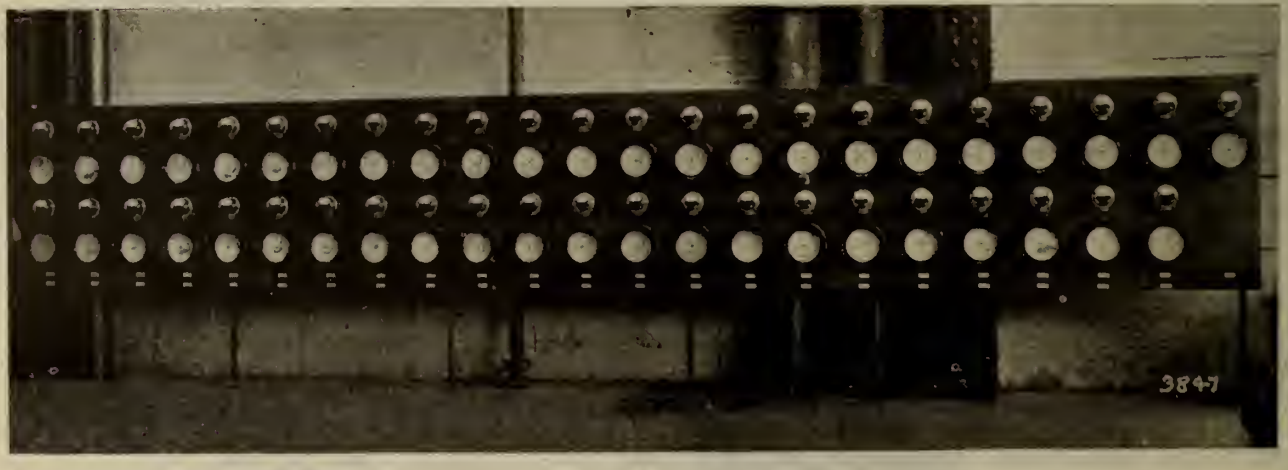

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E. J. Philip & Sons 103 Hamilton Trust Building TORONTO, ONTARIO

The Publisher's Page

TORONTO JUNE 20, 1919

The Canadian Association of Stationary Engineers

The Power House,
Toronto.

Hamilton, May 29th, 1919

Dear Sirs:—

It seems an age since I last wrote to you, but I have really been very busy owing to the strenuous pre-convention duties associated with the office of Secretary of the C.A.S.E.

I am enclosing my renewal POWER HOUSE subscription fee of $1.00. It is well worth twice or three times that amount, but as $1.00 is your price, here goes. The engineers certainly appreciate this exceptional price, which we understand cannot continue for long.

I am greatly pleased and amazed at the phenomenal success that has attended the publishing of POWER HOUSE, especially since it has been issued in semi-monthly form.

The excellent editorial contributions, plant articles, new equipment information, question box, etc., etc., have been of the highest order, and to my personal knowledge have been of great benefit to your readers.

MR. JOHN HALE
Secretary, Canadian Association Stationary Engineers.

The spendid industrial representation in the advertising pages is worthy of special notice—the educational nature of the advertisements being particularly valuable.

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Each issue is therefore looked forward to with great anticipation, and from my personal knowledge, I believe it is studied from cover to cover.

I hope to have the pleasure of meeting you at the Brantford Convention, which gives promise of being the best we have ever had.

Yours sincerely,

JOHN HALE,
Secretary, C.A.S.E.

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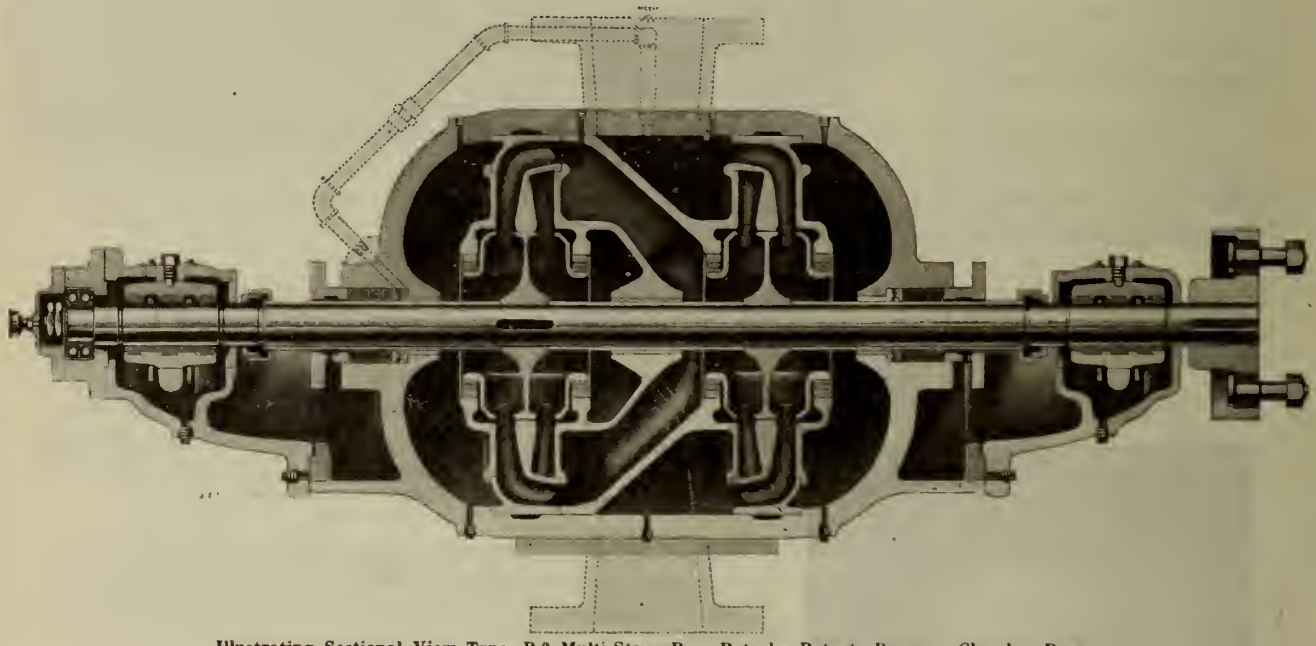
Is in use all over the World in Waterworks, Mines, Power Stations, Irrigation Works, Pulp and Paper Mills, Salt, Chemical and General Industrial Plants where highest efficiency, reliability and the best class of Engineering are demanded.



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POWER HOUSE

Established 1907

Published Semi-monthly

BRANTFORD The Scene of the Annual Convention C.A.S.E.

IN choosing Brantford as the convention city for 1919, the Canadian Association of Stationary Engineers have selected one of the industrial centres of the Dominion, and a city noted for its many historical associations.

The industries located in Brantford number upwards of one hundred, and include some of the largest and best known in the Empire. The Verity Plow Works, the Waterous Engine Works, the Cordage Co., and a firm making stoves and furnaces, are all representative of the manufacturing ability displayed in the community.

Historical

Historically, Brantford dates back to the time of the Indian, and the name of the city, and the statue of Joseph Brant, the Mohawk chief, in Victoria Park, are indicative of the city's origin. The Indian chief and the early white settlers lived together in peace and amity on the banks of the Grand River, near the ford, which formed a part of the well-known route of the Six Nations settlement to London.

Most of the early settlers were U. S. Loyalists, and by 1818, twelve families had gathered in the small community, which boasted two taverns, a blacksmith shop, general store, and grist mill. The settlers coming into this part of the country, which was practically an unbroken forest, had many hardships to bear and difficulties to overcome. He usually journeyed with his provisions, beds and cooking utensils on one horse, his wife and children on another. His cabin was made of round logs notched at the ends, and the chinks filled with clay. The door was made of split clap-boards hung on wooden hinges, and the flintlock rifle with powder horn and bullet pouch was always conveniently close at hand over the door. The wide fireplace was fashioned of rough stone, and its chimney of split sticks and clay. Homemade furniture was built by hand, while the spinning wheel, now an ornament, was sent swiftly whirring by the busy housewife.

Brantford obtained its present name in 1826, when the naming of the community, now numbering about one hundred settlers, was discussed, and several names were proposed. The memory of the Mohawk warrior who first designated the crossing over the Grand River rose in their minds and prompted them to christen the place Brant's Ford, which time curtailed to Brantford.

ALEXANDER GRAHAM BELL
the inventor of the telephone.

It is a city of happy homes, where industrial disputes are rare and short-lived. Significant of this may be recorded the fact that when the Waterous Engine Works found it necessary to erect a larger establishment some years ago, instead of importing some dignitary, they placed the trowel in the hand of their oldest employee, John Morice, who laid the corner-stone truly and well. Such is the spirit of the city. It is owing to this spirit that Brantford has achieved her present renown as a manufacturing city, and the names of her manufacturers are widely known throughout the Dominion.

The growth of a community depends on the transportation facilities offered by the railroads and other public carriers. Brantford's railroad connections are unusually favorable. The Grand Trunk built lines to Harrisburg and Tillsonburg, and later found it to their advantage to divert their main line so as to pass through the city. The T. H. and B. gives excellent connections with Toronto, Hamilton and Buffalo, while radial lines also connect Brantford with Hamilton and Galt.

From the time Brantford's first little frame church was endowed by an Indian chief, the religious side of the community has expanded, until nearly every denomination is represented

Brantford has every reason to be proud of her educational institutions, which have grown from a frame building, first to be erected on the market square, until nine public schools, one

manual training school, and the new Collegiate Institute are required to keep abreast of the city's educational requirements. The Brantford Collegiate Institute, recently erected on the site of the Young Ladies' College, is one of the finest buildings in the city. The Provisional School for the Blind, opened in 1872, has been the means of alleviating much of the distress of those suffering from this affliction. The ample grounds, together with the educational facilities and comforts provided, are commensurate with the importance of the institution.

Prior to 1848, Brantford had no hospital. In that year the city was visited by a severe epidemic of cholera, which swept over the country, and temporary hospitals had to be erected. The John H. Stratford Hospital, originally the gift of Mr. Stratford, now expanded into the city hospital, and the Brant Sanitarium, on a site commanding an excellent view of the city, the gift of E. S. Cockshutt, promote the welfare and health of the citizens.

MOHAWK CHURCH

The Story of the Telephone

When, in 1876, a goodly handful of residents of Brantford heard the voices of a trio of singers over a telephone line which had its terminus in Tutela Heights, the home of Alexander Melville Bell, father of Alexander Graham Bell, the inventor of the telephone, it was accounted one of the wonders of the age, yet to-day, when messages are exchanged between New York and San Francisco, when Boston hears Los Angeles celebrating, or the sound of the surf at Seal Rocks, it is dismissed as one of the day's normal happenings. The telephone is accepted as one of the necessary adjuncts of the business, professional, industrial, or social life of the day.

Joy and sorrow, business and pleasure —the telephone wires carry them all, yet prior to the year 1876, when in Brantford the first telephone message was sent over a real telegraph line, all messages had to be carried by hand. The telegraph had been invented by Morse in 1835, and thus messages could be transmitted over by wire through electric energy. These messages, however, had none of the personal touch. That the conveying of the actual intonation of a speaker with all the mannerism of inflection was made an actual accomplishment, is due entirely to two men— Alexander Melville Bell and Alexander Graham Bell, his son. The former was a noted master of elocution and the inventor of a new theory of articulation, by which all audible sounds could be reduced to signs translatable by any person instructed in the symbols. The son, also versed in the science of speech, when but a young man became possessed with the idea of teaching deaf mutes to speak, being the first, at least in England, to do this. Later, Alexander Graham Bell accepted a position teaching deaf mutes in America, the father accompanying the son and settling at Tutela Heights, Brantford. The son, during the school session, lived in Boston, spending the summer vacation and Christmas holidays at the parental home in Brantford.

To carry out his plan of teaching deaf mutes to speak, Alexander Graham Bell secured a phonautograph, a hollow cylinder with one end covered with a membrane, to which was attached a long bristle stylus. As one talked into the other end the bristle, because of the vibration of the membrane, was made to write a waving line on a revolving cylinder of smoked glass placed before it. These lines were the outline of the sounds uttered.

At this time he was also work- experimentally upon multiple telegraphy, whereby he hoped messages could be sent along the same line simultaneously without confusion, by employing musical signals of definite pitch. These researches culminated in the invention in Brantford, in 1874, of what is now known as the harp telephone, the ancestor of the speaking telephone.

It struck the young scientist, while at work with the phonautograph, how simliar that instrument was to the human ear, and how perfect a mechanism the human ear was. The suggestion came to him, after studying the ear's mechansim, that a phonautograph modelled after a human ear would be extremely effective for his purpose, and accordingly, on the advice of an eminent aurist, he secured a human ear. This he made into a phonautograph, taking a single fibre of hay as a stylus. The waves of sound as he talked into the ear, vibrating the delicate membrane of the tympanum, caused the bone to move and the wisp of hay to record the movements of the diaphragm upon a piece of smoked glass. The thought entered his mind, as he watched the tracings, that if the tympanum of the ear, so delicate, could move relatively so massive a structure as that of the bones of the ear, why could not a piece of iron be caused to vibrate in front of an electro-magnet by means of a larger and thicker membrane?

Thus was the telephone conceived in the Bell homestead on Tutela Heights. The significance of the movements of the membrane did not escape the young scientist, who realized that at last he had solved the problem upon which he

VICTORIA PARK IN THE CENTRE OF THE CITY.

MOHAWK LAKE, BRANTFORD, A FAVORITE PICNIC GROUND.

had been working for some years. He converted the harp telephone into a membrane-speaking telephone modelled after the human ear by attaching one of the reeds of the harp telephone to a stretched membrane, and thus forcing it to copy the movements of the air during the utterances of a sound which caused it to vibrate. And the telephone was an actuality.

But though the telephone was a reality, it was by no means perfect. He continued his experiments, and by the following summer, while again visiting at his home on Tutela Heights, he had so far advanced that he was able to write out the patent specifications during the month of September, 1875. These patents were largely based upon the liquid spark arrester which he had invented and made in Brantford during that summer vacation. He found difficulty in working the multiple telegraph apparatus on account of the spark which appeared between the contact point of the transmitter when the circuit was broken. This he overcame by bridging the gap with water and by dipping one of the conducting wires very slightly into the water. The wire was adjustable up and down to regulate the amount of resistance introduced when the main circuit was broken.

This invention was of more than ordinary importance because, in drafting his specifications, he laid stress upon the variable resistance apparatus, upon which the famous Government suit was won by him in later years.

The following year the first messages were sent over a real telegraph line, all experiments hitherto being conducted by means of wires in coils, kept in one building. In 1876 the inventor again spent his summer holidays at Tutela Heights. Through the kindness of the Dominion Telegraph Company of Canada, the local chief being Mr. W. H. Griffin, with Ewen Cameron, still residing here, as a member of the staff, its lines were placed at his disposal for experiments. On August 10, or close to that day, 1876, experiments were made on the telegraph line between Brantford and Paris, which had two very important results. For the first time a message was transmitted by telephone over a real telegraph line, and the proper relation of the parts of a telephone to each other was discovered, enabling its use upon a long line. The receiver of the telephone was in Paris, the transmitter in Brantford, and the battery which supplied the motor power, in Toronto. The young inventor had made arrangements with his uncle, the late Prof. David C. Bell, then a resident of Brantford, to take charge of the transmitting station, as his father had stated that he would not be able to be present. Persons were to sing, talk or recite into the transmitting instrument in Brantford, while he listened at the receiver at Paris. After observing the effects for some time, he telegraphed by another line to Brantford, instructing Mr. Griffin, the manager, as to changing the arrangements of the coils. As a result of this, a combination was at last arrived at which resulted in loud and clear articulation being heard at Paris. He thought he could even recognize the voice of one of his speakers as that of his father. Surprised, because of his understanding that his father could not be on hand, he wired back to Brantford to ascertain if his father had actually spoken into the telephone, when the reply came that the voice was that of his father, who had been reciting into the telephone for some time. The first public demonstration was given within a few days of this event and conversation took place between Brantford and Tutela Heights.

"To Commemorate the Invention of the Telephone by Alexander Graham Bell, in Brantford in 1874."

MOHAWK INSTITUTE: INDIAN SCHOOL

BRANTFORD COLLEGIATE INSTITUTE AND TECHNICAL SCHOOL

So runs the inscription, cut in granite, ever enduring, on the Bell Memorial, unveiled in Brantford on October 24th, 1917, by His Excellency the Duke of Devonshire, Governor-General of Canada. Thus is commemorated the fact that in the city of Brantford, on Tutela Heights, was the telephone conceived; and that from this city emanated the first telephone message to be transmitted.

GRAND RIVER AND POWER DEVELOPMENT

The Grand River has often been a menace and expense in the matter of floods, but there is still a notable balance in favor of the stream in the matter of municipal service.

In the early days it constituted the motive power for many small flour mills, but the most important part which it played in the early portion of 1800 was in the use to which it was put by the Grand River Navigation Company. A large sum of money was invested in the construction of a canal to connect with the river to the east of the city and "slack water." Navigation was adopted which permitted of passage of boats of light draft to Buffalo. For a considerable period this canal was the only available avenue through which the produce of the country round about Brantford could reach an outside market, and produce for shipment was teamed to the place from a considerable radius. A tremendous impetus was thus given to the town. The encroachment of the railroads led to the final collapse of the navigation company, but it served a valuable purpose during the period of its existence, not alone for Brantford, but also in the development of the Grand River Valley.

That the stream could be still utilized in the matter of power developed, does not admit of any question. At the present time it is estimated that there is some 600 h.p. at the Slingsby Canal Head, and 1200 at the Locks, situated at the head of Grand River Canal. There is a great fall in the stream from Elora to Brantford, and by means of storage reservoirs—a plan successfully followed in the States and other countries—it would undoubtedly be possible to prevent the great water wastage during the spring freshets, and develop a large amount of continuous power for electric or other plants.

This is a matter which is well worthy of consideration and investigation.

TUTELA HEIGHTS, WHERE THE TELEPHONE WAS INVENTED

THE CARBONIZATION AND DISTILLATION OF PEAT

The value of peat lies in the direction of distillation rather than combustion, and on these lines it could supersede wood in the production of acetic acid, methylated spirit, ammonia and tar, the basis of so many dyes.

In the process of distillation, peat, being a light material, requires larger retorts than coal, and of a design which facilitates the transmission of heat from the surface towards the centre. Experiments have shown that revolving retorts produce the best results. The apparatus devised and described is on the principle of the roasting appliance used for coffee, chicory, etc., of course with the addition of a receiver for collecting the distilled vapor, the great object being to provide an apparatus complete in itself for continuous and all-round operation.

This apparatus consists of six cylindrical retorts, each mounted on its own axis and capable of uniform rotation,

THE BELL MEMORIAL HAS BEEN ERECTED TO COMMEMORATE THE INVENTION OF THE TELEPHONE IN THE "TELEPHONE CITY."

whilst the individual cylinders are arranged in radial relation to a rotary central pivot, so that the retorts charged with peat can be entered into and withdrawn from a stationary semi-circular furnace in succession.

When the apparatus is in operation there are always three retorts undergoing distillation in the furnace, the other three being outside, one condensing, another emptying, and the third recharging. The distillation takes on an average about 40 minutes for retorts holding a ton of peat, and making six revolutions per minute.

To enable the gas arising from the carbonized peat to pass out of the retorts, the hollow shaft of each is perforated so as to provide a passage from the inside of the retort to a collecting chamber in the axis of the pivot and thence to the stills for fractional distillation.

The rotary movement of the retorts ensures rapid transmission of heat from the furnace, and as this heat acts on a very large surface, the peat is uniformly carbonized in a short time at a relatively low temperature—a result which is impossible to obtain by any other process.

THE INSTITUTE FOR THE BLIND HAS ATTRACTIVE GROUNDS.

COAL STORAGE

For the prevention of heating in coal stacks, the following plan has been found to be of value in the South Wales coalfields in Great Britain. Wherever possible size the coal before stacking it, and put each size in a separate heap. Never stack heaps of "through" coal or mixed smalls to a greater height than 12 ft. If necessary, on account of lack of space, to store "through" coals or mixed smalls to a greater height than 13 ft., the stack should be laid in succeeding layers of not more than 3 to 4 ft. thick. These heaps should also be provided with perforated ventilation pipes, 3 in. to 4 in. in diameter. Iron or earthenware pipes should be used, one pipe to every 300 square feet of surface. The lower ends of these pipes should be at different heights from the ground throughout the stacks. A thermometer should be lowered occassionally through the pipes to ascertain the temperature at the various depths of the stack.

MAKING CORRECTIONS ON BLUEPRINTS

By Harrison Jenkins

Readers no doubt at some time or other have required to make some corrections on blueprints, and perhaps went through the laborious task of first blotting out the dimension in black with pen and ink before adding in the new figures. This scheme has two disadvantages: first the time necessary to blacken in the figures not desired, and second, that you cannot very well place the dimension in its former position, except you write the correction in white ink (which is not always easy to get). If white ink is not to be had, then it means that you must crowd in the figures somewhere else, not always a wise plan to follow.

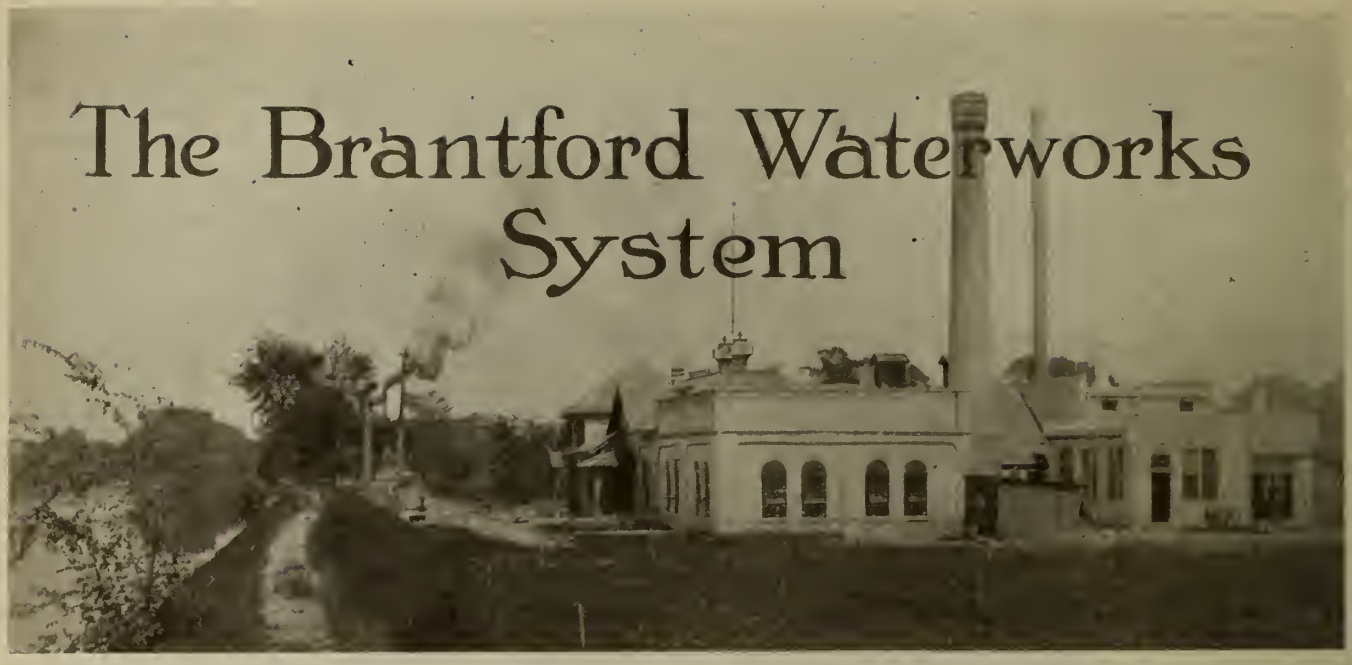
An easy way to overcome all such trouble is to make little blocks of such length and width as best suits your usual needs. Four such blocks more than likely will cover all the changes you will ever desire. Glue (or hold by thumb tacks) pieces of blotting paper as shown.

Simply moisten these pads with the usual bleaching solutions of washing soda, caustic potash, or strong ammonia, in fact any alkali, and press the pad on your blueprint, when you will not only accomplish a quick job, but will make a neat white space in which you will be able to print in black ink your desired correction.

Mr. R. S. Wright, of Box 1,034, Sudbury, Ontario, writes: "I have always looked on POWER HOUSE as our own country engineers' journal, and it is up to us stationary engineers at this time to show our patriotism and support home industry."

LEFT—POST OFFICE AND GOVERNMENT BUILDING. CENTRE—LIBRARY. RIGHT—BRANT MONUMENT. TOP—BUSINESS CENTRE OF BRANTFORD.

The Brantford Waterworks System



IN keeping with the importance the city of Brantford has as an industrial centre, the waterworks and other municipal utilities offer features of interest. The present waterworks system is the result of a somewhat rapid growth extending over a number of years, and the present layout in consequence combines in an efficient manner older equipment with more modern pumping units.

Historical

The waterworks system was established in 1870 by the Brantford Waterworks Company, a private corporation. The supply was obtained from a small spring creek, which had its source in the hills north of the city and empties into the Grand River. The pumping station was located on Colborne Street at the Clarence Street intersection. This first waterworks system was mainly used at the start for fire protection.

Owing to the unsatisfactory condition of the water, together with other features not satisfactory to the municipality, the company was taken over by the city in 1888 at a price of $64,700. which included about nine miles of mains.

The pumping station was moved in 1889 to its present location near the Grand River, and the Gaskell & Worthington pumps, mentioned further on, were installed. Nine miles of water main were also laid and a collecting gallery laid in the flats adjacent to the pump house.

Collecting Galleries

In looking for a suitable source of water-supply, a series of test wells were driven, and observations as to the depth and variations of the water level were made. It was found that over this district was a very porous soil, much of it a gravel bed, beneath which was a stratum of clay impervious to water. The average depth of soil overlaying the clay was about sixteen feet. The data collected showed that by laying a line of pipe on the surface of the clay a large quantity of water could be intercepted and collected for pumping.

The collecting gallery was constructed by laying tile pipe 15 in. in diameter in a trench excavated to the clay, the pipe being laid in two rows side by side, two

D. L. WEBSTER
Chief Engineer Brantford Waterworks.

feet from centre to centre. The pipes are perforated for about two thirds of their circumference and were covered with screened gravel to a depth of two feet before filling up the trench with the excavated gravel and earth.

The collecting gallery first constructed was laid in a south-westerly direction from the power station for a distance of 750 ft. The fall in this distance is about 4 ft. The bottom of the pump well is about 24 ft. below the station floor.

Underground water collected in this manner, when the watershed is such as to guarantee freedom from dangerous contamination, is an excellent means of procuring a public water supply. Observations made in Brantford would indicate that the supply is largely fed from the Grand River, the porous soil being a means of natural filtration.

As time went on the first collecting gallery became inadequate to supply the needs of the city, and in 1889 another gallery, this time of 24 in. tile, was laid. This gallery ran parallel to a hydraulic canal which supplies power to a number of factories, and about fifty feet from it to a point in the river flats. Part of the pipe is laid with closed joints and the remainder at the river flats with open joints.

The system proved inadequate, and the pipe line which runs to the river flats was extended into the river at a point opposite Dickie's Cove. This pipe was used to carry water to the gravel bed and an infiltration gallery was constructed 300 ft. long to take the water to the pumping station.

The system was extended in 1908. It was also found that the sediment from the river was choking the filter bed and a screen house was installed with stationary screens and a sedimentation basin. A 10 in. pump is also installed at the inlet at present and pumps the water into the pipe line supplying the natural filter bed. This pump is of the single stage type, and is driven by a 50 h. p. motor. Two intakes at present extend into the river, two being necessitated by the erratic behavior of the Grand River in flood time. Normally one intake should have about nine feet of water over it, but after a flood it is no unusual thing to find ten feet of gravel.

At the present time about 1,000,000 gallons of natural ground water are obtained, the rest being drawn from the

river and filtered through the natural gravel.

During the period of 1911-14, additional filtration galleries of a length of 6,000 ft. total have been added.

Pump Wells

All the water pumped is drawn from two pump wells. The older one, 15 ft. diameter and 20 ft. deep, supplies the steam pumps, and the latter one, 25 ft. diameter by 29 ft. deep, supplies the turbine driven and electric pumps.

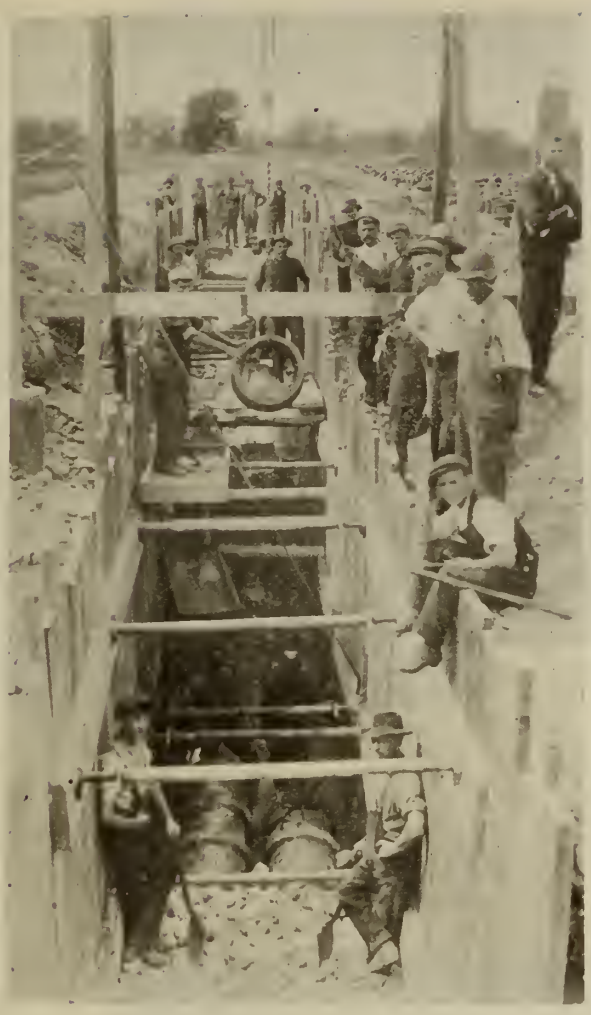
An emergency source of supply exists in the hydraulic canal adjacent to the station, and in this connection it may be stated, that all water from both the emergency supply and the filter beds is chlorinated.

Three artesian wells have also been sunk, but the water obtained was either salt or sulphur laden, and so not suitable for water supply.

Pumping Engines

Three pumping engines are installed. Two of these were purchased at the time of the reconstruction of the system in 1890. Each of these pumps has a capacity of 2,000,000 U. S. gallons of water per 24 hours. The Worthington pump has a high pressure cylinder of 14 in. diameter, low pressure 20 in. diameter, water cylinder of 1 4in. diameter, and has a 15 in. stroke. The pump may be run either condensing or non-condensing, and has been thoroughly overhauled this year, the major portion of the work being done in the waterworks machine shop.

The other two million gallon pump is of the Gaskill type, manufactured by the Holly Manufacturing Co., Lockport, N.Y. It is fitted with poppet steam valves and gridiron intermediate and exhaust valves. The steam cylinders, which are steam jacketed, are 12 and 24 inches in diameter, and have a stroke of 22 in. The water cylinders are 14 in. diameter. Jet condensers are fitted with four air pumps direct connected. Four feed pumps are also direct connected.



LAYING THE INFILTRATION GALLERIES. NOTE THE PERFORATED PIPES. THESE ARE COVERED WITH GRAVEL BEFORE THE BACK-FILL IS PLACED

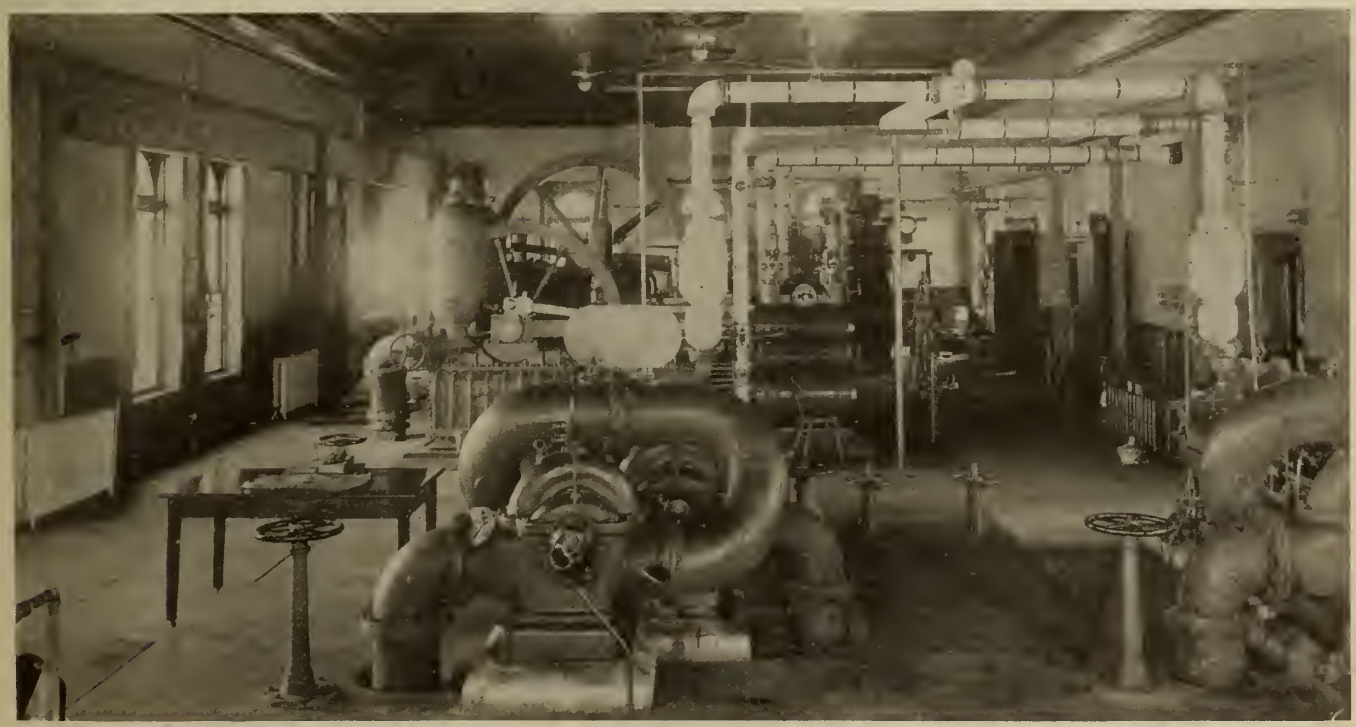
Six Million Gallon Unit

The third pump was purchased in 1900, and is No. 5 Holly, horizontal high duty twin compound engine with a capacity of 6,000,000 U.S. gallons per 24 hours. This pump was installed by the Waterous Engine Works, of Brantford. The high pressure cylinders are 18 in. diameter, the low pressure 36 in., and the water cylinders have 19 in. plungers. The stroke is 32 in. The valve gear is of the Corliss type, with positive cut-off regulated by water pressure.

This unit is fitted with two direct connected air pumps to feed pumps, and two jet condensers. This pump has been in almost continuous operation for fifteen years since its installation. The main rods are fitted with metallic packing.

Boiler Room

Three boilers were originally installed, sixty-three by 14 ft. These were later removed, and the present equipment consists of three John Inglis 72 by 16 horizontal return tubular boilers, and one 72 by 18 ft. Waterous boiler, the latter



GENERAL VIEW OF WATERWORKS.

SHOWING SWITCHBOARD AND DE LAVAL PUMP

being fitted with its own stack 6 ft. in diameter.

The above boilers are fed with feed water, heated with live steam in a Hoppes closed heater. A Cochrane 350 B.H.P. open feed water heater is also installed, and a Cochrane vee notch meter has been purchased for installation shortly.

The feed water is pumped by feed pumps, direct connected to the main pumping engines, and when these are not in operation by a Waterous duplex pump or a Davidson pump 12 by 6 by 11 in., made by the M. T. Davidson Co., New York City.

For an emergency source of supply, two injectors are fitted, a Morrison 1½ in. injector and a 1¼ in. Penberthy.

The feed piping is of brass throughout and is installed in duplicate. For checking purposes a two inch meter is used when required.

All the boiler settings are covered with Protecto-coat and the boilers are fitted with surface and circulating blow-offs.

The steam piping is being overhauled and duplicate mains put in.

McDonough damper regulators are fitted and a Canadian Westinghouse locomotive type air compressor is mounted on the wall of the boiler room. This latter is an exceedingly useful piece of equipment, as it does not only keep the pump air chamber filled with air, but is also used to run the Deane tube cleaner instead of steam. It also supplies the machine shop with compressed air for the operation of light tools.

Motor Driven Pumping Units

Hydro power makes an admirable source of power for the driving of waterworks pumping units, as the character of the load is well suited to the use of synchronous motors, and a material improvement in the power-factor on the transmission system results.

Two motor driven units are installed. The motors are of Canadian Westinghouse make and are of 250 h.p. each. They are of the synchronous type and take three-phase 25 cycle power from the Hydro-Electric System of Brantford, at 4,000 volts. The pumps are direct connected and run at 750 revolutions per minute. They are of De Laval make and are rated at 4,000,000 Imperial gallons each per 24 hours. By means of their three stage design, they are capable of delivering water at a head of 200 feet.

Each of these motor driven pumps can be run in series with the steam turbine driven pumps for fire purposes, and a total head of 300 feet obtained.

The two turbine driven pumps can also be coupled in series for domestic use, a head of 200 feet resulting in this case. Ordinarily the turbine driven pumps are used for fire purposes only.

Steam Turbine Units

Two De Laval steam turbine driven pumping units are installed, taking steam at 90 lbs. pressure. The turbines are of the single stage impulse type and run at 12,500 revolutions per minute. They develop 115 h. p. under normal rating, with a maximum of 145. They can be run condensing or non-condensing, and when run condensing, a vacuum of 28 ins. is obtained by means of a Wheeler surface condenser. This condenser is common to both turbines.

The water end of each of these units consists of two single stage pumps coupled in series with a resulting head of 100 ft.

A Bowser circulating and filtering system is being installed on the turbine driven units.

Switchboard

A slate switchboard of Westinghouse make controls the electrical equipment of the plant. The first panel is the incoming line panel with oil breaker, graphic voltmeter, and voltmeter and ammeter plugs for the indicating instruments on a swinging bracket. The oil circuit breaker is fitted with a no voltage release.

The next panel meters the plant load and is fitted with a graphic power factor meter, graphic wattmeter and an integrating wattmeter.

Panel No. 3 controls the booster station and screen house described below, and is fitted with two knife switches for the remote control of the motors in the booster station. Ammeter plugs and a breaker are also supplied. For the re-recording of the pressure developed at

SHOWING THE DE LAVAL TURBINE DRIVEN AND MOTOR DRIVEN PUMPS

BOILER ROOM.

the booster station a Bristol long distance recording pressure gauge is mounted on this panel.

Panel number four controls the lighting, two supply circuits are provided for by a double throw switch, one the Hydro-Electric fed from station transformers and the other a sixty cycle supply obtained from a power plant run by means of the Grand River.

Panels five and six control the synchronous motors, and are fitted with indicating power factor meters a. c. and d. c. ammeters, the latter for the exciter and the usual field rheostats, etc. First, second and main breaker switches are installed for the starting and running positions of the synchronous motors.

The motors are started by means of an auto-starter which may be used with either machine.

Garton-Daniels lightning arresters are used.

Discharge Mains and Metering

The city of Brantford is fed by three discharge mains from the pump house. These mains are 10 in., 14 in. and 20 in. in size, and a fourth main of 8 in. pipe feeds West Brantford. The mains are all so arranged that any group can feed into any main independent of the others. Large relief valves are installed on all mains at the pump house.

The plant discharge is all metered by two Venturi meters. An eighteen inch Venturi meter takes care of the discharge of the steam turbine and motor driven centrifugal pumps, while a similar meter of 20 in. throat meters the discharge of the older steam pumps.

Chlorinating Apparatus

All the water is chlorinated with liquid chlorine apparatus, two units being installed by the Electro-Bleaching Gas Co., New York City.

These units automatically feed the chlorine gas in a measured amount, depending on the flow of water through the Venturi meter tubes.

Heating System and Drips

A Burnham receiver pump collects all jacket returns from the steam pumps, and all drips around the plant, returning the hot water to the boilers.

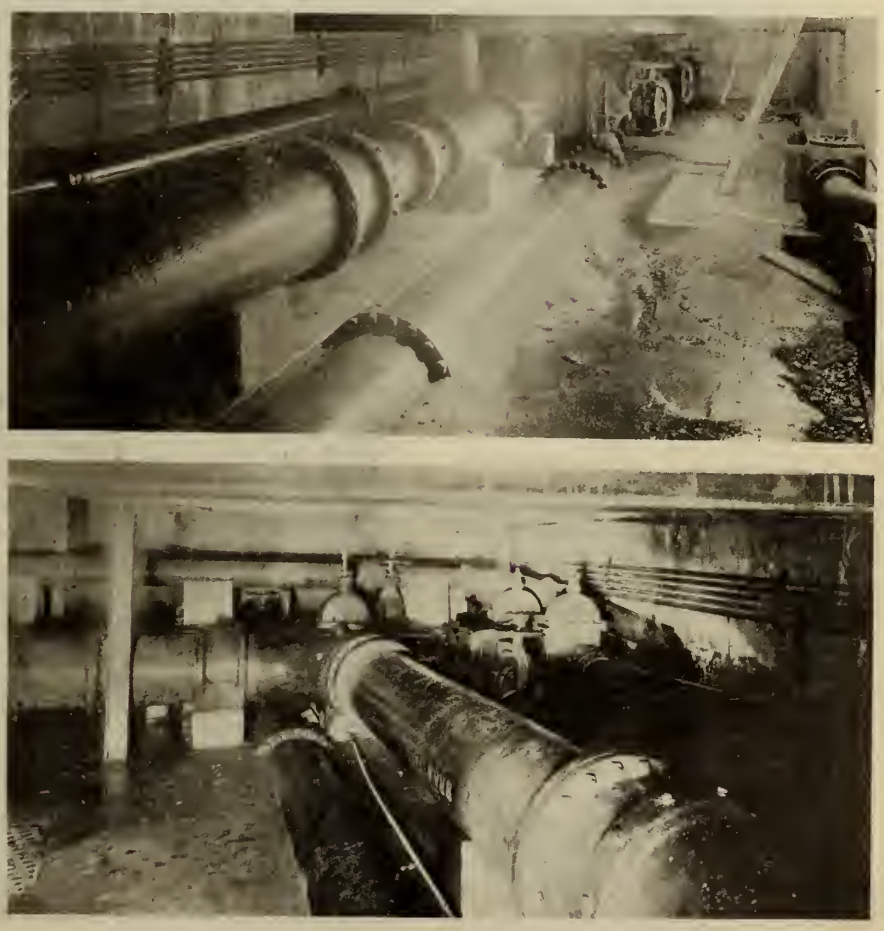
The exhausts from feed and vacuum pumps during the winter months are used for plant heating, the live steam heater being used for feed water, while in the summer months the Cochrane open feed water is used. The Webster system of steam heating is used by Darling Bros., Montreal.

Machine Shops

In any waterworks system much repair work always has to be done to hydrants, water meters, etc., and to station apparatus. A machine shop then, while not an absolute necessity, is an extremely useful part of the plant equipment, and one which in the course of a year saves considerable money and time.

All wattmeters are repaired and tested, all valves and fire hydrants are repaired, together with repairs to any of the engines or turbines forming part of the pumping equipment. The steam pumps have been completely overhauled and all work done on them except some which was too big for the lathes has been done in the machine shop.

A Hendey toolroom lathe, 14 in. by 6 ft., forms part of the equipment, together with a Lodge & Shipley 20 by 10 ft. lathe. Other equipment includes a 16 in. shaper and a 20 in. drill. All

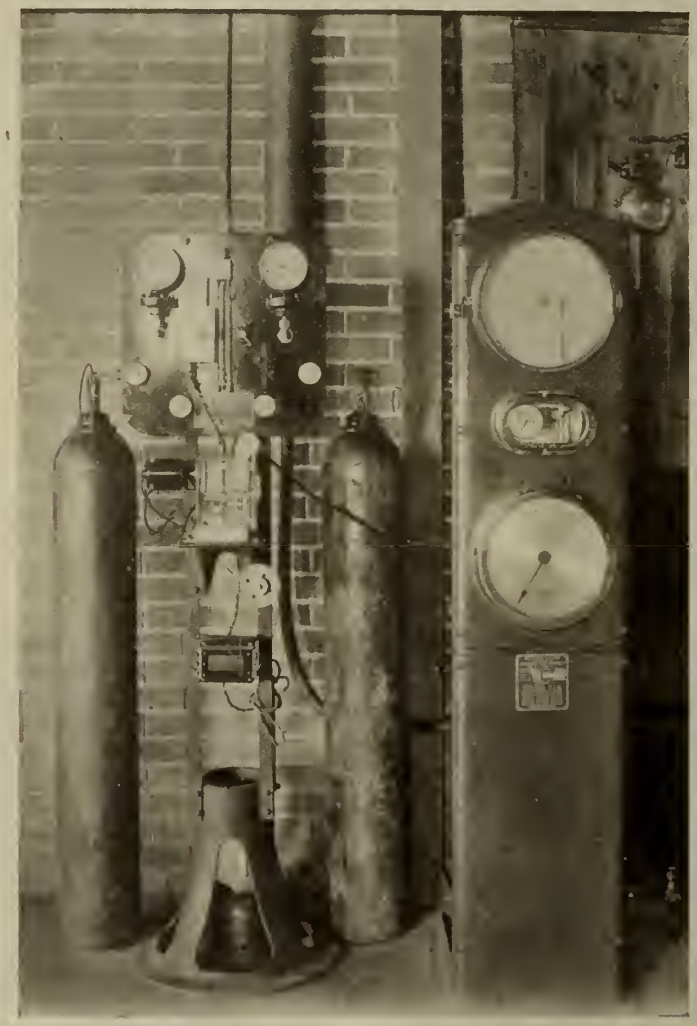


ARRANGEMENT OF PIPES AND VENTURI TUBE IN PIPE TUNNEL

drills and small tools are kept in lockers adjacent to the tools on which they are used.

The floor is part concrete and part wood surfaced. The concrete floor is useful for the repair of the waterworks motor trucks and traction engine. The remainder of the floor is built up of a concrete sub-floor, on top of which is laid a 3 in. plank floor and a lighter plank floor.

Fire hydrants are tested in a concrete lined pit provided with mains and



VENTURI METER AND CHLORINATING APPARATUS.

feet for their ready attachment and removal.

A ten ton Herbert Morris crane is provided in the engine room for plant purposes.

Distribution System

At the end of 1918 the distribution system had a total length of 63 miles, 3,434 feet, made up as follows:

20	in. mains	6,818 ft.
14	in. mains	16,997 ft.
12	in. mains	4,082 ft.
10	in. mains	8,488 ft.
8	in. mains	34,694 ft.
6	in. mains	160,451 ft.
4	in. mains	104,544 ft.

338 fire hydrants and 478 valves are installed on the systems. Service connections to the number of 7,050 have been made and 2,123 of these are metered.

Booster Station

A portion of the city of Brantford is at a considerably higher level than the remainder and for the better serving of this part of the city, a booster station has recently been put into service.

This station contains two centrifugal pumps of De Laval make, rated at 300 imperial gallons per minute each. These are driven by two Canadian Westinghouse 550 volt, three phase, 25 cycle induction motors of 20 h. p. at 1450 revolutions per minute. The pumps serve to raise the head of the water supply by 100 ft. The motors are provided with oil circuit breakers provided with plain overload release in series, with starting contactors controlled from the main pumping station. Two control wires and three wires for the Bristol long distance pressure gauge are carried on an overhead pole line to the main pumping station, and the station is thus operated without the employment of attendants

Pumpage

The pumpage varies between wide limits, a variation of between 1,000,000 and 8½ million gallons per 24 hours being observed between the winter and summer months.

Personnel

The waterworks is managed by F. W. Frank, manager under the board of commissioners. The waterworks staff is composed of D. L. Webster, chief engineer; Geo. Drury, resident engineer, and the operating staff. The staff are on eight hour shifts, one fireman and an engineer being on duty during each shift. The cleaning out of the galleries requires the services of an additional man from time to time. Five men are employed in the repair shops and on the repair gang.

ANNOUNCEMENT

Wm. B. Scaiffe & Sons Company, of Pittsburgh, announces the opening on July 1st of a Chicago sales and engineering office at 38 South Dearborn Street, with Charles F. O'Hagan, formerly chief engineer of the company at Pittsburgh, as resident engineer and manager.

This company is the oldest manufacturing concern west of the Allegheny Mountains. During the more than one hundred years since their business was founded they have from time to time as conditions arose added to their manufacturing facilities. They now manufacture black or galvanized, riveted, brazed or welded steel tanks for air, gas and liquids, steel shipping drums, range boilers, steel structures, also the well-known We-Fu-Go and Scaiffe water softeners and filtering equipment.

The Betson Plastic Fire Brick Co., Inc., was organized on May 17, 1919, and Frank J. Jewell was elected president and secretary and Nelson Adams, vice-president and treasurer, thereof. This corporation has been organized for the purpose of selling and marketing Betson Plastic Fire Brick and Betson Hi-Heat Cement.

SPECIFICATIONS FOR BOILER FEED REGULATION

An eight-page bulletin, embodying specifications for the Copes system of boiler feed regulation has just been published by the Northern Equipment Co., Erie, Pa. Size 8½ x 11—convenient for filing. A cover is provided with punched holes for adding future bulletins or specifications that will be published by the company.

The bulletin discusses the following points: principle of operation; heat storage; reduction of furnace temperature fluctuations and sudden load change; service performance; constant characteristic; thermostat; control valve; standard dimensions and drilling, and the Copes Steam Pump Governor. The last page is devoted to a review of the company, the history of boiler feed regulation and the service rendered by the manufacturers.

Boiler Room of the Sheet Metal Products Co., Ltd.

A Power Plant Generating Steam for Factory Use and for Power Generation Which is Operated at a High State of Efficiency—Good Operating Results Have Been Obtained From the Apparatus Installed

By W. F. SUTHERLAND

THE isolated plant, when economically operated, is well able to compete with central station energy where steam is required for plant processes or for heating. This fact is well illustrated in the power plant of the Sheet Metal Products, Ltd., Toronto, where tests have been made at various times by central station engineers to determine the feasibility of purchasing power from outside sources.

The accompanying article is descriptive only of the boiler-room, the engine-room and its equipment being overhauled at the present time and an additional engine-driven unit installed. It is hoped at a later date to give a further description of the whole plant and to present some figures giving operating economics, etc.

Boiler Room

Three Erie City boilers are installed. These boilers are of the vertical water tube type and are rated at 316 b.h.p. each. They were made by the John Inglis Co. and were installed in April, 1916, the fires being started on August 2 of the same year. Each boiler has a total of 3,160 sq. ft. heating surface, and the boilers are fitted with McDonough feed-water and damper regulators. A pressure of 140 lbs. gauge is carried.

Two of the boilers are arranged in a double setting, the third one being isolated. Detroit stokers are installed on all three boilers and the accompanying illustrations give a good idea of the general arrangement of the plant, together with the constructional features of the boiler settings and stoker design. Fig. 1 shows the stokers in the foreground with the overhead track and coal car for coal handling. The coal is lifted from the covered storage pile outside by means of a bucket conveyor and discharged into the bunker at the top left hand corner of the illustration; from this it is fed into the bottom dump car, seen over the far stoker. The steam header is also visible in this illustration, and the Lunkenheimer automatic non-return stop valves on each boiler are also clearly seen.

FIG. 1—GENERAL VIEW OF BOILER ROOM SHOWING STOKER, HOPPERS, ETC.

Fig. 2 shows two of the three stokers with the driving mechanism and control. Ashes and any crushed clinker fall into the pits below, from whence they are removed as required. Natural draft is used and draft gauges are provided.

Fig. 3 shows an interior view of one of the stokers. At the time the picture was taken ashes were present on the right hand side of the inclined grates and on the clinker crusher at the bottom. One of the most interesting features of this installation is the excellent condition in which the firebrick furnace linings and boiler baffling are found. During the whole time, three years, in which the plant has been operating, only one brick has had to be replaced, and that a tuyre brick over the grates on the left hand side of the illustration. The firebrick, of Savage make, are as good to-day as when they were originally installed.

Fig. 4 shows a view taken in the combustion chamber in the opposite direction to that shown in Fig. 3. This view shows the boiler tubes, the firebrick lining and the boiler baffling, visible between two tubes in the centre of the illustration. The excellent condition of the baffling and brickwork is clearly visible.

The boiler settings are provided with Diamond soot blowers, blown-down columns, and are covered with Statite plastic boiler covering.

The excellent condition in which the boilers are maintained is largely due to the monthly cleaning down which they undergo and to the thorough overhauling which is given them at the time of their inspection once a year.

Very little scale is formed in the boil-

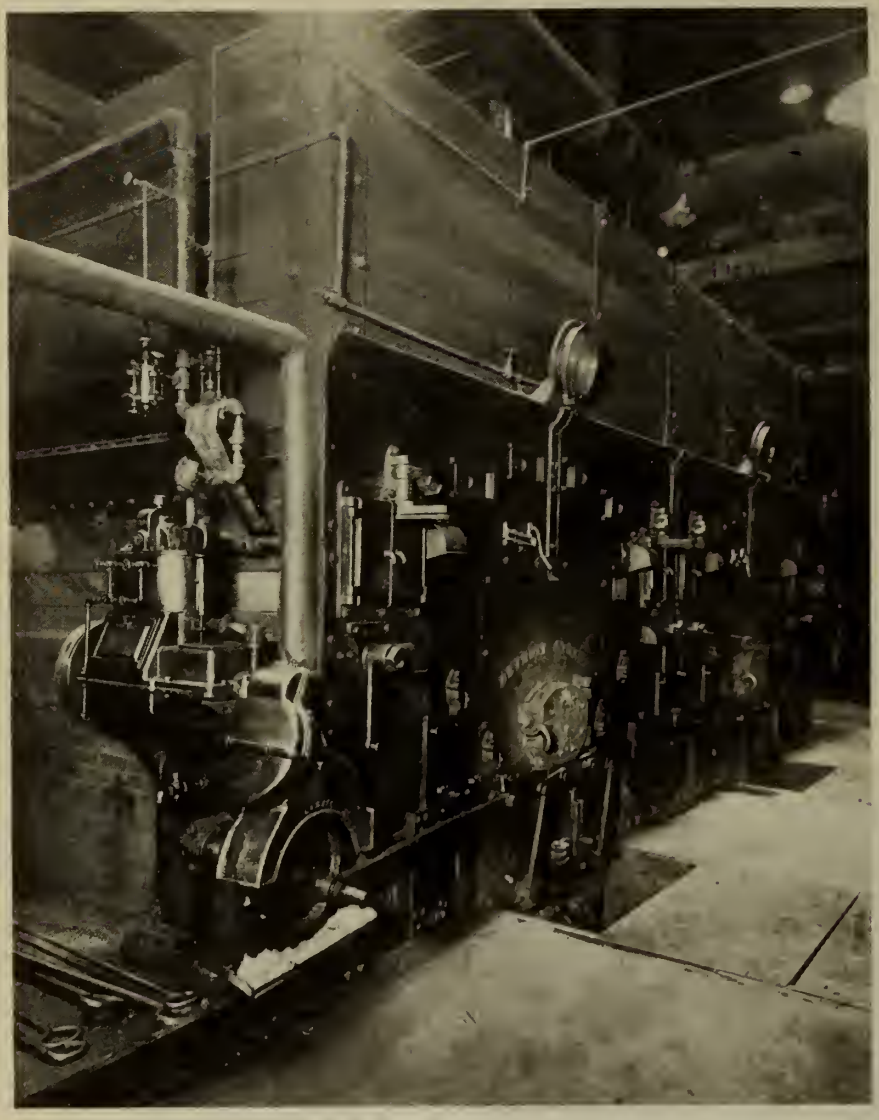


FIG. 2—PARTIAL VIEW OF DETROIT STOKER INSTALLATION.

ers, about one-sixteenth being the greatest amount ever found. No tube cleaners are needed for its removal, as it comes away easily. The feedwater in large measure accounts for this freedom from scale, as it almost entirely consists of condensate from the exhaust lines, together with a little make-up water.

The boilers, when the engine-room is again in operation, will feed two 400 h.p. cross compound engines of McIntosh and Seymour make, and one 100 h.p. vertical high speed engine made by Reavel, Ipswich, England. This latter drives a direct connected d.c. generator for plant lighting, etc. The two larger units are also direct connected to d.c. generators supplying the factory power requirements.

In addition to feeding the engines the boilers also supply steam to the enamelling room furnaces, a 2½ in. line being run. A 3 in. line is also run to the remainder of the factory and supplies whatever steam is needed for general purposes.

Exhaust steam is used for kilns, driers and the usual shop heating requirements. All exhaust from the engines is taken through an oil separator of special design, and from this enters an exhaust manifold from which all lines are piped. Live steam is used when the engines are shut down, and for this purpose a live steam connection is made to the exhaust manifold through a Keely reducing valve, balanced up to one lb.

All condensation from the exhaust lines, heating mains, plant returns, etc., is taken to one central point in the boiler-room. Each separate line is fitted with a two-way header, provided with valves and discharging into either one of two manifolds. One of these manifolds delivers condensate to a Blake and Knowles vacuum pump, which discharges into the Hoppes feed-water heater. The other manifold discharges directly into the heater. Both of these manifolds are provided with valves, and it is thus possible to operate the return system as a gravity return system or a vacuum system.

Bawden and Goldie and McCulloch Co. outside packed plunger type feed pumps are provided and are equipped with Richardson-Phoenix lubricators.

Between the feed pumps and the feedwater heater a hot water reservoir or tank is installed for the evening up of any fluctuations in the return of condensate. This reservoir is fitted with a by-pass, so that it may be cut out at any time for cleaning or inspection.

All steam piping, both exhaust and live steam, is lagged with insulation provided by the Armstrong Cork and Insulation Co.

Remember our remarkable offer of one dollar per year for POWER HOUSE. Now is your opportunity to secure this paper for any number of years at that rate. Apprentices especially should take advantage of this offer.

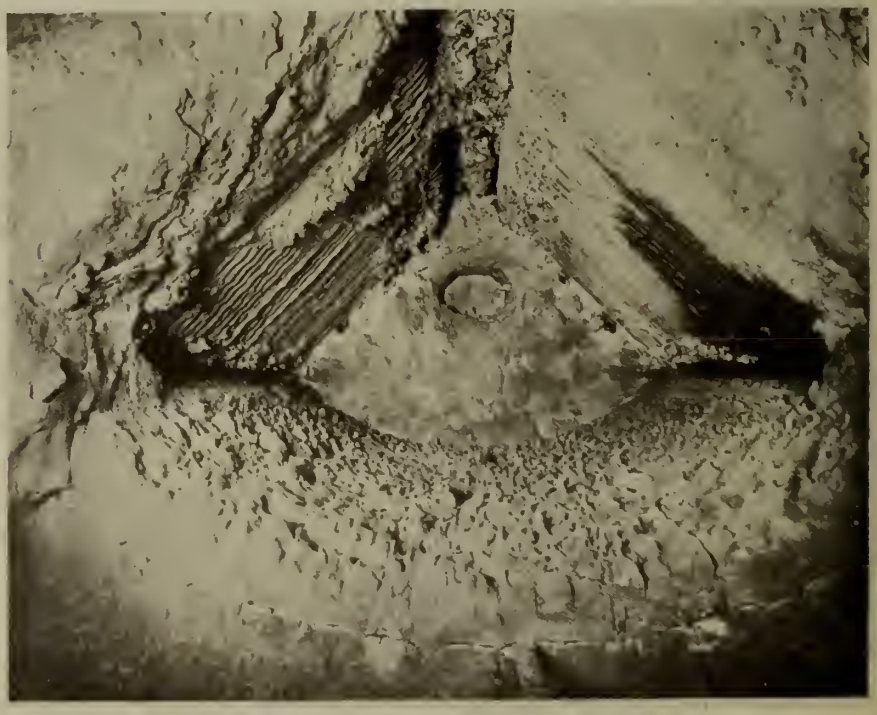


FIG. 3—INTERIOR VIEW OF FURNACE LOOKING TOWARD STOKER. THE BRICKWORK HAS BEEN IN USE FOR THREE YEARS.

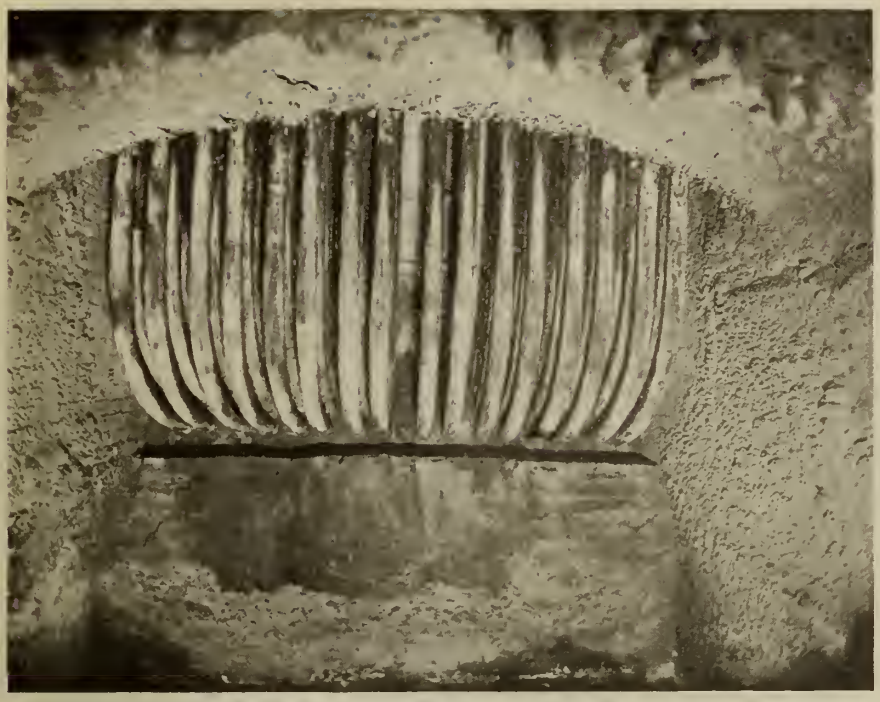


FIG. 4—INTERIOR OF COMBUSTION CHAMBER. NOTE THE EXCELLENT CONDITION OF THE BAFFLING AND BRICKWORK.

GASIFYING COAL COMPLETELY

In view of the atmosphere of controversy which at present surrounds the problem of carbonization, and particularly the future methods to be employed, it is interesting to refer to endeavors which are being made in the direction of the complete gasification of coal and coke in one operation. It is generally known that if a ton of coal is treated in special plant for the purpose it may, apart from the ash it contains, be converted entirely into gas, of which product it will yield some 65,000 cu. ft., saving a calorific power of about 375 B.Th.U. The "Double-Gas" plant for this purpose is the invention of an Englishman, and particulars are now to hand of a plant which is being employed for the same purpose in Germany, and which is made by the well-known Dellwik Water-Gas Company of Frankfort.

The plant possesses some novel features, but consists in the main of a producer, the lower portion of which is divided into two halves by a certain wall. Coal is fed into the upper portion and is converted into coke before reaching the divided chamber. The process is very similar to that employed with the ordinary type of water gas plant, in that air and gas are admitted during intermittent periods; but in this case a superheated supply of air is utilized, and by this means the fuel in the coke chambers is raised to a temperature of 1,400 deg. C., the producer gas being taken off at a point which corresponds with the zone where the coal is completely changed into coke. During the gas making period a gas outlet is opened above the coal bed, superheated steam is admitted to the base of the producer, and the water gas thus produced rises through the coke and passes upwards through the entire column of coal. This water gas at the time of its formation is at a temperature of some 1,300 deg. C., and provides the greater part of the heat for the carbonization of the coal, the gases from which are swept from the producer and carried through subsequent plant of the ordinary type for the removal of sulphuretted hydrogen, tar, and ammonia. Condensation is largely effected in the upper layers of the coal bed so that the gas leaves the producer outlet at a temperature of only some 200 deg. C. The producer gas yielded during the blowing period is not wasted, but is utilized for superheating the steam for gas-making.

The duration of the intermittent periods of blowing and gas-making varies in accordance with the class of coal employed, but generally speaking the "blow" continues for from one to three minutes, while gas-making may be carried on for from five to ten minutes, and it is found that by employing an excess of steam a maximum of ammonia is obtained. An unsatisfactory feature of the process, a feature which is absent from the English system, is the necessity for admitting a certain quantity of air during gas-making. It is said that the quantity of heat demanded for the coking of coal is greater than that which can be supplied from the stream of water gas, and hence the necessity for introducing air; but it seems that by modifications in the working it is possible to produce a gas of moderately high calorific power or one of lower quality. When a comparatively good coal is employed the final mixture of gases obtained contains 50 per cent. of hydrogen, 10 per cent. of methane, 30 per cent. of carbon monoxide, and 1 per cent. of unsaturated hydrocarbons. The calculated calorific power of such gas is 384 B.Th.U. per cu. ft. and in this respect it corresponds very closely with the suggestions recently put forward for the provision of a low grade gas by Mr. George Helps, of Nuneaton.

Mr. R. E. Wright, of the R.D.V. Lodge, C.A.S.E., of Drumheller, Alberta, writes: "We will do our best to make this district 100 per cent. strong with POWER HOUSE and help to maintain and advance the magazine, which we all feel is second to none in America."

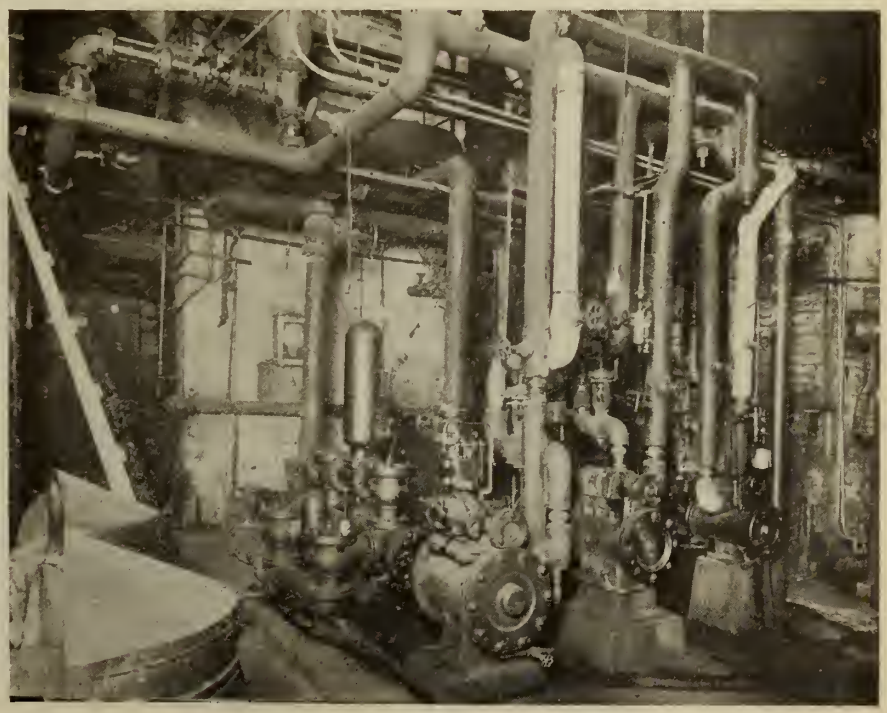
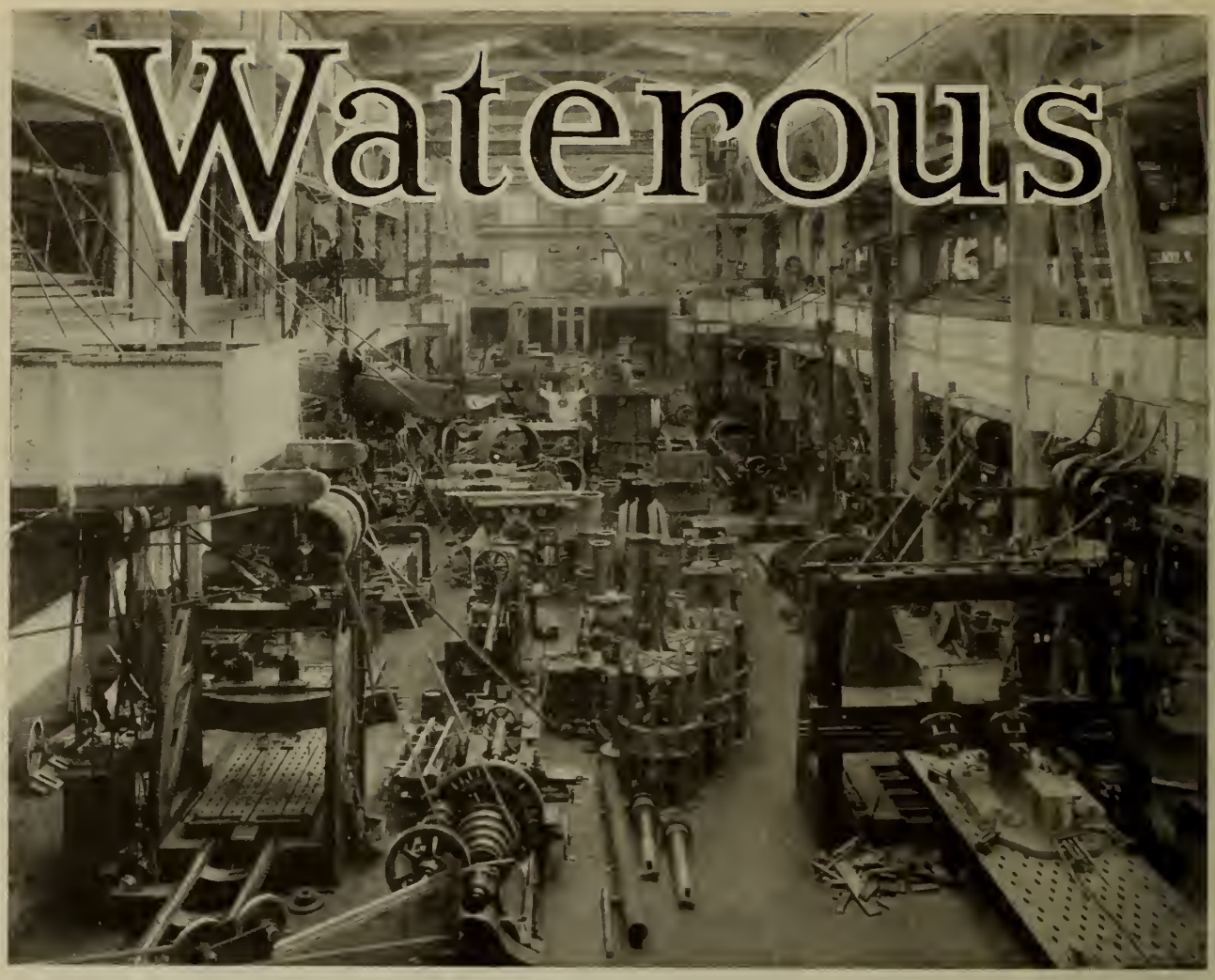


FIG. 5—FEED AND CONDENSATE PUMPS. THE FEEDWATER HEATER WILL BE NOTICED TO THE REAR ABOVE THE PUMPS.

Waterous



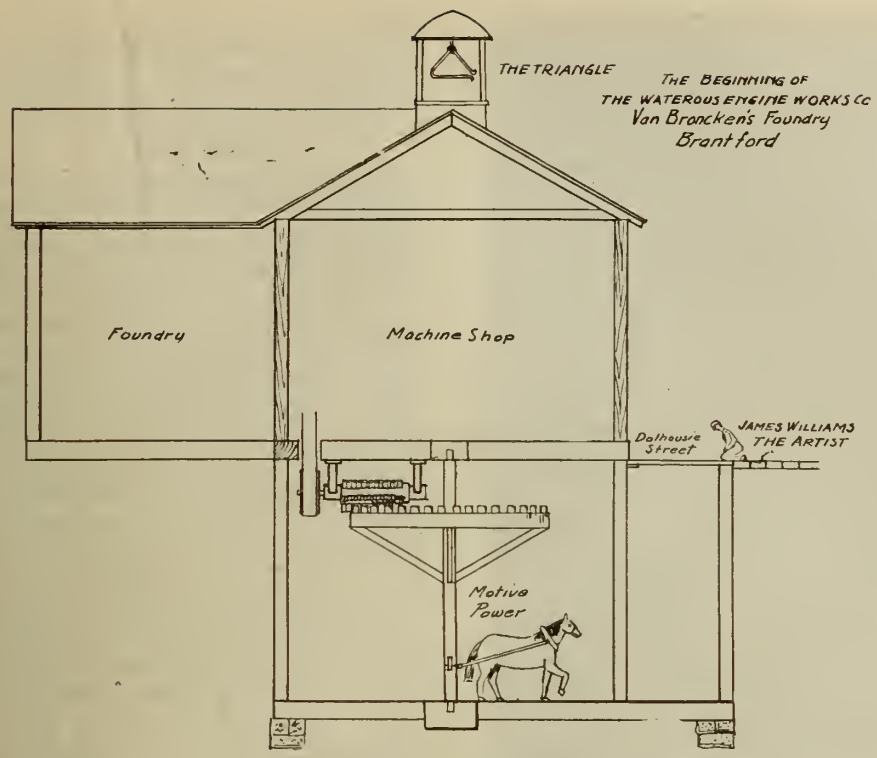
THE Waterous Engine Works Company, of Brantford, Ont., enjoys the reputation of being one of the oldest industrial firms in Canada. Seventy-five years is more than the span of man's life, and while the founders of the original business have long since left the sphere of their earthly activities the business which they established remains a monument to the business ability and integrity of both the founders and their present successors.

The busines was started in 1844 by P. C. Von Brocklin, under the name of P. C. Van Brocklin & Co. The scene of operations was a small building on Dalhousie Street, present-day inhabitants knowing of it in the form of a livery establishment. Conditions under which the plant was operated seem primitive in the light of modern conditions, yet the very source of power by which the work was then done is to-day a source of much interest and pride to the management. In 1848, when the late Charles H. Waterous became interested in the business, the motive power for driving the machinery in the little engine shop amounted to one horsepower nominal, brake and indicated, and was developed by a single specimen of man's best friend, which, with traditional faithfulness, journeyed round the cellar floor from morning till night. One of our illustrations shows the means whereby Dobbin carried on his share of the foundry's early operation. The artist from whose sketch the engraving has been made, drew it from memory, and has represented himself as looking through a grating on street level at the equine motive power.

A LARGE FLY WHEEL ON THE BORING MILL.

In 1854 the business was reorganized under the name of C. H. Waterous & Co., and in 1874 it was incorporated under Dominion Charter under the name of Waterous Engine Works Co., Ltd.

From its inception the business was successful and prospering, and grew, requiring from time to time successive additions. In the early days the industry devoted its attention to the production of miscellaneous articles castings, stoves, boilers, and general work.



THE ORIGINAL MOTIVE POWER USED

These lines were in time replaced by agricultural engines and general boiler work, power plant equipment, sawmill machinery, pulpmill machinery, fire apparatus and road-making machinery.

The power plant equipment manufactured by this firm includes high-speed engines, heavy duty mill engines, portable and stationary engines, boilers of all types, return, tubular, vertical, locomotive, and marine. Accessories such as pumps, injectors, air compressors, condensors and coal handling plant are also made.

The production of sawmill equipment has advanced in keeping with the development of Canadian forest wealth. From the time the timber logs are drawn from the river down which they have been floated from the lumber camp until they leave the sawmill in the form of rough-dressed lumber, the material is seldom out of touch with some item of equipment of Waterous manufacture. Log handling apparatus, feed carriages, large and small sawmills, band mills, etc., may be mentioned as giving some idea of the scope of this item of manufacture.

The great growth of the paper industry in recent years afforded an allied field in which the company's experience stood it in good stead. Complete pulping machinery, barkers, grinders, beating engines, screens, disintegrators and accessory equipment indicate the scope for mechanical equipment offered in this industry.

With the coming of the automobile, good roads have become a necessity, and Waterous products have more than kept pace with the requirements of the good roads movement. Starting with the rough rock and passing over crushers, screens, conveying apparatus and graders, the culmination of roadmaking plant is reached in the steam road roller.

The adoption of motor fire apparatus by city fire departments created a considerable demand for equipment of this type. Steam fire engines, self-propelled apparatus, and horse drawn sets with gasoline pumps, are some of the products of this department, together with hose waggons, reels and hook and ladder trucks.

Modern Plant Development

In 1895 it was found necessary to erect an entirely new plant on a new site as the old plant in the centre of the city of Brantford had outgrown the business and there was no further room for extension. The new site, consisting of nearly thirty acres of land, was secured within the city limits, and upon this was erected a number of modern buildings, suited to the class of work that the company was turning out.

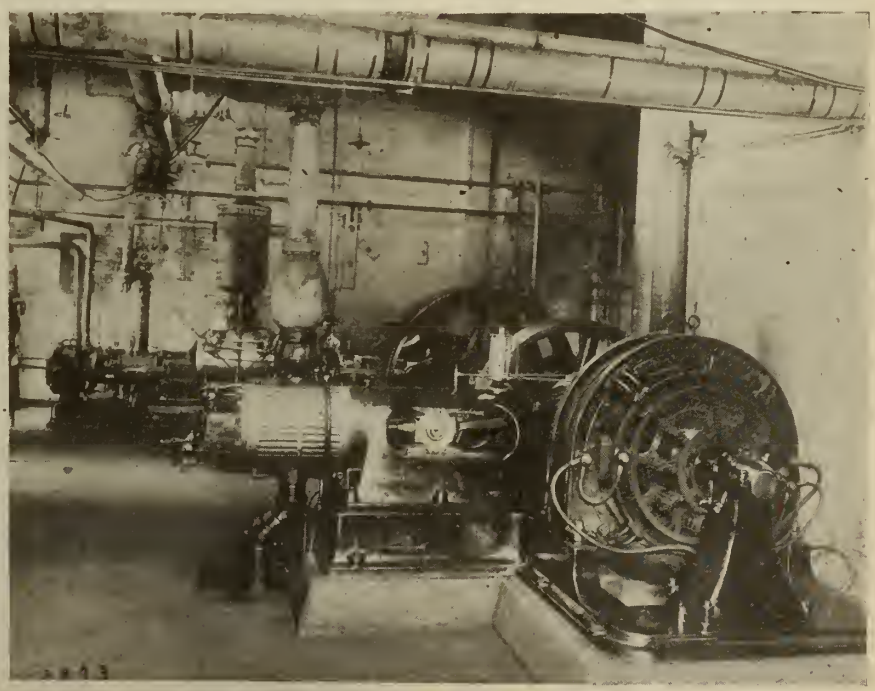
Since 1895 a very large growth has taken place in the business, and very considerable extensions and additions have been made to the original plant as laid down.

In 1912 a new foundry was built—this is a thoroughly up-to-date all steel building of very heavy construction. It is 243 ft. long by 114 ft. wide. It has one centre bay of 50 ft. span and two side bays. The centre and one side bay are served with overhead cranes. The other side bay has above it a reinforced concrete gallery, upon which is stored all the various sands used and the sand-mixing apparatus. Also upon this is located the charging floor for the cupolas and also the brass castings department.

Below the gallery is located the core making department, consisting of three large up-to-date core ovens and all modern core making equipment. The capacity of this foundry, in heavy and light castings, is in the neighborhood of 30 to 35 tons per day.

Outside of the foundry the steel work of the centre bay is extended for 150 ft. This is arranged so that the main crane can run out on this crane way, and under it is stored flasks and other equipment used in the production of the castings.

The main machine and erecting departments occupy a building 300 ft. long by 120 ft. wide, made up of one centre bay with overhead traveling crane and two side bays with galleries above. The heavy erecting and machine work is done under the centre bay. Lighter machine work and erecting is done under the side



WATEROUS ENGINE WORKS; ENGINE ROOM

BOILER ROOM, WATEROUS ENGINE WORKS

bays and on the side galleries. One gallery is devoted to a pattern and millwrighting department.

In addition to this shop there is also another machine shop for small machine work. This is 180 ft. long by 8 ft. wide.

As the lines manufactured by this company are very extensive the patterns required for the production of castings are numerous and a very large three-storey pattern storage department is provided. This building is 42 ft. wide by 209 ft. long.

The plant is equipped with its own smithy department, which is located in a building 100 ft. long by 50 ft. wide. This building is equipped with heavy steam hammers, bulldozers, hand forges, and all other necessary appliances for the production of a large variety of heavy and light forgings.

The boiler department is located in a building 300 ft. long by 79 ft. wide. This building has one large overhead crane and one side bay. The side bay being devoted to machine work and light sheet iron and boiler work, the centre bay being reserved for heavy machine work and for the erecting of all boilers. The equipment in this shop is of the very latest, consisting of two hydraulic riveters, one of 50-ton capacity and one of 150-ton capacity, both served with overhead cranes. Heavy and light bending rolls, heavy sectional hydraulic flanging press, and all necessary equipment for the turning out of sheet iron work, light and heavy stationary boilers and light and heavy marine boilers. The main bay crane way is extended some 200 ft. outside of the building. Under this is stored plate and other material supplies used in the boiler shop, and the shop is so arranged that the main crane may be run out on this runway for the purpose of picking up such material as may be required from time to time.

Power Plant

Making boilers, engines and other power plant equipment, this firm might naturally be expected to develop its own energy whether mechanical or electrical. The boiler room contains a battery of six Waterous return tubular boilers, three of them being 78 by 16 ft., and the remainder 72 in. by 16 ft. These give a total of 800 boiler horsepower and carry a steam pressure of 115 pounds. The feed water is heated by a 1,000 h.p. Webster open feed-water heater.

The main shop drive is by belt from a Rigeway type Corliss engine manufactured by the Waterous Company, and having an indicated horsepower of 250 at 235 revs. per min. This engine has a cylinder of 19 in. dia. by 18 in. stroke. A high-speed McEwen 16 by 16 in. engine, also of Waterous make, is installed, and develops 210 horsepower, driving a Ridgeway direct current generator of 125 kw., 225 v. rating.

Hydraulic power is obtained from a duplex steam-driven plunger pump and pneumatic power from two air compressors, one Blaisdell 18 by 12 by 12, and one Franklin 18 by 14 by 14.

Steam Engine Products

The varied requirements and frequently strenuous conditions under which prime movers are operated in the pioneer districts of Canada, are in some measure responsible for the different types of engines built by this company.

Steam engines are built suitable for the rough usage of the lumber camp and on the other hand the highest type of engine for electric generator connection, factory and mill driving, where economy and regularity of operation are the chief desiderata, is found in products of the Waterous Company.

The former type is exemplified in the

SCOTCH MARINE BOILERS IN THE BOILER SHOP

centre crank engine of general and heavy duty types in which power, durability and simplicity are outstanding features. This design is characterized by the use of a Corliss type of steam valve located under the cylinder and operated by a single eccentric on the crank shaft. A perfectly balanced valve is obtained, which, along with the short travel and large bearing surfaces insures a high degree of reliability and long life.

McEwen Engines

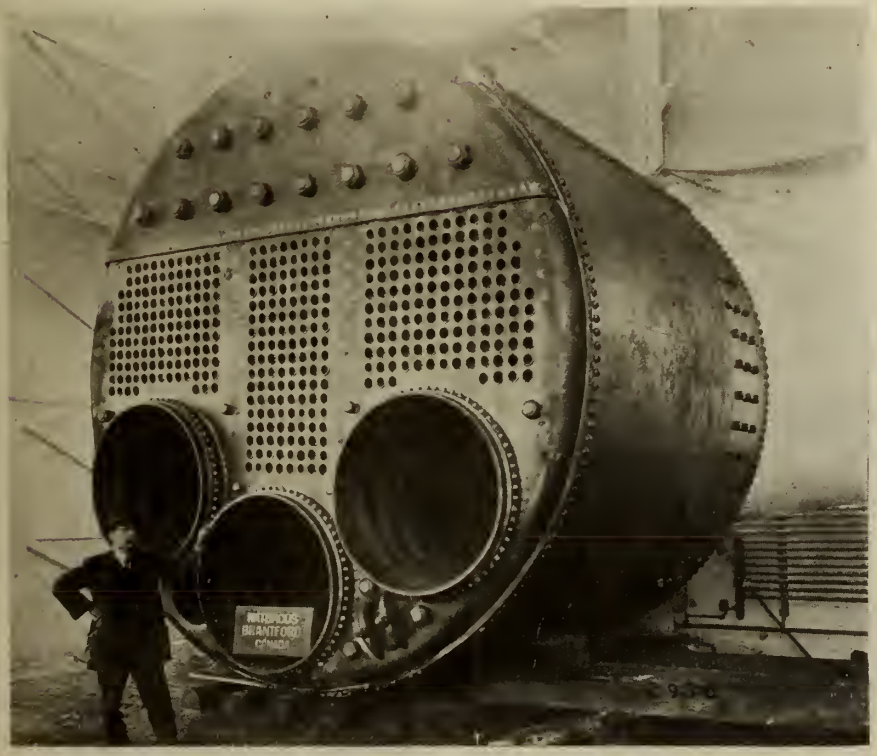
More than twenty years ago the McEwen engine was placed on the market by the Waterous Co., and an enviable record has been built up around this type of prime mover. It is a high-speed automatic engine specially designed for close governing under excessive load fluctuations, such as electric service of all descriptions, mine haulage, crane work, etc. The engine bed is of heavy construction, with the sides open for the purpose of adjusting cross-head shoes and wrist pin boxes. Guides, main bearings and end of bed are machined at one setting to insure accuracy. A feature of the main bearing design is the arrangement of the babbitt liners, which may be removed by simply relieving them of the weight of the shaft, thus obviating the necessity of removing armatures of direct connected units before removing bearing liners.

A swivelling eccentric adjustment is provided for the cross-head shoes, which assures a full bearing on the guides and allows adjustment to be made by simply loosening a single nut and turning a bolt to draw in or force out the shoe as required. Accurately balanced discs are fitted to the crank shaft, which is a single-piece forging.

The remarkable regulation for which these engines are noted is obtained through a simple form of quick-acting governor of the flywheel inertia bar type. Governing limits of one revolution are obtained, the instantaneous variation in speed when full load is thrown on or off being seldom more than 1 per cent.

EXCELLENT TRANSPORTATION FACILITIES ARE PROVIDED.

In the building up of an industry connected at their source with so many lines of industry, experience is necessary, and this is reflected in the personnel of the company. When C. H. Waterous died a few years ago the responsibility of the work rested upon his son, C. H. Jr., who, along with the other members of the firm directs the activities of the company, the officers being: President and general manager, C. H. Waterous; assistant general manager, C. A. Waterous; secretary, D. J. Waterous; sales manager and director, L. M. Waterous; treasurer, W. T. Mair.



MARINE BOILER FOR SEA GOING TUGS FOR THE AMERICAN GOVERNMENT.

PRESERVATION OF WOOD

Seven years' experience has proved zinc fluoride as a preservative of wooden poles. It compares favorably with copper sulphate. When complete impregnation of the wood is unnecessary, a partial application of sodium fluoride will be found to exhibit great preservative action.

INTERNAL COMBUSTION ENGINES

The great superiority of the Diesel engine is almost wholly obtained by the high compression which it is possible to give to the air before admission and ignition of the fuel oil to the cylinders. Compression is the chief characteristic of the internal combustion engine and is the essential foundation of all heat engine cycles. The Carnet cycle is the ideal one owing to its perfect efficiency, but cannot be strictly adhered to in practice, since the engine becomes too bulky and heavy even for small powers. The weight of an engine of this type when working under the maximum pressure obtaining in the modern Diesel at about 17 tons per brake horse-power, whereas the modern engine only weighs at least one-hundredth of this figure. The original Diesel engine was intended to work on the ideal cycle, although somewhat different from the ideal is still the nearest approach to it and hence its high state of perfection.

Hydraulic Plant of Watson's Limited

A Hydraulic Plant at Brantford, Ont., Which Utilizes Water From the Grand River for the Supplying of Power to a Textile Mill—Water Softening Plant Also a Feature of This Installation

MANY of the rivers of Western Ontario furnish sufficient water power to supply at least some of the requirements of the manufacturing industries in the nearby towns and cities. The Grand River is an excellent example of this fact, for while the head obtainable at any one point is nowhere very great and while its flow is subject to wide seasonal fluctuations, considerable power is developed along its course.

The Watson Mfg. Co. of Brantford, together with the Slingsby mills nearby, obtain much of their power from a hydraulic canal which takes its water from the Grand River at Wilke's dam. The raceway gives a head of about 15 ft. The hydraulic plant of the Watson Mfg. Co., supplies power to the various motors in the mill which run the textile machinery required in the making of Watson's underwear. Two 48 in. Stillwell water wheels of the vertical type are installed and drive a horizontal shaft of 6 in. diameter through crown gears. One turbine only is used at present, the other being held in reserve and providing for future requirements. A Woodward governor is used for regulating the speed.

The generator is of Canadian General Electric make, type ATB, and is driven at 200 revolutions per minute. At full load it has a capacity of 241 amps at 600 volts. An exciter forms part of the generator, but owing to the extreme vibration of the generator shaft, caused by the crown gears, its use has been discontinued and a separate exciter used. This machine, driven by a small countershaft, has a capacity of 140 amps. at 125 volts and serves not only to excite the a. c. generator, but is also used for lighting and for the preparation of bleaching solution.

The bleaching solution is prepared in a small electrolytic tank. Salt or sodium chloride is added to the water and the electric current liberates the chlorine which goes into solution. This bleaching solution is used in the preparation of the various fabrics which enter into the manufacture of the underwear.

Switchboard

A two panel board serves to control the generator and also makes provision for the use of Hydro-Electric power when necessary. The usual exciter switches and field switches are mounted on the generator panel, and a double throw oil switch throws either the generator or Hydro-Electric energy onto the busses. This panel is provided with three generator ammeters, three ammeters for Hydro, and two voltmeters. A recording steam pressure gauge is also fitted.

Fire Pumps

A Rodney Hunt rotary fire pump, manufactured in Orange, Mass., is driven off the main shaft by means of a friction clutch and Morse chains. This pump is driven at 275 revolutions per minute, and is capable of furnishing four 1 1-8 in. streams at 90 lbs. pressure. The details of the chain drive for this pump may be seen in one of the accompanying illustrations.

The generator room is well lighted and its well-kept appearance, together with the attractive foliage plants, reflect credit on the engineer, Thomas Hurst.

The mill is driven by fourteen motors which drive separate line shafts. Three Otis freight elevators are installed.

Steam Equipmemnt

A 125 horsepower horizontal return tubular boiler supplies the mill with the steam used in the dye-house, for washing and other purposes. This boiler is fitted with rear end Diamond soot blowers and a surface blow off. A Sims closed feed water heater is also installed and Bundy traps return the condensate from the heating system, dryers, etc.

A 45 I.H.P. Wheelock engine is used as a reserve supply of power.

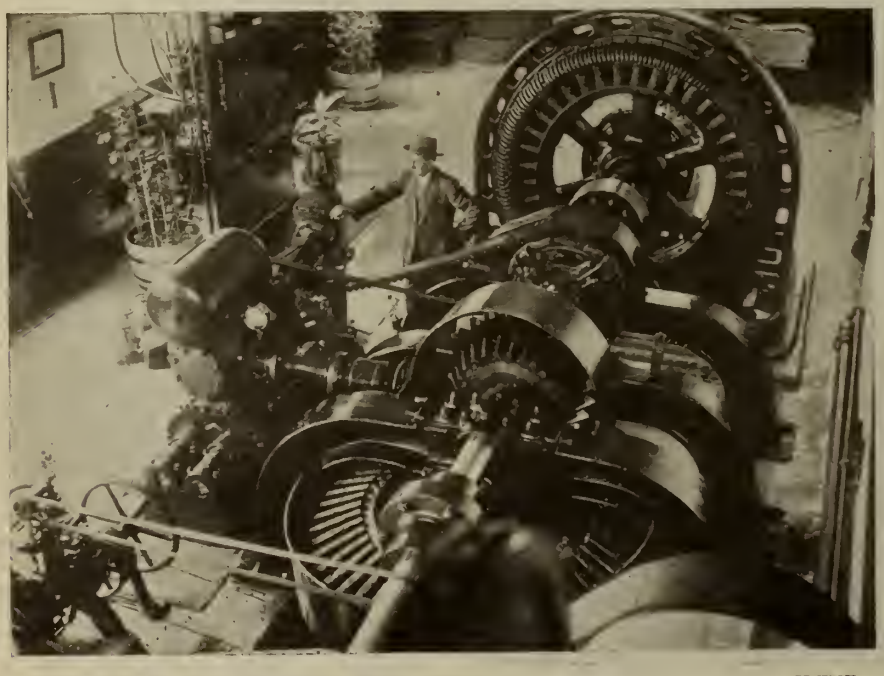
At one time the mill was fitted with two Lancashire boilers. One of these was replaced with the horizontal return tubular boiler, and the other is now used for heating purposes.

Water Softening Plant

While not strictly a part of the power plant equipment a water-softening plant is one of the interesting features of this mill. All the water used for textile purposes in the mill is treated, as it is essential that it be of high purity and as soft as possible. The treated water is also used for all other plant purposes except for the drinking water, and makes an admirable supply for boiler feeding.

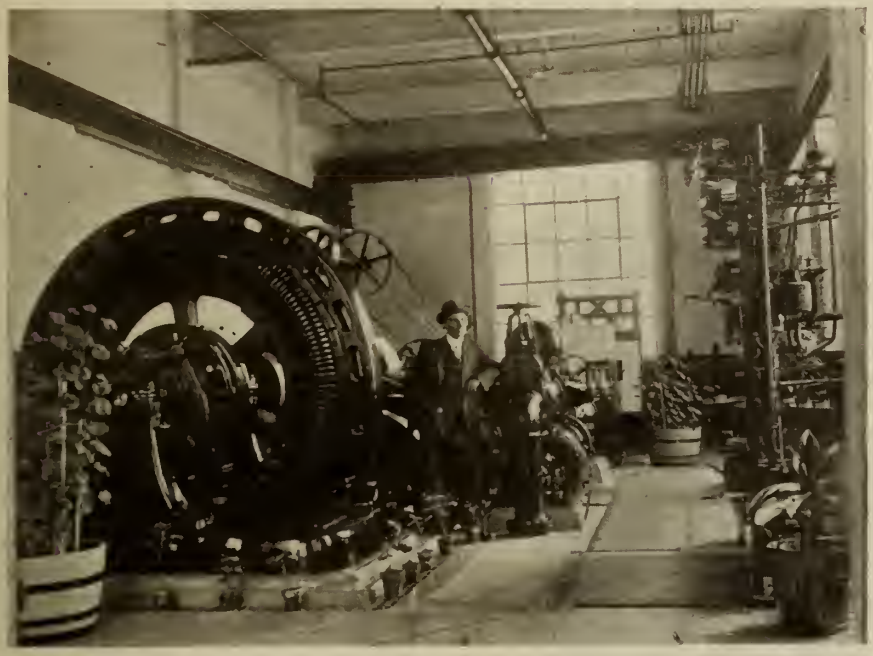
The water-softener and purifier was installed by the International Water Softener and Filter Co., Chicago, and has a capacity of 80,000 Imperial gallons in 24 hours. The water is first treated with alum for the coagulation of organic matter and to facilitate its removal, and is pumped into a settling tank. This tank is 17 ft. in diameter and is 20 ft. high. The entering water and also a mixture of lime and soda enter this tank through an inner chamber, which extends to the bottom of the settling tank, and which has alternate staves cut away for about two feet at the bottom. The entering water and the lime and soda solution thus flow to the bottom of the tank and out through these openings.

In the bottom of the settling tank is a series of pipes having numerous elbows opening downwards; these serve to pick up all sediment and mud and discharge it to waste through a sluice valve manually operated.



WATSON MFG. CO., SHOWING CROWN GEARS TO TURBINE SHAFT AND SILENT CHAIN DRIVE TO FIRE PUMP.

The now softened water passes from this tank to a smaller filtering tank, where it is filtered through sand and is made clear and sparkling.



GENERATOR ROOM, WATSON'S, LTD.

The chemicals used are mixed in a mixing tank, which automatically supplies the proper amount to the settling tank.

FUEL OIL AND ITS APPLICATION

By M. M.

Apart from its superiority to coal for marine propulsion the use of oil on railways is advantageous in countries which are not favorably situated in respect of coal supply. A typical instance is that of the Mexican railway, where conversion from coal to oil has resulted in reductions of 32 per cent. in the weight of fuel consumed per train kilometre and of 40 per cent. in the cost of fuel. The oil can be handed from tank cars to storage tanks, and thence to locomotives for about 0.03 cents per ton, while the average cost of handling coal is about 5 cents. The wastage in handling, between shipment and consumption, (estimated at 8 per cent. to 10 per cent. with coal), is eliminated. No men are required to load upon the engine or clean out ashpans, there are no ashpits to empty, or ashes to be loaded up or hauled away.

In the comparative tests carried out by the Tehuantepec National Railway, the following information was obtained:

The gross weight of train being approximately 500 tons, time getting 180 lb. steam from coal, 150 mins; time getting 180 lbs. steam from oil, 70 mins.; improved speed with oil over coal (average) 16.2 per cent.; improved evaporation per lb. fuel, 5.62 lb. or 90 per cent.; pounds of coal per 100 ton miles, 20.8; pounds of oil per 100 ton miles, 10.3.

The grades on this railway vary from level to 2.15 per cent., with many curves up to 11.5 degrees, where the train's speed is limited to 15 miles per hour.

The output of the boilers could be augmented by 30 per cent. to 100 per cent. by substituting oil for coal. Where used as an auxiliary equipment to coal-fired boilers to meet recurring peak loads, its use not only enables the plant to meet sudden and heavy demands, as in the case of electrical power stations, but many obviate the necessity of putting down additional boilers with the growth of the average output of current.

The perfect smokeless combination of oil fuel would prevent or abate the smoke nuisance in closely populated districts.

On a comparative test run at Wallsend Slipway on coal and oil on a Scotch marine multitubular type boiler, the following results were obtained:

Fuel Oil

Specific gravity at 60 degrees, F., 0.953; viscosity at 100 degrees F., (red No. 1), 2,130 secs.; flash point, (close), 160 degrees F., (above); calorific value in b.t.u., 18,430.

Water Evaporated

Pounds of water per lb. of oil, 12.15; lbs. of water per lb. of oil (from and at 212 degrees F.), 14.38; boiler efficiency, 73.37 per cent.

Coal

Calorific value in b.t.u., 14,432.

Water Evaporated

Pounds of water per lb. of coal, 7.76; lbs. of water per lb. of coal (from and at 212 degrees F.), 9.31; boiler efficiency, 62.28 per cent.

Efficiencies as high as 84.8 per cent. have been obtained on Scotch marine type boilers, using Mexican fuel oil, with the pressure system of oil burning.

At a large London factory Lancashire boilers have been converted, and the following comparative figures obtained:

	Fuel Oil	Coal
Calorific value	18,750 b.t.u.	11,451 b.t.u.
Evaporation per lb.	14.44 lb.	7.22 lb.

Do. per sq. ft. heating surface 7 lb., 3.31 lb.

In the United States a large series of actual working temperature tests have shown that with coal the thermal efficiency of boilers varies from 66.6 per cent. to 68.1 per cent., with oil from 80.6 per cent. to 81.5 per cent.

In Great Britain fuel oil is used in industrial furnaces for such processes as billet heating, metal melting, riveting bolt and nut making, and the manufacture of glass bottles. Of the three systems of burners for oil fuel the pressure jet system, in which the atomizing agent is pump pressure and steam temperature, has been developed during the last 10 years to such an extent that it is now recognized as the most economical system for use under land and marine boilers, and is being rapidly developed for locomotive purposes. The oil is drawn from the storage tanks by a steam pump through suction strainers, and delivered through heaters and discharge strainers to the oil fuel burners.

A point which usually appeals to every works manager is the fact that when utilizing coal fuel the size of the furnace is reduced by 30 per cent., and the workings are occupied by a furnace and its adjacent machines is only about 50 per cent. of that of coal fired furnace, where a stack of coal occupies a certain amount of space in front and the ashes another space behind. Another interesting feature is that many metal melting furnaces have either scrapped their coke fired furnaces or converted them to gas or oil.

In the early years of this century a French engineer introduced the subject of oil as an auxiliary. The main advantage of auxiliary firing lies in being able to obtain at will a large increase in the power of boilers. The combustion of the petroleum does not in any way prejudicially affect that of coal; in fact, by the introduction of jets of petroleum the condition and efficiency of combustion are improved by a more complete mixture of the gases. It is, therefore, not correct to consider the evaporative power of coal as identical when passing from ordinary auxiliary firing.

Admitting this as a principle, and supposing the quantity of water evaporated by the coal to be constant, the extra evaporation due to the better mixing of the gases is credited to the petroleum.

In several evaporative trials made on the same boiler of a French navy ship, when coal alone was burnt at the rate of 18.8 lb. per sq. ft. of grate area per hr., the water evaporated per lb. was 9.05 lb. With a mixture of coal and 45 per cent. oil, the corresponding figure was 11,341 lb., with a mixture of the coal and 64 per cent. oil 14.12 lb. In this last test the efficiency of the mixture was higher than when burning petroleum only.

These tests served as a basis for further experiment, about four years ago, by power station engineers. Their theory

was that a poorer class of coal could be used in conjunction with oil fuel. When used alone the inferior coal tended to cake on the links of the chain grate stokers, thereby retarding the necessary quantity of air from being drawn through the bars to complete combustion. The result was a smoldering mass, which travelled slowly along to bars and was dumped into the ashpit as a partly consumed coal. On analysis this ash would probably be found to contain a very high percentage of combustible matter. Therefore a very much higher quantity of coal was burned per hour to maintain, say rated evaporation.

The theory was that when fuel oil was applied the combustible gases arising from the coal fuel bed were quickly ignited, causing the top of this mass to become much more incandescent, and thereby tending to aerate the bottom mass, which would allow sufficient air to be drawn through to complete the combustion of the inferior coal.

Sufficient interest was taken in this theory for a large London power station to give sanction for tests to be carried out under a coal fired Sterling water tube boiler. One burner was introduced into each side of the boiler approximating about 25 per cent from the back of the grate, the burners being opposite each other. The oil was stored in an overhead tank, capable of holding three or four days' supply. It gravitated to the burners, which were of the Kermode steam-jet type, operating with steam as an atomizing agent at a pressure of about 25 lbs. per sq. in.

The first test was carried out on a nutty slack, having a calorific value of 10,400 b.t.u., and a boiler efficiency of 69.25 per cent. was obtained. The temperature of the combustion chamber was 2,648 degrees F., and uptake 660 degrees F.

The final of a series of experimental mixed burning tests was carried out on a mixture of nutty slack, having a calorific value of 10,300 b.t.u., with Mexican fuel oil, having a calorific value of 18,750 b.t.u. A boiler efficiency of 74 per cent. was obtained. The temperature of the combustion chamber was 2,850 deg. Fahr., and uptake 628 deg. Fahr. The proportion of oil to coal on a B.t.u. basis was 8 per cent., and on a weight basis 4.96 per cent. The comparative costs were—with coal only 2.8; with the mixture mentioned, 2.62, showing a monetary saving of 6 per cent.

The tests showed that with oil at a cost of 2½ times the cost of coal, and burning in the aforementioned percentages, a saving is effected which should induce power station engineers to consider adopting this method of firing in the super-power stations of the future.

As an example of the saving effected, the following figures have been given by a well-known firm of bolt and nut makers in the Manchester district:

Gas costs 1s. per 1,000 cu. ft., less 5 per cent.; consumption 450 cu. ft. per hour; temperature in furnace, 1,750 deg.; size of bolts, ⅜ of an inch dia. to ⅝ of an inch dia., calorific value; gas equal 660 B.t.u. per cu. ft.

Comparing with oil on B.t.u. basis for ten hours' working, then

$$\frac{450 \times 10 \times 660}{18{,}750} = 159.5 \text{ lb. oil} = 16.7 \text{ gals.}$$

Cost of gas for 10 hours

$$= \frac{450 \times 10}{1{,}000} = 4\text{s. } 6\text{d. less } 5\% = 51.3\text{d.}$$

Cost of oil at say 2¾d. per gal. $= 16.7 \times 2.75 = 45.9$.

Saving per day by using oil = 5.4d.

Saving per year of 300 days = £6 15s. per furnace.

Figures given in the Manchester district with regard to bolt making:

One furnace feeds two bolt-making machines.

The output of these two machines is four tons per day.

	£	s.	d.
To obtain this output, 1 ton 10 cwt. of coal is used at 12s. per ton	0	18	0
Using oil at 5 gals. per hour (10 hours per day) at 2¾d. per gal. = 1s. 2d. × 10	0	11	8
They have seven furnaces in operation. This means that they pay out for coal in six days per week (12s. per ton coal; one furnace burns 1 ton 10 cwt.) 18s. × 7 × 8	37	16	0
Oil consumption per week of 53 hours at 5 gals. per hour (7 furnaces) 5 × 55 × 7 = 1,925 gals.; 1,925 gals. at 2¾d. per gal. oil	22	1	1
Saving in favor of oil	15	14	10

Comparative tests between coke furnace (Baumann) and oil furnace (Buess).

Tables of Costs for a Production of 300 Tons (Baumann)

	£	s.	d.
Coke consumption, 12.3 per cent., 36 tons 18 cwt. at 30s. per ton	53	7	0
Power 960 hours, at 5s. 6d. per hour	13	6	8
Crucibles, including stands, average life 40 charges for 300 tons, 1,500 charges, 37½ crucibles at 50s. each	93	15	0
Lining four times at 30s.	6	0	0
Wages for furnacemen, 125 days at 8s. 6d. per day	53	2	6
Loss in melting, average percentage of 1.62 per cent., 4 tons 19 cwt.	336	4	0
Total	£555	15	2

Buess

	£	s.	d.
Oil consumption at 9.8 per cent., 29½ tons at 60s.	88	10	0
Power, 1,380 hrs. at 5s. 6d., 8 h.p.	38	6	8
Cost of crucibles, including stand, average life 40 charges per 300 tons, 1,500 charges, 37½ crucibles, at 41s	76	17	6
Cost of lining twice and one cover	5	0	0
Wages of furnacemen (7½ tons cost 18s.), 300 tons	36	0	0
Loss in melting at average percentage 0.3 per cent., 18 cwt. 7½ lbs.	66	0	0
Total	£310	14	2

Saving in Favor of Oil

	£	s.	d.
Baumann	555	15	2
Buess	310	14	2
Total	£245	1	0

PRESSURE ON FOUNDATIONS OF TALL CHIMNEY

It is often necessary to calculate the pressure on the subsoil of the foundation of a chimney stack. Taking a circular steel chimney stack 120 feet high by 9 feet diameter, with a weight of about 27 tons, as an ordinary modern works' chimney, it is interesting to find the total direct load on the foundation, particularly where the chief difficulty is the question of wind pressure. The particular chimney which was taken as an average stands on a brick base 20 feet square by 12 feet high, with a circular hole 9 feet in diameter for the full height of 12 feet, and the flue entrance on one side was about 9 feet high by 8 feet wide.

The total direct load on the foundations will consist of 27 tons for the steel chimney 9 ft. dia. and 120 ft. high; added to 20 ft. by 20 ft. by 12 ft. high for brick base, with 9 ft. hole through it = 4.037 cub. ft. at 112 ft. per cubic ft. — 202 tons; added to 24 ft. by 24 ft. by 3 ft. concrete slab = 1,728 cub. ft. at 144 lb. per cub. ft. = 111 tons; together 27 + 202 + 111 = 340 tons. The wind pressure may be taken as 35 lbs. per sq. ft. acting on the diametrical plane of the chimney and base. The moment of the wind pressure about underside of concrete will be

$$\frac{35 \times 9 \times 120}{2{,}240} \times \left(\frac{120}{2} + 12 + 3 \right) =$$

1,267 ton-ft.

The moment of the wind pressure on the brick base about the underside of the concrete will be

$$\frac{35 \times 20 \times 12}{2{,}240} + \left(\frac{12}{2} + 3 \right) = 32 \text{ ton-ft.}$$

or total amount M — 1267 + 32 = 1,299, say 1,300 ton-ft. To get the distribution of the load over the foundation we have $\frac{W}{A} + \frac{M}{Z}$ where W = direct load.

A = area; M = moment; Z = section modulus of base = 1-6bd². Then

$$\frac{W}{A} + \frac{M}{Z} = \frac{340}{24 \times 24} + \frac{1300}{1\text{-}6 \times 24 \times 24^2} =$$

.591 + .564 = 1.155 tons per sq. ft. maximum compression on soil, which will be on the leeward side; also = .591 — .564 = 0.027 tons per sq. ft. minimum compression of soil, which will be on the windward side.—M.M.

Town of Newmarket Scene of Serious Explosion

Rear Head of Steam Drum in a Babcock & Wilcox Water Tube Boiler Blows Out—Accident Attended With Loss of Life, and Severe Injuries, Besides Considerable Property Damage

By T. H. FENNER, Editor Marine Engineering

ON the morning of June 12, at about 9.30 a.m., an explosion occurred of a drum in a Babcock & Wilcox water-tube boiler, in the wood-working factory of Wm. Cane and Sons, Newmarket, Ontario. The rear drum head ruptured around the flange where it was riveted to the drum, and the escaping steam carried death and destruction in its path.

The boiler room was on the ground level, thus bringing the drums to the level of the floor above. The illustration shows how this section of the building was completely wrecked, the people employed there being blown out on the street, and severely burned, as well as hurt by the fall. Five of the victims have died since, and eight others are making slow progress towards recovery.

The drum head was defective for about three-quarters of its circumference, but the deteriorating effect had not spread to the portion which was normally over the water level. This portion of the head, being of its original tenacity and ductility, opposed sufficient resistance to cause the head to turn upwards as on a hinge, and resulted in it being deflected, when it did shear, to a course directly opposite to the escaping steam. It rose up through the roof, sailed over the boiler room, and landed out in the yard at the back of the building, almost burying itself in the soft sawdust-covered ground.

VIEW OF DRUM SHOWING FRACTURE AND TORN PORTION OF DRUM HEAD AT TOP.

GENERAL VIEW SHOWING HAVOC CREATED

Immediately behind the boiler room were situated the drying kilns where the green lumber was made ready for manufacturing operations. When the explosion took place, some of the escaping steam found its way into the setting, blew the fire doors open, and sent a blast of flame and hot sawdust into the drying kilns, setting them on fire. The two firemen were severely burned by this blast of flame, followed by the steam, and the engineer also received some of it, injuring him severely.

Prompt measures were taken to fight the fire and relieve the sufferings of the injured, but it was several hours before the fire was finally subdued.

The Cause of the Failure

The writer visited the scene of the explosion the morning following the occurrence, and was enabled to make a fairly close examination of the boiler, externally. The boiler was a 14-tube wide by 9 high Babcock & Wilcox water-tube boiler of the ordinary stationary type. Looking from the front it was the left hand drum that suffered, and the rear head. This head contained the manhole opening, and there was also a two-inch pipe entering into the drum, evidently used as a surface blow off.

The steam connections of the boiler consisted of a main stop valve, 6 in. diameter, on the back end, and an auxiliary valve for supplying steam to the dry kilns, etc., on the front, and each drum carried the usual 4-inch safety valve.

As before mentioned, the fractured head showed an area of defective metal extending round the circumference from about 45 deg. above the centre line, one each side. The remaining portion of the metal had preserved its original qualities, as shown by the elongation that took place before it parted. Now, before going any further, it occurs to the mind of the observer to ask this question: What was the particular circumstance that caused the head to break away at that particular moment, and on the other hand, why had it not parted before? It is possible to make deductions without claiming that events were

SHOWING STEAM PIPE PARTED FROM ELBOW AND DEFLECTION OF EQUALIZING PIPE AND FITTING

as deduced, but at least to find a starting point.

It will be seen from the illustration that the equalizing header, on which the 6 in. connection was mounted, has been bent back from the normal position about 20 deg. The 6 in. steam pipe has been drawn clean out of the elbow, the thread in the elbow being torn off about five threads back. A further circumstance is that from the appearance of the brickwork in front of the boiler, the drum did not move in its setting in a longitudinal direction to any great extent. Examining these facts, a possible solution presents itself. The fracture was not continuously through the rivet holes, but followed an irregular line, in some cases leaving a considerable amount of metal around the rivet. Chiefly the line followed the line of rivets.

The fact that the fracture had apparently reached its limit, and that for some time had not made any progress, is indicated by the appearance of the fractured edges. This leads one to think that failing a sudden shock the head might have held indefinitely, the frictional hold of the rivet heads being sufficient to resist the steam pressure. This would be quite feasible in a boiler with the quality of workmanship so evident in the B. & W.

If we accept this hypothesis we must look for the second factor: "What was the nature of the sudden shock?"

Let us turn to the steam pipe again. The elbow faced to the front end of the boiler. The steam escaping from the drum rushed from front to rear. Tracing the causes of the steam pipe and elbow parting company, assume that the head of the drum blew out first. The recoil of the escaping steam would cause the drum to jump forward, pressing the elbow on to the pipe and either bursting the elbow, or shoving the whole length of steam pipe and connections in front of it. Obviously this did not happen. Instead of that, the elbow shows a thread pulled out. In the light of this, would it not be reasonable to think that the pipe pulled out of the elbow before the explosion, and that the sudden escape of steam supplied the necessary shock to cause the final rupture of the head? The writer thinks it would, and offers the suggestion for what it is worth.

VIEW DRUM HEAD SHOWING FRACTURE

The Primary Cause

As to the initial cause of the defect, it is not possible to form an opinion with the evidence at hand. The embrittling effect of free hydrogen on steel has been mooted as the cause, and it may well be that a searching investigation will undoubtedly be made by the makers of the boilers in conjunction with the inspection authorities.

Full particulars of this investigation will be available to readers of the POWER HOUSE in due course.

WATER STORAGE ON ST. MAURICE RIVER

New Power Developments Made Possible By La Loutre Reservoir

The great benefit derived from water storage is soon to be further demonstrated on the St. Maurice River, where a large water-power undertaking will soon be started.

The increased power made possible at the various sites on this river by the La Loutre Reservoir, the largest but one in the world, is a strong incentive to prospective power users. It is estimated that the conserved water thus made available represents a total increase of over 500,000 h.p.

The proposed development above referred to is reported to be in connection with the operations of the St. Maurice Paper Company, the latter having leased two sites in the lower portion of the river, known as Les Forges and La Gabelle. It is intended to combine these two, giving a total effective head of 33 feet, while the regulated flow from the La Loutre reservoir increases the power now available at this site, namely 20,000 h.p., to 42,000 h.p.

Another proposition reported in this connection is the construction of a hydro-electric plant utilizing the combined site of La Gabelle and Les Gres, the latter site being controlled by the Shawinigan Water & Power Company. The latter power company would carry out the development and supply hydro-electric power to the St. Maurice Paper Company under a special contract.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before The House

24.—(a) Name the various forms of rivet heads used in boiler construction; (b) How are rivet heads formed? (c) In what respect has machine riveting advantages over other processes of riveting?

25.—(a) What is a lap joint?; (b) What is a butt joint?; (c) Distinguish between single and double-riveted joints?; (d) Distinguish between chain-riveted and staggered-riveted joints?

26.—Which is the strongest type of the ordinary riveted joints?

27.—What precautions are taken in locating the longitudinal seams of externally-fired boilers, and also of cylindrical furnace flues of internally-fired boilers?

28.—What objection can be urged against constructing the fire-door hole of a locomotive type boiler by flanging the inner and outer sheets to a single curve?

Answers to Questions In Last Issue

Question 13.—If your safety valve has been blowing off at 100 lbs. and now commences to blow at 80 lbs., what would you do to remedy the same, in the event of the steam gauge indicating 120 lbs. before the safety began to blow? What would you consider the possible cause, and what would you do to remedy the same? What action would you take?

Answer.—I would find out if my safety valve was clean or dirty and would try blowing off by hand in the morning when it might be stuck to the seat. I would certainly have the safety valve blow off at the pressure for which it was set if at all possible.

Question 16.—Explain fully the construction and action of a safety valve spring-loaded pop. In what does it differ from the other ordinary spring-loaded valve? What is the advantage of the pop over the ordinary? How does the connecting of a long discharge pipe affect its working.

Answer.—A spring-loaded safety valve is mostly used on large boilers, and a long discharge is not as satisfactory as a short outlet. There is too much condensation and back pressure.

Question 20.—If you were in charge of a steam plant where there was boiler power to spare, but the engine in its present condition was fully loaded, what would you do to increase the power of the engine in order to run extra machinery, assuming that the boiler pressure can not be raised, and that all parts of the engine are strong enough to carry the extra load?

Answer.—I would run the engine a little faster by adjusting governor. If this did not prove satisfactory I would change the pulley on the line shaft to compensate for increased speed of engine.

Editor's Note.——Our correspondent has overlooked increasing the cut-off to give higher mean effective pressure.

Question 22.—What is the safety head of an ammoniac compressor? What purpose does it serve, and how is it constructed? What precautions are necessary in taking compressor cylinder apart in order to prevent injury from inhaling ammoniac gas, if this gas should be inhaled to such an extent that a person becomes unconscious, what action would you take to save him?

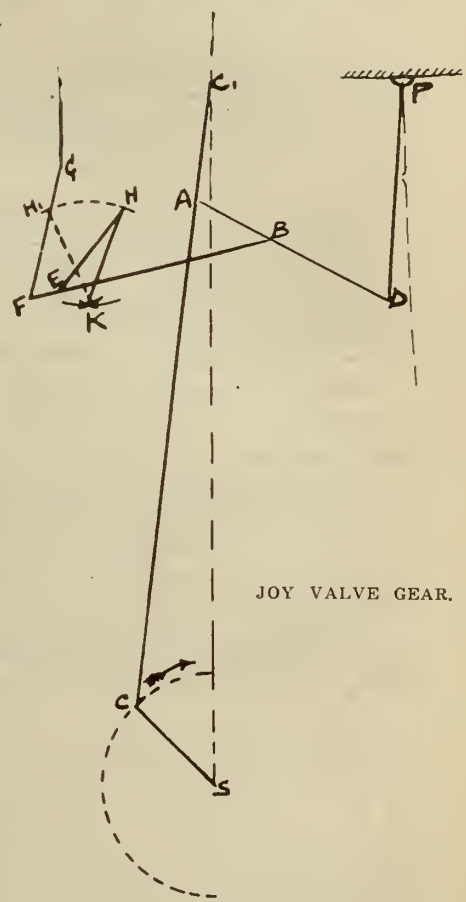
Answer.—In taking cylinder head off, see that the machine is free by turning flywheel by hand. Discharge the machine and open windows in compressor room. Close expansion valves if person should be overcome by gas.

Toronto J. Q.

Reader's Query

Question.—An engine fitted with Joy valve gear is out of order. Suspended and compensating links, also lever connecting compensating links to valve rod, all on the scrap heap. I want to know how to get the length of the different rods, etc., so that when I erect engine valve gear will be O.K.—G. A., Toronto.

Answer.—The following diagram proportions are as below for the correct functioning of a Joy valve gear.



JOY VALVE GEAR.

$$\frac{C\ A}{C\ C} = .2 \text{ to } .23$$

$$\frac{A\ D}{C\ S} = 1.4 \text{ to } 1.5$$

$$\frac{B\ D}{A\ D} = 05. \text{ to } 0.6$$

$$\frac{D\ P}{C\ S} = 1.4 \text{ to } 1.5$$

$$\frac{B\ E}{C\ S} = 1.5 \text{ to } 1.65$$

$$\frac{E\ F}{C\ S} = 0.2 \text{ to } 0.3$$

$$\frac{E\ H}{C\ S} = 0.8 \text{ to } 1.0$$

$$\frac{F\ G}{C\ S} = 1.0 \text{ to } 2.5$$

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A Baffling Proposition

WHILE in many instances it is comparatively easy to determine the direct cause of boiler failure and explosion, the history of the events leading up to the rupture are more or less obscure and somewhat difficult to determine. Such seems to be the case in the recent explosion at Newmarket, where five and possibly more lives have been lost. The boilers themselves, made by one of the most widely known firms, embodied careful workmanship and were far removed from the type of boiler usually featuring in such accidents. Monthly cleaning-down seems to have been practised, inspection was in the hands of a reputable insurance company, and the boiler at the time of the accident was notably free from scale and evidences of corrosion.

The failure in itself was due to a crack existing in the rear head of one of the drums and which extended, roughly speaking, throughout that part of the circumference below the water line. The remainder of the head showed, by the tear made when it parted company with the boiler, the excellent quality of the steel and its freedom from flaws.

While the immediate cause of the explosion is easily determined, it is in the history of the crack that the true explanation of the accident must be found. The location of the crack immediately outside the rivet holes, and the entire absence of pitting or other forms of corrosion render usual explanations untenable, and the character of the flaw which indicates crystallization necessitates other considerations.

Of late years obscure chemical phenomena occurring in the operation of boilers have received attention, and it is possible that the embrittling action of sodium salts through the action of liberated hydrogen caused the initial failure of the plate.

Trouble has been experienced elsewhere due to this cause, and if such failures become prevalent it will add one more burden to the load of vigilance carried by the operating engineer.

Thirtieth C.A.S.E. Convention

THE established custom of engineering societies and other like organizations of holding conventions each year has much to commend it. And while conventions are primarily essential for the transaction of business relating to the organization, the discussion of matters affecting the welfare and advancement of members in their avocation and otherwise often proves equally valuable.

Such is the convention of the Canadian Association of Stationary Engineers which takes place at Brantford during the present month With the cessation of war activities, the engineer enters upon a period less marked perhaps by hectic activity, but with many of the conditions imposed by war still prevailing. Need for economy in fuel is still evident and with this necessity comes the continued advancement of the power plant and its operator to a higher state of efficiency. The papers of a technical nature which will be given hold promise of being very instructive and useful.

The value of such occasions as these for strengthening the bond of friendship amongst members is well known and social events and plant visitations form an attractive feature. Brantford's power plants are numerous and are well cared for, while her various parks and other recreation spots are well adapted for the entertainment of visiting conventions.

THERE'S no chance for any reduction in the price of coal, and coal dealers are even advising people to burn egg coal in their furnaces. Firing the average furnace with egg coal is about as entertaining and as unsatisfactory as eating peas with a knife.

* * *

HAVING won the war, and made the world safe for democracy, the nations are now doubling up their standing armies and looking over the new designs in guns and munitions.

* * *

TORONTO relief firemen, boiler washers and helpers, chemical attendants, outside attendants, outside coal and ash men presented to the mayor a request for an increase in their weekly wage from $25 to $28 a week. Old H. C. of L. is always hanging around, waiting to lead in a new deputation.

Association and Personal

Program of Convention C.A.S.E., Brantford, June 23, 24, 25 and 26

The 30th Annual Convention of the Canadian Association of Stationary Engineers will be held at Brantford, June 23rd, 24th, 25th and 26th, 1919. The following programme has been arranged:—

Monday, June 23rd—Installing Exhibits (All Day)

3.00 p.m.—Meeting of C.A.S.E. Executive.

7.30 p.m.—Chalk talk on Piston Valve Setting, by J. W. A. Drummond, Drumheller, Alberta.

8.15 p.m.—Power Plant Accessories, by S. Balmfirth, Toronto.

9.00 p.m.—Illustrated lecture on Steam Heating, by E. T. Flanagan, Toronto.

Tuesday, June 24

10.00 a.m.—Official opening.
Welcome to Brantford, by Mayor Morrison McBride.
W. Welsh, President Brantford Lodge, and D. L. Webster, Secretary Brantford Convention Committee.
Reply by W. Cooke, President C.A.S.E.; C. N. Schrag, President Exhibitors' Association; Lieut. L. Archibald, Past President Exhibitors' Association; Fred W. Raven, Secretary N.A.S.E.; D. N. Medcalf, Chief Boiler Inspector for Ontario; Fred R. Low, Editor of *Power;* W. C. McGhie, Chairman Engineers' License Board for Ontario, and C. Z. Wise, Educational Secretary N.A.S.E.

11.30 a.m.—Meeting C.A.S.E. Excutive.

12.30 p.m.—Lunch.

2.00 p.m.—Meeting C.A.S.E. Executive.

2.30 a.m.—Ladies' trip through some of Brantford's factories.

7.30 p.m.—Educational Session and Smoker (men only).

7.30 p.m.—Illustrated lecture on Generators, by C. J. Porter, Hamilton.

8.15 p.m.—Address by Fred W. Raven, Chicago.

8.45 .p.m.—Causes of Boiler Failure, by D. N. Medcalf, Chief Boiler Inspector for Ontario.
Song by Jack Armour

9.30 p.m.—Illustrated Lecture on Turbines, by J. M. Brown, Hamilton.

8.00 p.m.—Theatre party for the ladies.

Wednesday, June 25

9.00 a.m.—C.A.S.E. Executive session in Convention Hall. Exhibition Hall open morning and evening (not afternoon).

2.30 p.m.—The Engineers and their friends will be the guests of the Exhibitors' Association at Mohawk Park. Special cars will be provided to take the party to the park. Ice cream and peanuts will be supplied. There will be an excellent programme of sport with valuable prizes supplied by the Exhibitors' Association.

5.45 p.m.—Cars leave the park for the city.

8.00 p.m.—Meeting in Convention Hall, open to Engineers and friends.
Presentation of prizes.
Address by Dr. W. A. Riddell, Superintendent Trades and Labor Branch for Ontario.
Prize drawing contest.
Unique sale of curios in aid of a Brantford institution.
Address by W. C. McGhie.
Music—vocal and instrumental, including songs by E. F. Hetherington and E. B. Curzon, two popular exhibitors.
Speech by Jack Armour.
Recitations, etc.

Thursday, June 26

9.00 a.m.—C.A.S.E. Executive sessions.
Exhibition Hall open all day (not in evening).

10.30 a.m.—Annual meeting Exhibitors' Association.

11.30 a.m.—Exhibitors' Association entertains the Grand Lodge in Exhibition Hall, demonstrating exhibits and distributing souvenirs, etc.

2.00 p.m.—Lecture by C. C. Carison, M.E., Waterous Engine Works, Brantford.

3.00 p.m.—Installation of C.A.S.E. officers in open meeting.
Installation of officers of Ladies' Auxiliary.

8.00 p.m.—Annual Engineers' Ball in the Masonic Hall, under the auspices of the Brantford Lodge. Tickets, $1.00. Ladies free. A caterer will serve refreshments, which will be extra.

The Entertainment Committee consists of E. B. Curzon (chairman), Earl F. Hetherington, Geo. Moll and G. C. Keith in co-operation with C.A.S.E. Executive and Brantford Lodge.

Submarine Indemnities

AT an international conference of transport workers held in Amsterdam recently the Belgian delegate introduced the following motion:

The International Conference of Transport Workers, taking into consideration that approximately twenty-two thousand seamen of all nationalities have been murdered in consequence of submarine warfare, appeals to the German Government to grant full indemnity to the families of these murdered seamen. The report says that the German delegates expressed approval of this motion.

A PENNSYLVANIA peanut and fruit stand man left an estate of $30,000. The man who stows away a nickel's worth of peanuts in his vest pocket will be willing to believe this.

* * *

ON A Detroit street a doctor, undertaker and tombstone maker have their establishments side by side. As the efficiency man in the machine shop would say, the sequence of operations is admirably arranged.

Plant Equipment Exhibitors' Association Feature

Efforts of Manufacturers and Dealers Insure Interesting and Instructive Display—Featuring Power Plant Equipment and Operating Necessities

AS in former years a feature of the annual convention of the Canadian Association of Stationary Engineers will be the exhibition of power house apparatus, accessories and supplies, organized by the Exhibitors' Association.

While the urgent need for fuel economy from a patriotic standpoint has passed, the lessons learned from the practice of rigid economy under war conditions have remained and the necessity for economical power production yet remains. This fact lends interest to the various exhibits and will color many of the addresses and discussions which will take place.

As indicated in a previous issue of POWER HOUSE, the convention opens on Tuesday, June 24, the opening ceremony in Convention Hall being performed by Mayor McBride, following which the appointments of the various committees will take place.

Tuesday afternoon will be given over to an executive meeting and a trip for the ladies through various Brantford factories as guests of the C.A.S.E. executive. Tuesday evening will be devoted to an educational session and smoker for the men and a theatre party for the ladies arranged by the Brantford Lodge. The educational features of this session promise to be of high value.

The program for Wednesday, as will be seen above, includes a picnic at Mohawk Park, one of Brantford's beauty spots on the shore of what is known as Mohawk Lake. The prizes for the sporting events of the day will be donated by the Exhibitors' Association. These prizes will be presented at a meeting in Convention Hall at which entertainment is provided.

The final event on Thursday is the Annual Engineers' Ball in the Masonic Hall, under the auspices of the Brantford Lodge.

Brantford as a convention city is admirably suited for the double purpose of holding business and educational sessions and for the entertainment of visiting members. Convenient of access by railroad and offering many attractions to the engineer, the activities and labor of the local lodge, under Mr. D. S. Webster, should meet with a record of attendance.

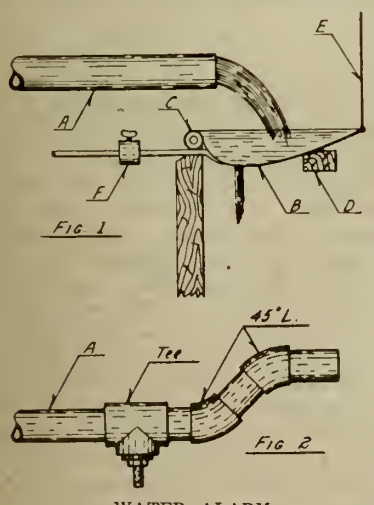
The Exhibitors' Association is under the presidency of C. N. Schrag, of the Equipment Specialties Co., Toronto. As in former years, G. C. Keith, editor of *Canadian Manufacturer*, will discharge the duties of secretary, the other officers being Wm. Welsh, Brantford, honorary president; C. B. Turner, Toronto, 2nd vice-president; E. B. Curzon, Darling Bros., Montreal, chairman entertainment committee; L. H. Rumage, V. O. Anderson Co., Buffalo, assistant secretary; Jas. S. Mock, Jenkins Bros., Montreal, 1st vice-president; L. Archibald, Dart Union Co., Toronto, past president; B. G. Newton, manager THE POWER HOUSE, Toronto, treasurer; H. J. Remshaw, Garlock Packing Co., Hamilton, chairman reception committee; Arthur Belton, Jas. Morrison Brass Mfg. Co., Toronto, chairman exhibit committee.

The Operators' Point of View

ELECTRIC SIGNAL

An electrical signal device to give warning when the flow from the discharge pipe of a pump stops, or, if preferred, when it reaches a certain predetermined allowable minimum, may be rigged providing the pump is discharging to the atmosphere with a few inches of drop for the water after it leaves the discharge pipe. As, for instance, when going to waste for dumps in mining, or prospecting practice, or when filling tanks from above, etc.

A, Fig. 1, is the discharge pipe. B is a somewhat ladle-shaped apron, onto which the water falls. It is hinged at C, and when full of water is supported at D. It has a hole in the bottom just large enough to empty the apron quickly if water ceases to flow into it from A. E is a galvanized iron wire, which is attached to the outer end of B and to a spring above. Just above this spring again is an ordinary push button in a bell wire circuit, but the button is placed as though fastened to a ceiling. Adjust the spring so that so long as water enough flows to keep the apron full in spite of the hole in the bottom,



WATER ALARM.

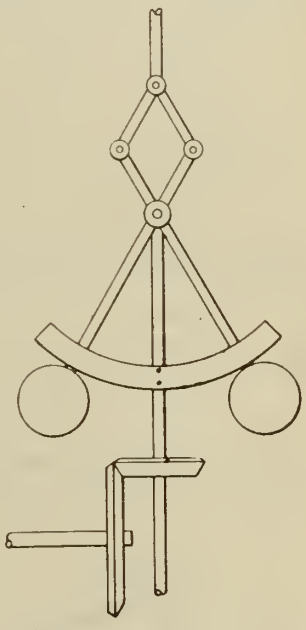
the weight of the apron and the water in it will hold the spring down, but if the discharge at A ceases, thus allowing B to empty through the said hole in the bottom, this allows the spring above to rise and press the button, thus closing the circuit and ringing the bell. If the margin between rising and not rising is too small to make the spring action reliable, an apron holding a little more water is required. It is the weight of water in the apron (together with some force from the fall), that holds the spring down. With no water in the apron the spring should positively rise. If it will not, and the apron is as light as seems consistent, then a stronger spring is required, or a small counter balance weight F may be added to partially offset the weight of the empty apron. This weight may be a sliding one on a small beam and having a set-screw to hold it where placed, thus making its effect adjustable.

By the above method the bell only rings when the pump fails to discharge enough water to keep the apron full. To have it ring when the discharge has fallen to the lowest allowable discharge, put a tee on the end of the discharge pipe and turn the side outlet to one side or downwards. Into the end of the tee screw a 45° street elbow, or else a nipple, and an ordinary 45° elbow and turn the elbow to pointing upwards; then insert another short piece of pipe and add another 45° elbow, its outlet pointing horizontally, and, if desired for purposes of protecting the screw threads, another nipple may be added. See Fig. 2. Place the apron under this, as was shown under A, Fig. 1. Now, bush down the side outlet of the tee until what experiment proves to be the minimum allowable, discharge will just escape at the tee without any overflow into the apron. The discharge from the tee, of course, does not go to the apron. Now, so long as enough water is discharged to keep the full stream running from the tee, and, in addition to this, keep the apron full, the electric circuit will remain open. If the water can all escape through the tee, the apron will empty itself and allow the spring to rise, thus closing the circuit and causing the bell to ring.—J. E. M.

BELL ALARM OF CONVEYORS

By J. E. McCormack

To arrange for warning by electricity when a conveyor stops, procure a cheap set of governors such as would be suitable for use on a small steam engine. Remove the valve chamber and take the valve from its spindle. Set the remainder where you can drive it from a pulley placed on the conveyor shaft. Choose the shaft that stops when the conveyor stops. Most governors will, when relieved of the duty of compressing a spring or raising a weight, raise or lower the valve spindle at comparatively low rates of speed. This feature is a necessary one to secure. Now run your wires to an easily operated yet reliable self-closing spring electric contact, where the valve spindle of the governor will



CONVEYOR BELT ALARM.

hold it open while the governor is in motion. In case the governor stops then the spindle will cease to touch and the spring will close the contact and thus the circuit, and ring the bell. To economize in current, do not forget to open the switch when shutting down at night. If you are in the habit of remaining behind until the machinery stops, the bell ringing will remind you of the switch.

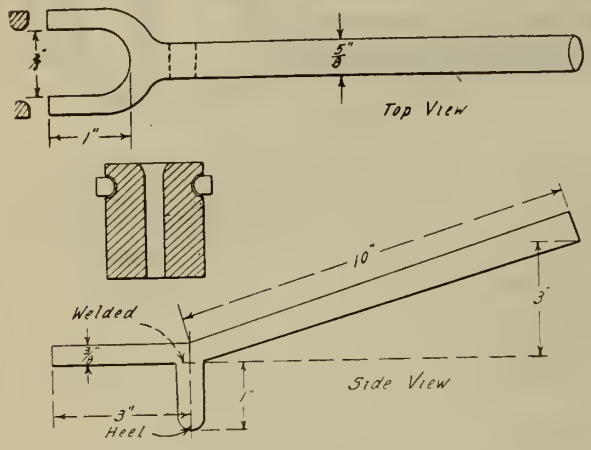
The sketch indicates a simple form of governor which may be easily constructed from two small gear wheels, some small shafting, and rods, bolts and a small pulley. Probably the patent, if any, has been expired for years. The balls may be molded from lead or babbitt, and if cubical will do almost as well if easier made that way. The appearance will be the worst feature perhaps. It will be seen that the arms cross each other and swing in a slotted sector. They are shown in "Mechanical Movements, Powers and Devices," by Gardner D. Hiscox, M.E., a very good book for mechanics to own. If this type of governor were used the spring contact used should be self-opening and placed above so the governor rod would push up on it, shoving it shut when the governors quit revolving: a common push button serving in this case.

A KNOB REMOVER

J. L. Martin

(Copyright. All rights reserved.)

We have used a tool, made about as shown in the accompanying sketch, for removing knobs in knob-and-tube jobs and if properly manipulated we find it quite successful. We had our remover made by a local blacksmith from a rough pencil drawing.

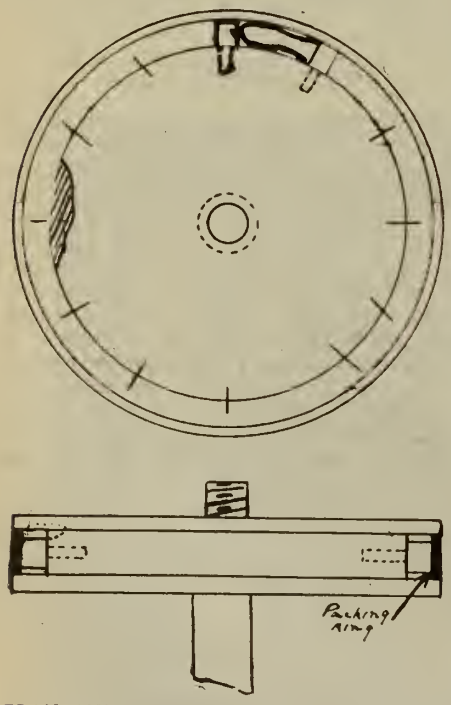


KNOB REMOVER.

INTERESTING PISTON TROUBLE

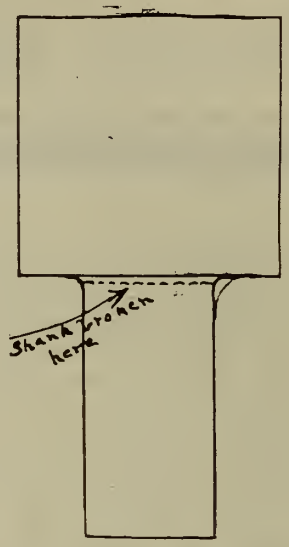
By T. H. F.

An example of a piston defect that very nearly led to serious trouble occurred in the low pressure side of a McIntosh, Seymour vertical compound engine.



PLAN AND ELEVATION OF PISTON SHOWING THE BREAK.

The piston was of the usual McIntosh, Seymour type, that is, the ring was held concentric to the piston by a number of square blocks. These blocks were made with round shanks, which fitted in holes bored in the body of the piston. One of these blocks had been broken off at the junction of the shank, and had, being free, gradually worn away the metal of both piston and junk ring, till it had made a large hole. A little further running would have resulted in the breaking of a cylinder cover, or the block, getting into the vaive openings, would have smashed up the valves.



VIEW OF DISTANCE PIECE.

Repairs were made by cutting out the metal, and fitting a patch held on by studs, riveted over into countersunk holes on the patch.

GEARS FOR RECIPROCATING ENGINES

The undoubted success which has accompanied the application of speed reduction gears to marine steam turbine installations, and the high efficiency which is obtained with these gears when they are carefully manufactured, raises the question whether it might not be an advantage to install mechanical speed reduction gearing in conjunction with reciprocating engines of the internal combustion type. There is no question as to the advisability of using them in conjunction with steam reciprocating engines, as these can be most economically built to run at a speed of about 70 revolutions per minute, which is perhaps the most economical rate of revolution for the propeller of slow-going cargo vessels having a speed of about 11 knots. But with Diesel engines, as now built, it is found impossible to run these at such low speeds, and a study of the Diesel engines built for cargo vessels would show that though the speeds vary considerably with different makers, it is always higher than that of the reciprocating steam engine, and usually between 150 and 300 r.p.m. It would appear then as if experiences are needed to determine what may be considered the most economical speed of high-powered Diesel engines, and then to build engines of this speed and install gearing having a speed reduction of two or three to one, so that the most economical propeller speed may also be employed.

The Principles Underlying the Operation Storage Battery

B. S. T. BUTLER

THERE are in use at the present time two types of batteries, the primary and the secondary. It would be advisable to make things more clear to first consider the primary battery, of which there are two groups, the closed and open circuit types. The closed circuit type will work continuously, being composed of a position pole of carbon, a negative pole of zinc, the electrolyte sulphuric acid ($H_2 SO_4$), together with bichromate of potash. In the chemical action which takes place in the cell, positively charged hydrogen (H_2) goes to the positive pole, gives up its charge to the carbon, and at the same time polarizes the positive pole, due to the high resistance of the hydrogen. The negatively charged SO_4 goes to the zinc pole and gives up its charge to the plate, at the same time dissolving the metallic zinc and forming zinc sulphate, $ZnSO_4$. The oxygen of the bichromate combines chemically with the hydrogen H_2 at the positive pole, forming water, H_2O; at the same time it depolarizes the carbon pole by reducing the resistance, thus enabling the cell to work continuously until the negative pole is consumed. This equation would be expressed: $C + Zn\ H_2 SO_4 + K_2 Cr_2 O_7 = C + ZnSO_4 + H_2O + K_2 Cr_2 O_7$. Zinc sulphate, being soluble, would be held in solution. Theoretically current sent through this cell in the opposite direction from the carbon to the zinc, would break up the zinc sulphate, $ZnSO_4$, into positively charged zinc and negatively charged SO_4. The Zn radical would go to the negative and form metallic zinc; the SO_4 would combine with the water previously formed and form H_2SO_4; this cell would give out current again and would be termed a secondary cell. The equation of this action would be expressed: $C + ZnSO_4 + K_2 Cr_2 O_7 = C + Zn + H_2 SO_4 + K_2 Cr_2 O_7$. The chemical action in the open circuit battery is the same, with the exception that the depolarizing agent acts more slowly, therefore the battery needs a longer space of time to recover itself. The voltage E.M.F. of a battery depends on the difference of potential between the two elements used; also the nature of the electrolyte. The current strength or amperes depend upon the surface area of the plates used.

Before taking up the chemical action in the secondary cell, it would be advisable to give a brief outline in connection

with the chemical terms used further on: Atomic weight, valency, and chemical equivalent and also the term molecule. For example: Henry Cavendish, in the year 1781, made the following experiments: By putting equal parts of hydrogen and oxygen into a glass receiver, from which the air had been previously exhausted, and detonating the gases by an electric spark, he found that he had created a water vapor, but still had some gas not combined. By admitting more hydrogen detonation produced the same results, giving proof that oxygen was in excess. Then by putting two parts hydrogen, one part oxygen by volume and detonating the contents he formed water vapor with no remaining gases, therefore proving their combining power or valency. In this case, hydrogen may be said to have a combining power of one and oxygen of two. For this reason it takes two atoms of hydrogen with only one of oxygen to form water.

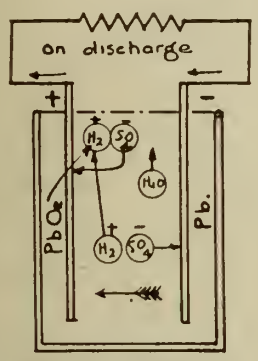


FIG. 1—ON DISCHARGE

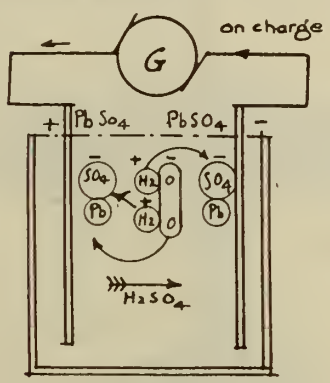


FIG 2—ON CHARGE

Combining Weight

Hydrogen being the lightest gas known is taken as the standard or starting point, and its weight is denoted by the figure one. Its chemical equivelent or combining weight is also one, for its valency, as explained above, is also one and it is for this reason termed a monad.

The atomic weight of oxygen is 15.9 as compared to hydrogen, which has a weight of unity, for equal volumes at equal temperatures and pressures. One atom of oxygen combines with two atoms of hydrogen to form water, and showing that its combining power is twice that of hydrogen. For this reason oxygen is termed a diad, its valency being two, the chemical equivalent will be $15.9 \div 2 = 7.95$.

The chemical equivalent of an element is nothing more nor less than the proportion by weight in which it combines with other elements. It also enters into the computation of the electro chemical equivalent of an element.

In writing chemical formulae correctly the positive radical should be written first, together with a number denoting the number of radicals or atoms always written to the right and slightly below the symbol. The negative elements or radicals are then written down in the same manner.

The number of the molecules found is denoted by a figure to the left hand and on the same level as the symbols.

The following examples will serve to make these terms clear: ($2H_2O$) ($2H_2SO_4$) ($2PbSO_4$). The first two examples are composed of mono-valent or monad, and di-valent or diad elements. The third one is composed of diad elements.

Having considered the primary cells and some of the more common chemical terms, we will next take up the secondary or storage cell. The term storage being objectionable and misleading, and, if used, should be used figuratively and not deliberately. To determine the action in a secondary cell, we will first give our attention to the elements used, their atomic weight, valency, chemical equivalent, and also the group to which they belong. First, hydrogen (H), atomic weight 1, valency 1, chemical equivalent 1, and in the monad group. Second, oxygen (O), atomic weight 16, nearly chemical equivalent 8, valency two in the diad group. Third, sulphur (S), atomic weight 32, valency 2, chemical equivalent 16, in the diad group. The electrolyte can now be studied. Hydrogen (H) being in the monad group. Oxygen (O), being diad, will combine two to one, thus forming a binary compound water (H_2O). Sulphur will combine with oxygen and forms sulphur dioxide (SO_2) in contact with platinum will take up one more atom of oxygen and forms SO_3. SO_3 being a binary compound, H_2O a binary compound, the two in combination give us the ternary compound, H_2SO_4, this being our electrolyte, plus H_2O, or water.

We will next take up the plates, the metallic elements in the cell, of which there are two types, the formed and the filled, their difference being mechanical more than chemical. The formed plate is made by chemical action, the filled plate is a mechanical construction, the active compound being the same on both, PbO_2. The formed plate being a chemical compound in itself can only be removed by chemical action and is thus more resistant to expansion and contraction troubles, one charge and discharge. To erect the cell we place in a glass cell one plate of lead peroxide (PbO_2), another plate of Pb or spongy lead, and so on, until cell is full; plates are covered about one inch above the top of the plated with the electrolyte (H_2SO_4), which should have a specific gravity of 1.212. The cell is now ready to give out current. We will now put our battery on discharge. See Fig. 1.

On discharge the electrolyte H_2SO_4 is broken up into oppositely charged elements. The hydrogen being positively charged goes over to the positive plate and combines with the oxygen of the litharge (PbO_2) and forms two atoms of water twice. Our negatively charged SO_4 goes to the positive plate, takes the plate of the O_2 and forms $PbSO_4$. The other part of the SO_4 goes against the current. to the negative plate and forms $PbSO_4$, lead sulphate; we now have two plates of like compounds, having no difference of potential. A battery in this condition would be termed dead. The safe working condition of a battery is reached long before this stage is reached. The specific gravity of the battery would be lowered owing to water being formed and the SO_4 going to the plate. It is by the density of the electrolyte that we determine our lowest point of discharge. Diagram No. 3 gives a normal discharge chart.

Before taking up the charge it would be well to note the relationship between electricity and chemistry during electrolysis, given quantity of electricity will liberate the same number of monad atoms irrespective of their nature, one-half this amount of the diad, one-third of the triad, one-fourth of the tetrad. Putting the battery on charge sends the current the opposite direction to the current on discharge. Assume both plates to consist of lead sulphate, $PbSO_4$, the water formed during discharge is now broken up into positively charged hydrogen and negatively charged oxygen. The positively charged hydrogen goes to the negative plate, unites with the SO_4 of the lead sulphate and forms sulphuric

(Continued on page 62.)

Time	Open Circuit Term Volts	Closed Circuit Disch'ge Volts	Normal Disch'ge Amps.	Temp. °C.	Specific Gravity	Acid %	Water %
A.M. 6.00	120	123	8	15°	1.216	29.74	70.26
7.00	120	120	8	15°	1.215	29.00	71.00
8.00	120	119	8	15°	1.212	28.74	71.26
9.00	120	118	8	15°	1.208	28.48	71.52
10.00	120	118	8	15°	1.207	28.22	71.78
11.00	120	117	8	15°	1.206	27.96	72.04
12.00	120	117	8	15°	1.205	27.70	72.30
P.M. 1.00	120	117	8	14°	1.202	27.44	72.56
2.00	120	116	8	14°	1.200	27.18	72.82
3.00	120	116	8	14°	1.198	26.92	73.08
4.00	120	115	8	14°	1.196	26.66	73.34
5.00	120	112	8	14°	1.194	26.40	73.60
6.00	120	110	8	14°	1.190	26.14	73.86

Based on 12-hour discharge, 8 amperes, 60 cells, in series, 3 square feet of active positive plate area.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$4 50
Tank plates, 3-16 in.	5 50	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 25
Steel bars, base, Toronto ...	4 25
Steel bars, 2" to 4" base...	5 50
Iron bars, base, Montreal ..	3 75
Steel bars, base, Montreal..	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 55	$ 6 00
Sheets, Black, No. 10.	5 15	5 45
Canada plates, dull, 52 sheets	8 50	8 00
Canada plates, all bright	8 50	9 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.		7 95
Premier, 10¾ oz. ...	....	8 25

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.....	26½
Black oil, per gal.	15
Cylinder oil, Capital	49½
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard	40%
Cut leather lacing, No. 1....	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws.....	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less...	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass....	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze..	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly 0	34
Solder, guaranteed 0	39
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums..... 6	75
White lead, pure, cwt. 17	80
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D." per lb..... 0	03
Rosin "G." per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd..	$0 30
Sheets, 24 oz. and heavier base	0 38
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1¼ in.....	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add	40, 10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1¼ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$19 00	$20 00
Electro copper	18 50	19 00
Castings, copper ...	17 25	19 00
Tin	58 00	55 00
Spelter	9 00	8 50
Lead	6 75	7 50
Antimony	8 00	8 50
Aluminum	35 00	40 00

Prices per 100 lbs...

ROPES AND PACKING

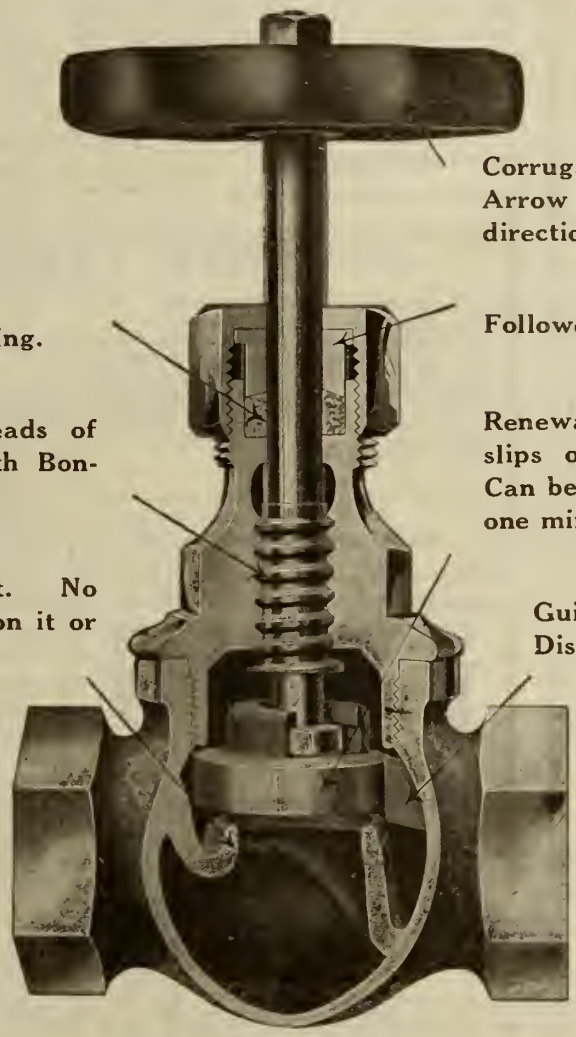
Packing, square braided ...	$0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila..	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb.	$12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb extra.

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Follower in Stuffing Box.

Palmetto Twist Packing.

At least Four Threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised Round Seat. No sediment can lodge on it or injure disc.

Guide cast on Body holds Disc centrally over seat.

Globe or Angle

Screwed or Flanged

The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

Everything in Mechanical Goods.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Town of Melville, Saskatchewan

ELECTRICAL SUPERINTENDENT

Applications are invited for the position of superintendent of the Electric Light and Power Department, the units of which consist of one 115 H.P. and one 75 H.P. engines, gas producer type. The successful applicant will be required to supervise the production and distribution of energy, and also the pumping of water from the deep wells, and will be required to assume duty as nearly as possible to July 1st.

Applications enclosing copies only of recent testimonials and stating salary required should be addressed to the undersigned.

FRED H. CLARKSON,
Town Clerk.

Wanted representing agents and merchants to sell and represent firm manufacturing Milling Cutters, Twist Drills, Reamers, Lathe Tools, Planer Tools, High Speed Steel and Alloy Tools, and Merchants' Tools. Good terms and discounts for selling or representing offered. Apply Lawton Bros., Woodseats Engineering Works, Sheffield, England.

For sale, complete patterns and drawings for 35 and 50 P.H. heavy duty gas engine suitable for producer gas, city gas and natural gas. These engines were designed for an American concern by an English engineer and are the type most popular in Canada. The present owners bought these at a bankrupt sale and will dispose of them at a very low figure. Write us for drawings and details.
SYRACUSE INDUSTRIAL GAS CO.,
Syracuse, N.Y.

Turbo Generators

1—1000 K.W. Rateau 50 cy., 3 ph., 525 v. surface cond.; Elect. Pumps, complete. Immediate delivery.
1—400 K.W., 60 cy., 3600 R.P.M., steam 160 lbs. Cond. Multi Jet; Elect. Pumps.
1 each 50-35-10-15 K.W. with generators.

Pumps, Engines and Boilers, etc.

Roderick J. McLean
128 Bleury St., Montreal

STORAGE BATTERIES

(Continued from page 263.)

acid (H_2SO_4), leaving spongy lead at the negative plate. The negatively charged oxygen flowing against the current goes to the positive plate, unites with the lead Pb of the lead sulphate $PbSO_4$ plate and forms lead peroxide (Pb_2). The SO_4 part of the positive plate united with the rest of the hydrogen liberated when the current broke up the water into H_2 and O, forming more sulphuric acid H_2SO_4 and leaves a plate of PbO_2, lead peroxide. The cell now has a difference of potential of about 2.2. This action would be attended with a rise in gravity of the electrolyte and ready to furnish current. Also a rise in temperature, due to H_2SO_4 being formed. Fig. 2 gives the chemical action on charge.

Western Association of Mechanical and Electrical Engineers

Edmonton District Loop No. 5

This Association would be pleased to receive correspondence from any engineers who would like to associate with us with a view of getting better conditions for the craft in general. We would also be pleased to have communications from any other society or societies of engineers who are endeavoring to secure these conditions. Address all communications to

The Secretary,
Western Association of Mechanical and Electrical Engineers.
P.O. Box 991, Edmonton, Alberta, Canada

THE LONG Patent Steam Trap

Has Only One Moveable Part

The Long Patent Steam Trap is advanced in construction. Has positive advantages over all other traps, and is protected by patent rights.

The valve is actuated by the expanding and contracting of a tube, a motion that is positive and of sufficient force to close the valve against a pressure of 200 pounds. The movement is due to the expansion and contraction of different metals.

Works against 1 and 200 pounds of pressure—no possibility of freezing. Has two outlets so it can be installed in any position. Applied to drain steam lines, mains, Jacket kettles and separators and can be adopted in drying room systems.

FULL DETAILS UPON REQUEST. YOU'LL SAVE MONEY.

J. T. LONG
84 Adam St.
MONTREAL CANADA
If your dealer does not sell it, write direct

3

TRADE GOSSIP

Electric Light for Barrington Passage: A company was incorporated at the recent session of the Nova Scotia Legislature for the purpose of developing power from the Barrington River to serve the villages of Barrington, Barrington Passage and Woods Harbor. The Naval Department has a large wireless station at Barrington Passage, which played an important part in the recent naval activities in this neighborhood.

Niagara Falls Gas Plant.—The Niagara Falls Gas & Electric Light Company are to erect a modern gas plant to cost $200,000 on a four-acre site at 27th Street and Buffalo Avenue. The plant will be completed and ready for operation by January 1st, 1920.

Oshawa. — Oshawa endorsed the proposition of the Ontario Steel Products Co. of Canada, by voting them a fixed assessment for ten years, by a majority of 596 votes. This concern will erect modern factory buildings on the Rider property in the north-eastern section of the town, for the manufacture of automobiles, springs and axles, of which the huge McLaughlin and Chevrolet plants will take almost the entire output. 150 men will be employed.

Agreement is Arrived At.—The Robb Engineering Works, of Amherst, N.S., have arrived at an agreement with their employees, under which the men get an eight-hour day, and a forty-eight-hour week. Time and a half for overtime, and double time for Sunday will be paid; also for holidays. These arrangements come into force after 30th August. From June 1st till Aug. 30th, a fifty-five-hour week will be worked, the pay to be the same as for the fifty-nine-hour week, at present in force.

New Mill Makes Progress: The development of water power, erection of buildings and installation of machinery for the new mill of the Kipawa Fibre Co. at Lumsden's Mills is proceeding rapidly. A dam has been built at Gordon Creek about 200 feet above the Ottawa River level, and an ultimate power development of 20,000 H. P. is expected here. Four thirty-ton digesters are in position, and about one-third of the buildings have been erected.

New Fire Alarm System: The town of Sarnia is about to install a new and up-to-date fire alarm system. The Northern Electric Company is carrying out the contract. The switchboard at the central fire hall will handle four circuits at present and provision for extension is made. Storage batteries will be employed, charged through a motor generator operating on hydro-electric current. An automatic indicator will be installed, which will show the number of the box from which the alarm is rung in. The outside equipment will also be added to where needed, and the whole system put on a thoroughly modern and efficient basis.

LLOYD HARRIS

Chairman of the Canadian Trade Mission in London, on his return from Europe last week, gave at the Annual Meeting of the C.M.A. an immensely interesting address with valuable, practical pointers closely detailed on

THE RIGHT METHODS FOR SECURING FOREIGN TRADE FOR CANADIAN FACTORIES

The only full stenographic report published of this splendid address appears in the June 14th issue of

THE FINANCIAL POST

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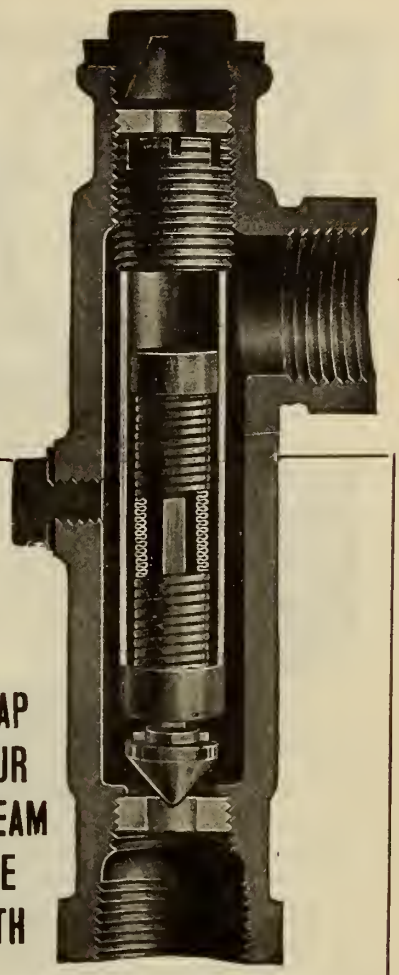

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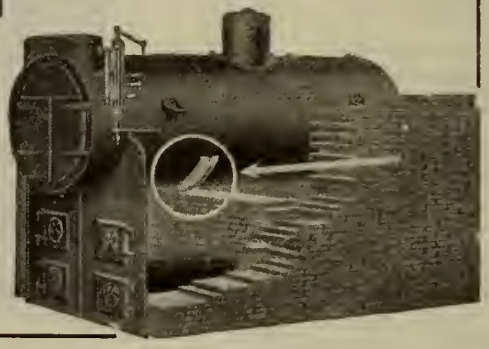

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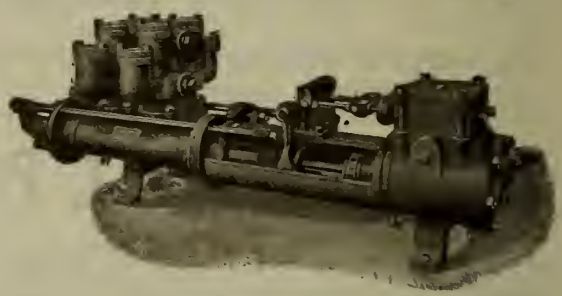

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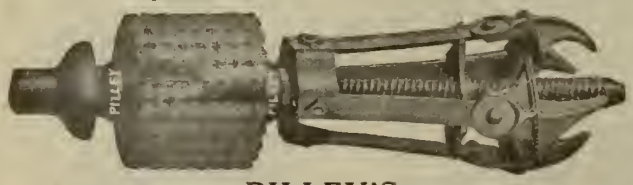

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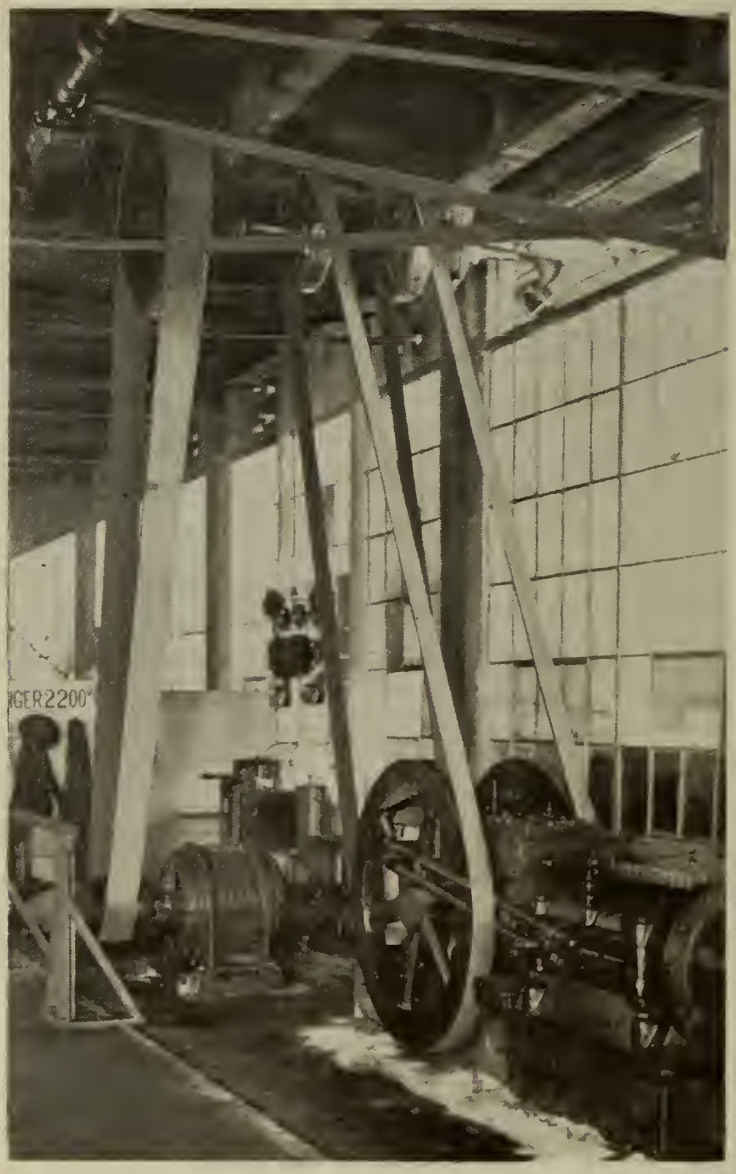

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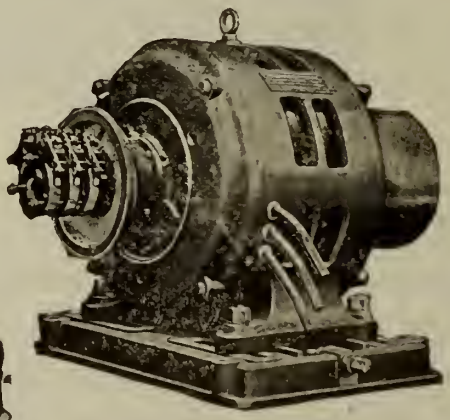

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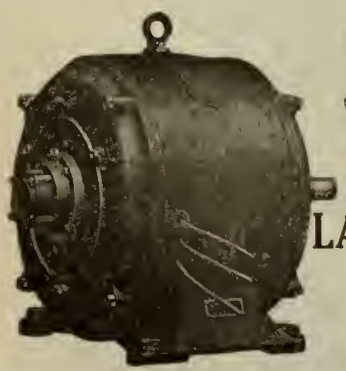

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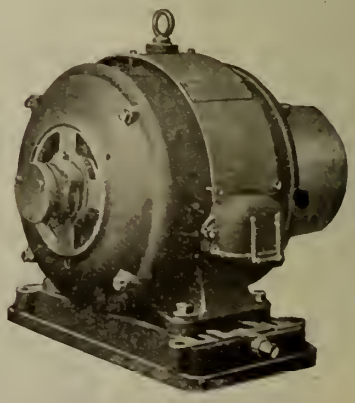

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MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
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Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto. Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
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Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

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Can. Allis-Chambers, Ltd., Toronto, Ont.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
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Waterous Engine Works Co., Brantford.

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Beveridge Paper Co., Montreal, Que.
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Darling Brothers, Ltd., Montreal, Que.
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Smart-Turner Machine Co., Ltd., Hamilton.

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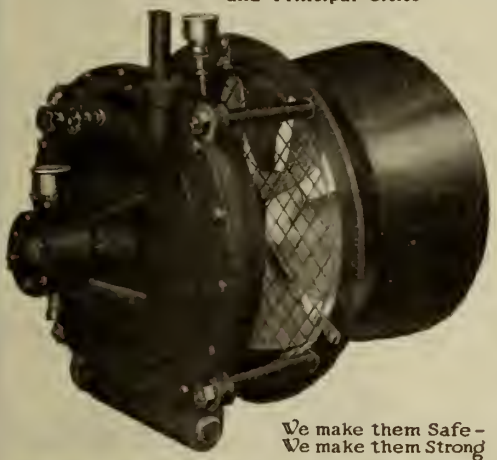

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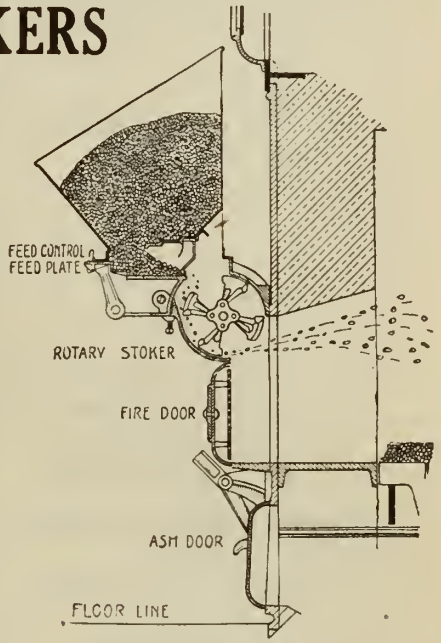

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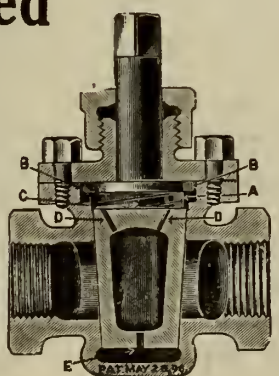

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Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
The Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

HANGERS
Bond Engineering Works, Toronto, Ont.
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HEAD GATE HOISTS
Wm. Hamilton Co., Peterboro.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Empire Mfg. Co., Ltd., London, Ont.

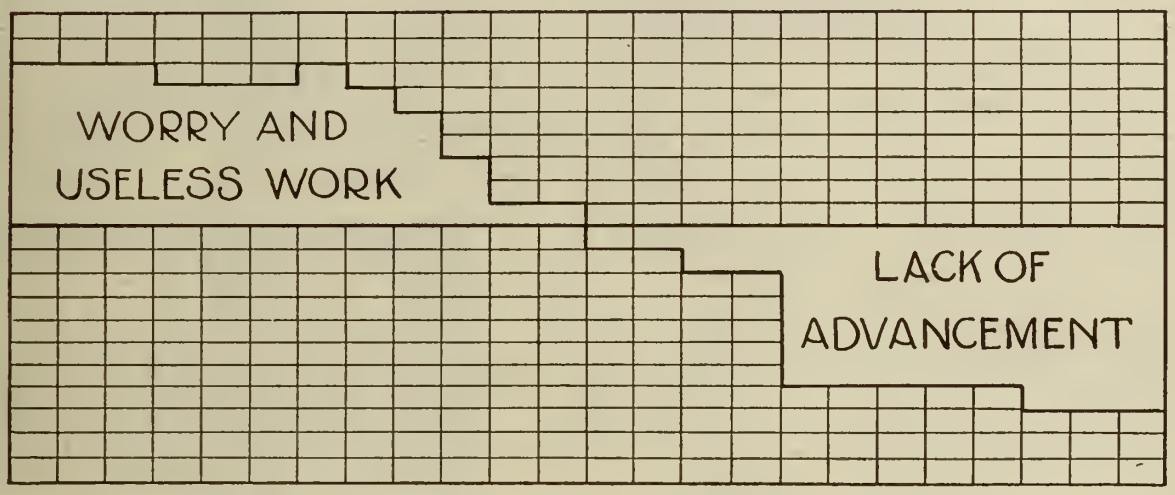
HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

MacGovern & Co., Inc., Montreal, Que.

HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.

HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.

INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, England.

KEROSENE PUMPS (SELF MEASURING)
Bowser & Co., Inc., S. F., Toronto, Ont.

KEROSENE TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que
Beveridge Paper Co., Ltd., Montreal, Que.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Galt Foundry Co., Galt, Ont.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. I. Philip & Sons, Toronto.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. I. Philip & Sons, Toronto.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. I. Philip & Sons, Toronto.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. I. Philip & Sons, Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
Bowser & Co., Inc., S. F., Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
Bowser & Co., Inc., S. F., Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
Bowser & Co., Inc., S. F., Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Crane Packing Co., Chicago, Ill.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Vorhees Ruhber Co., Ltd., Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
Bowser & Co., Inc., S. F., Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

BOB LONG
UNION MADE
OVERALLS
SHIRTS & GLOVES
Known from Coast to Coast
R.G. LONG & CO. LIMITED
TORONTO CANADA

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

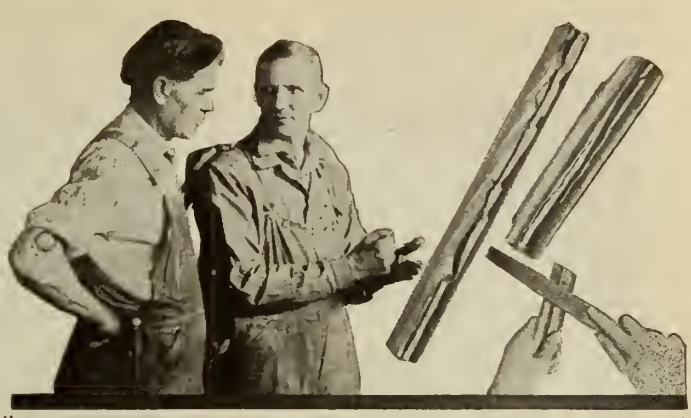
Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.



We Jacked 37 Tons on These Jeffrey Roller Bushings Before They Distorted A Bit.

"You see the Jeffrey people give the Double Bushings of the Jeffrey Improved Carrier a special heat treatment which makes a glass-hard finish that is practically immune to wear. But we wanted to be sure that these bushings had the right toughness and resilience to stand the 'gaff.'

"There's no proof so convincing as a practical test. When these bushings stood up without distortion with the gauge reading 37 tons, we were satisfied. Moreover, the ragged fracture shows that the initial toughness is preserved and increased.

"The second test was just as interesting as the first. They tried to gnaw through the outer walls with a sharp file—but nothing doing. It's glass-hard, all right."

The Jeffrey Co. are putting out **Bulletin No. 210-4**, which describes the Carrier completely and tells of the practical test they made before they were satisfied with the Reliability and Dependability of this New Jeffrey Carrier. You'll never regret investing a stamp to write for it.

THE
Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL
CANADA

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
Bowser, S. F., & Co., Inc., Fort Wayne, Ind.
PULLEYS
Bond Engineering Works, Toronto, Ont.
D. K. MacLaren, Ltd., Montreal, Qne.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.
PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
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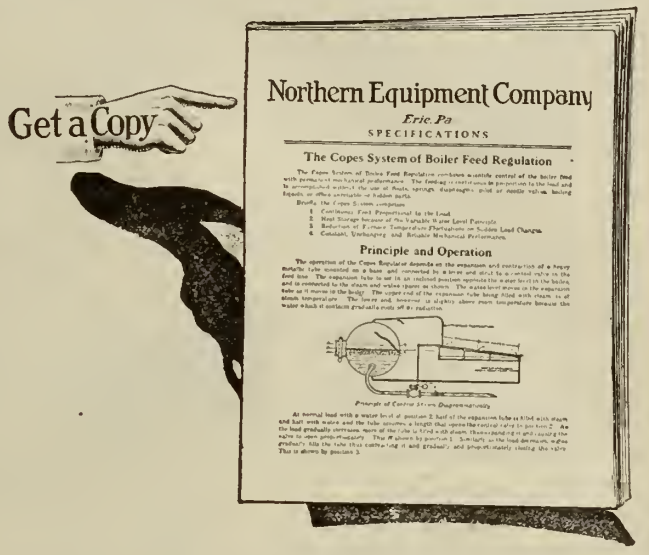

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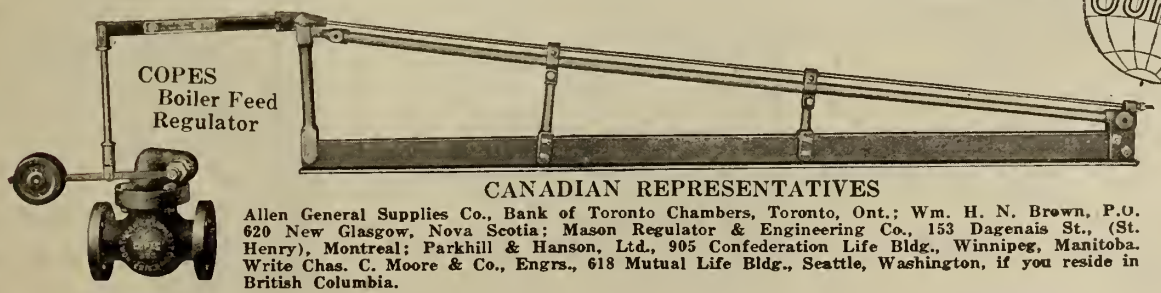

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Can. Detroit Luhricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, O.

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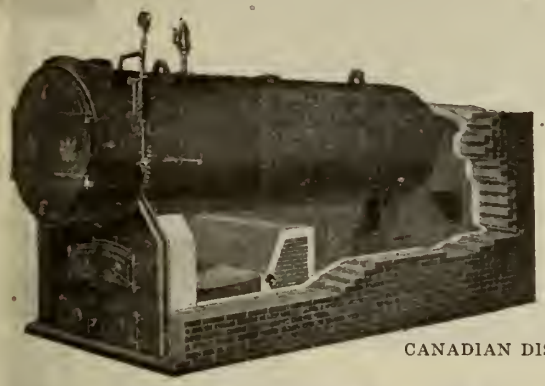

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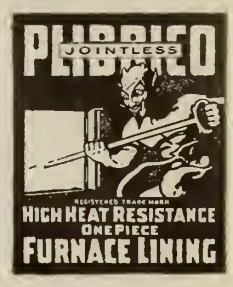

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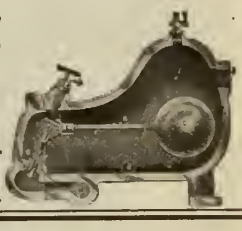

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Dependable "BOND" Transmission

FIG. 1—"Bond" Patent Universal Drop Hangers, Ring Oiling Ball and Socket, Universal Adjustment.

FIG. 51—"Bond" Double Flange Solid Set Collar.

FIG. 19—"Bond" Rigid Ring Oiling Pillow Block. A well constructed bearing babbitted and reamed and self oiling.

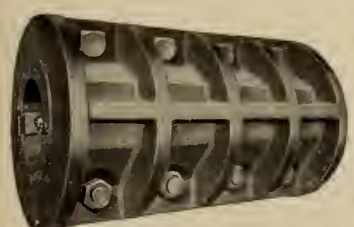

FIG. 45—"Bond" Clamp Coupling.

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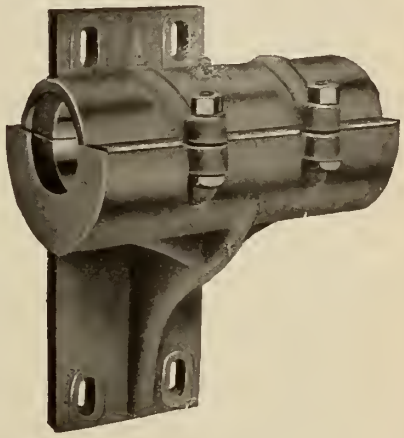


FIG. 26 "Bond" Rigid Ring Oiling Post Box.
Bearings Babbitted and Reamed

FIG. 22 "Bond" Extra Heavy Rigid Pillow Block, designed for extra heavy work.

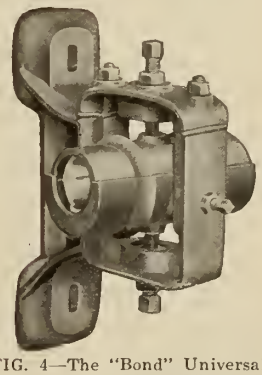
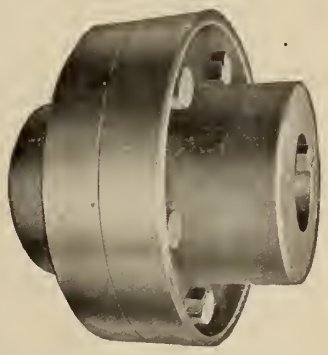


FIG. 4—The "Bond" Universal Ball and Socket Ring Oiling Post Hanger.



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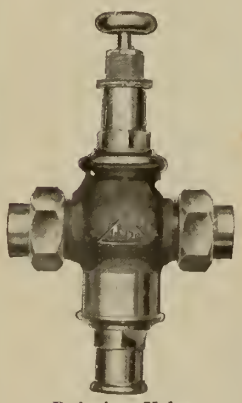
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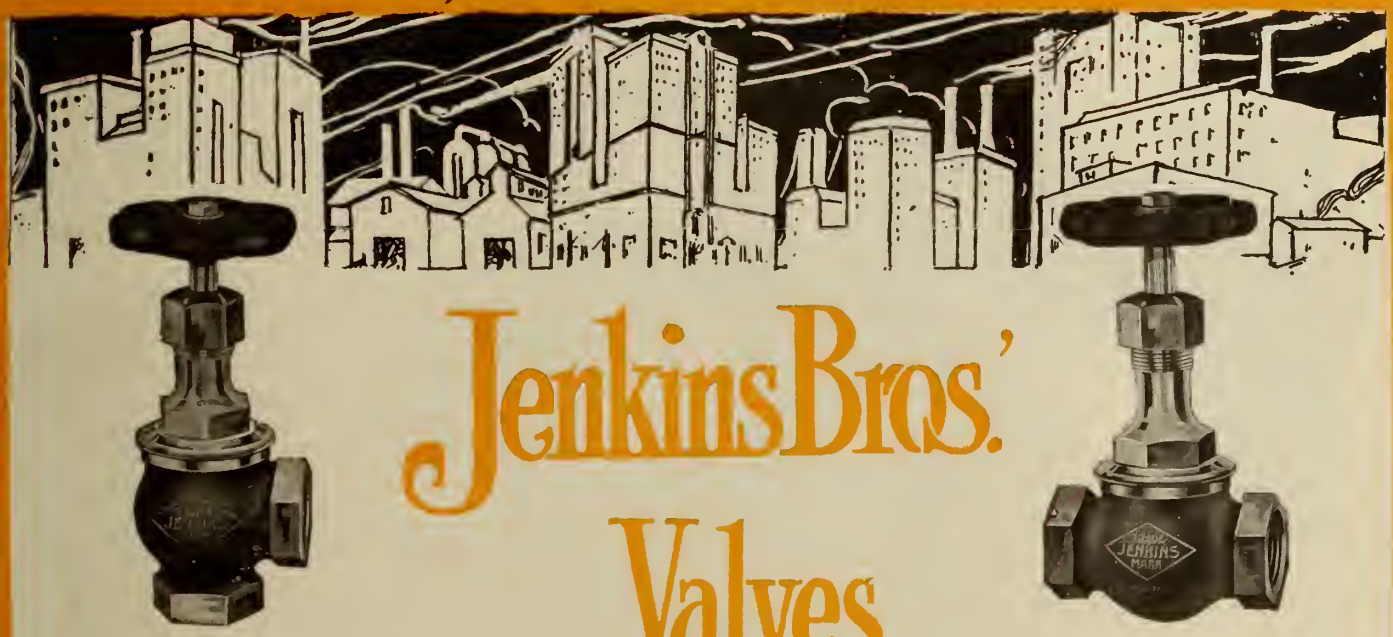

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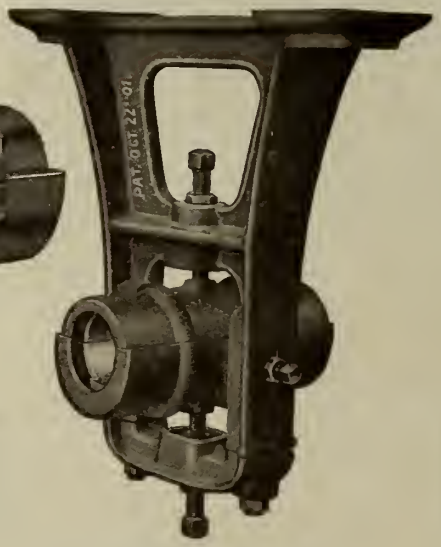
FIG. 19—"Bond" Rigid Ring Oiling Pillow Block. A well constructed bearing babbitted and reamed and self oiling.

FIG. 26—"Bond" Rigid Ring Oiling Post Box. Bearings Babbitted and Reamed



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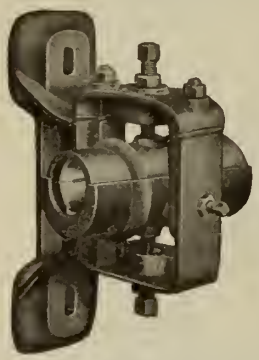

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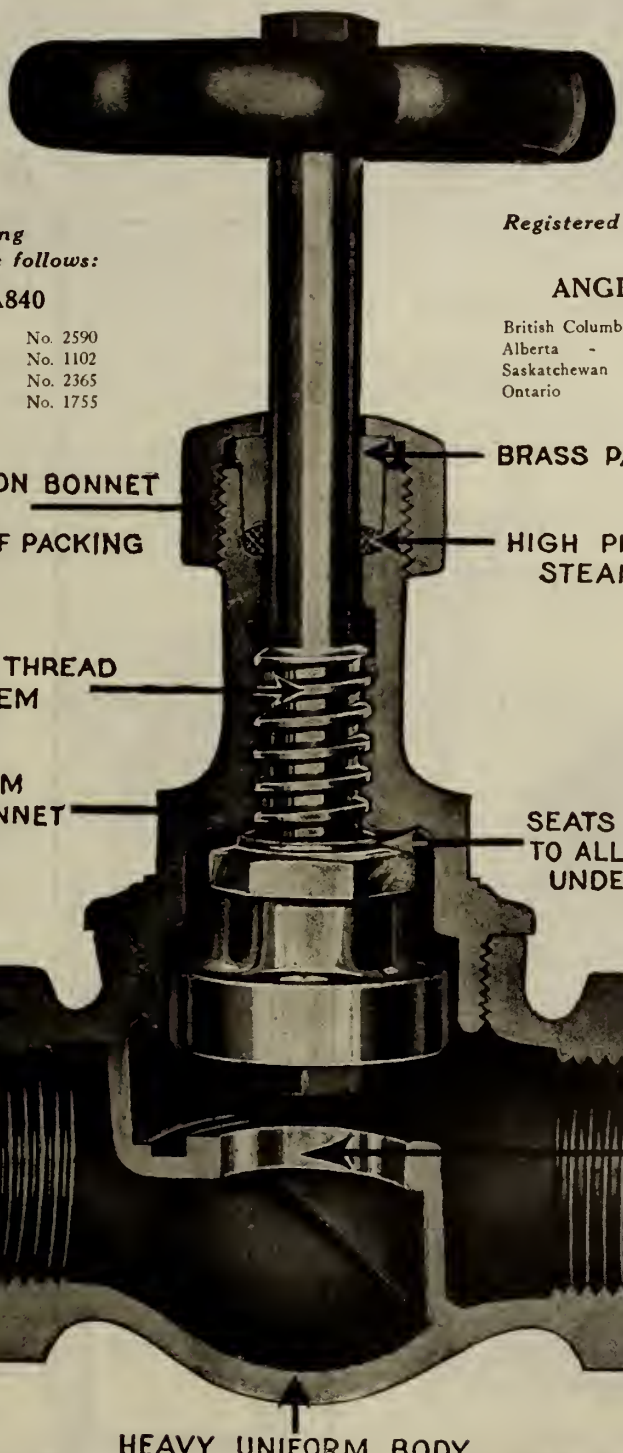
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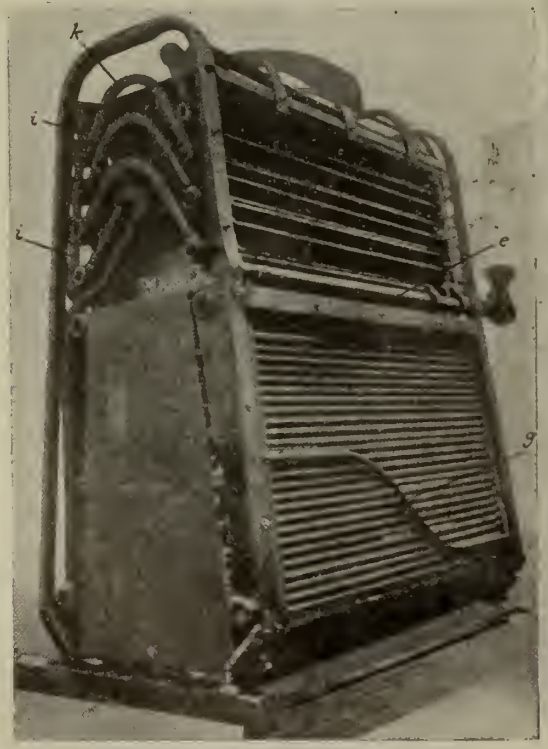

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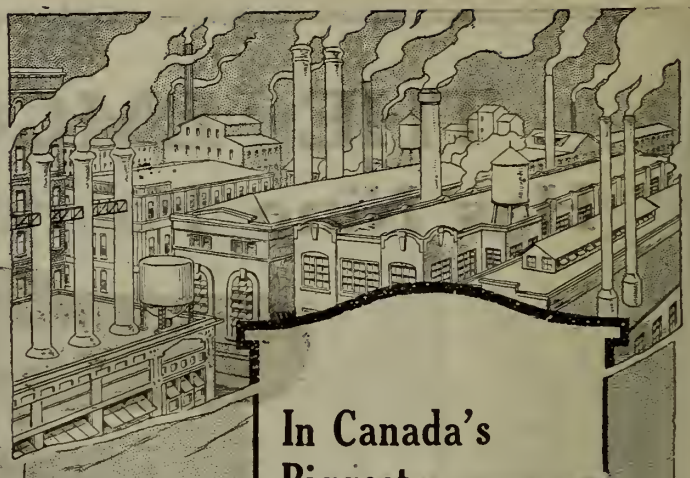

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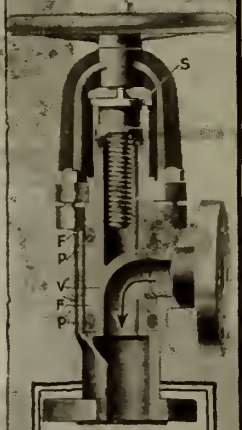

Operation: In closing valve shoulder "S" on plunger "V" engages the lose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

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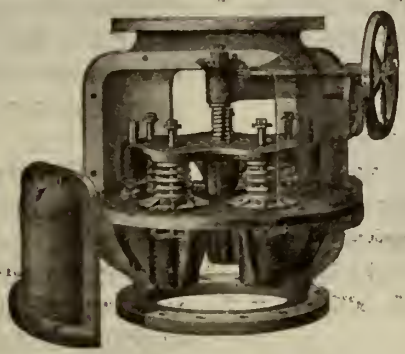
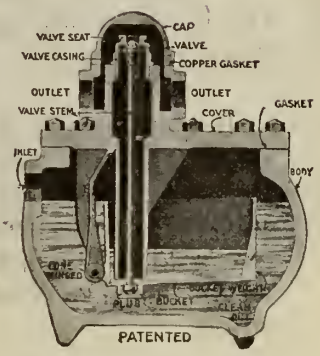
Reliable Power Plant Equipment

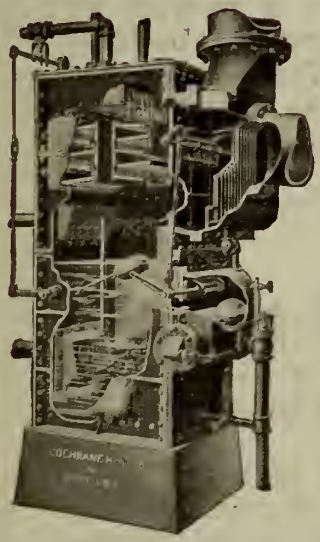
Manufacturers of Water Tube, Horizontal Return Tubular and Locomotive Type Boilers



Multiport Back Pressure Relief Valve

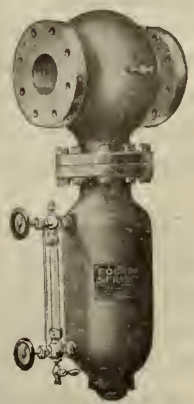


Squires Steam Traps



Cochrane Feed Water Heaters and Metering Tanks

Boiler Feed, Underwriter Fire, Turbine, and Centrifugal Pumps



Cochrane Steam and Oil Separators

CANADIAN ALLIS-CHALMERS
LIMITED

Head Office: TORONTO

Branch Offices: Montreal, Quebec, Halifax, Sydney, St. John, Ottawa, Hamilton, London, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Nelson, Vancouver and Victoria

The Publisher's Page

TORONTO JULY 5, 1919

Oversold Output Is Advertising Impetus

AMONG the factors which make advertising such a dominant force in American business is the faith of the largest investors in the printed word.

It wasn't so long ago—as a matter of fact has the time really passed?—that a manufacturer curtailed his advertising because his factory was oversold. The old cry, "Nothing to advertise; I'm flooded with orders," ruled.

Fortunately for the manufacturer, this view has given way to sound merchandising. The advertiser to-day sees the value and necessity of intrenching himself in the market he has won, even though the counter attack of his competitor seems far off, even improbable.

Back in the days when the world was engaged in position warfare it was a principle that a portion of captured line must be **consolidated** without delay. The whole idea was this—a section of the enemy's line had been captured, but that enemy's dominant purpose was to reform his forces and counter attack. Sometimes the position was lost and taken a dozen times.

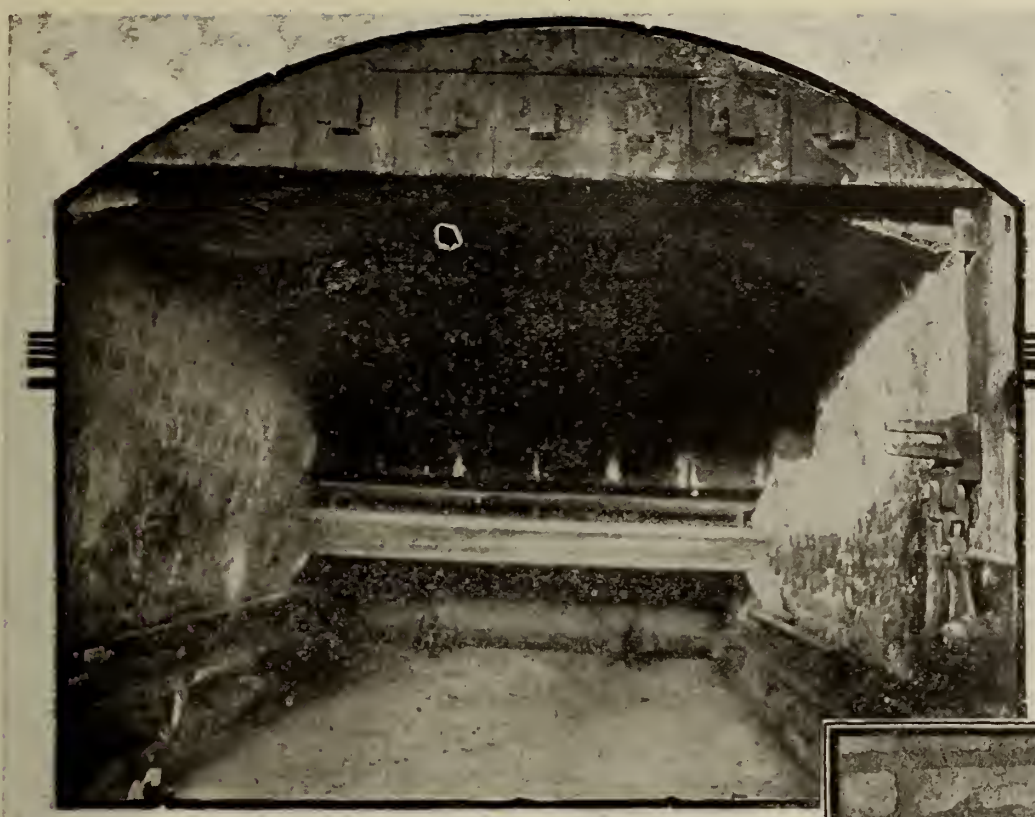
This necessity of consolidation, of digging in and preparing for the counter thrust, exists in business. And the more important the position held, the more tempting is the counter attack desire.

The Goodyear Tire & Rubber Company recently threw a bulwark of newspaper pages between its business and competition. This concern advertised that in spite of an output increased to an average of 24,536 finished tires a day, it had been impossible to meet existing demand for its product.

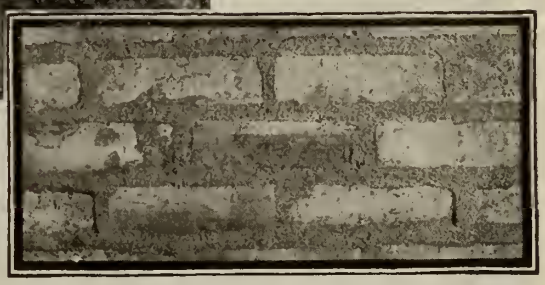
The consumer is told that the Goodyear Company regrets its inability to serve all of its customers, despite its increased production.

The dealer is not neglected. The consumer is asked to overlook any shortage in the dealer's stock because of the impossibility of keeping that stock complete. This is another link in a remarkably fine consolidation.

All this goes to show that this keen advertiser knows that it does pay to advertise aggressively even though the factory output is sold out a long way ahead.—Printers' Ink.



Western Clock Co.
La Salle, Illinois



Fire-Brick Wall Set Up With High Temperature Cement No. 31

Fortifying Furnace Settings Against Heat Attacks

IN every furnace setting there are hundreds of weak spots where adjacent brick sides and their edges meet.

It is here that heat inflicts its first damage—makes repeated attacks on the clay mortar, which crumbles, drops from place, and exposes the entire setting to rapid disintegration. This is the "why" of a short-lived and leaky setting.

The setting can be fortified against early failure by employing

Johns-Manville Heat Treatment

as a bond between bricks. They provide a cushion for brick expansion and contraction. They vitrify and retain their properties under high heats.

The entire fire-brick setting face should be coated with Johns-Manville High Temperature Cement, which, on vitrifying, presents an homogeneous, finished coating, which is unaffected by setting contraction and expansion, and proof against the adherence of clinkers. By filling in surface irregularities of the masonry, which it does, it prevents local hot spots and the consequent spawling or cracking of bricks. Ask our nearest branch to furnish interesting details.

Canadian Johns-Manville Co., Limited

Montreal Toronto Vancouver
Winnipeg Hamilton London
Ottawa

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

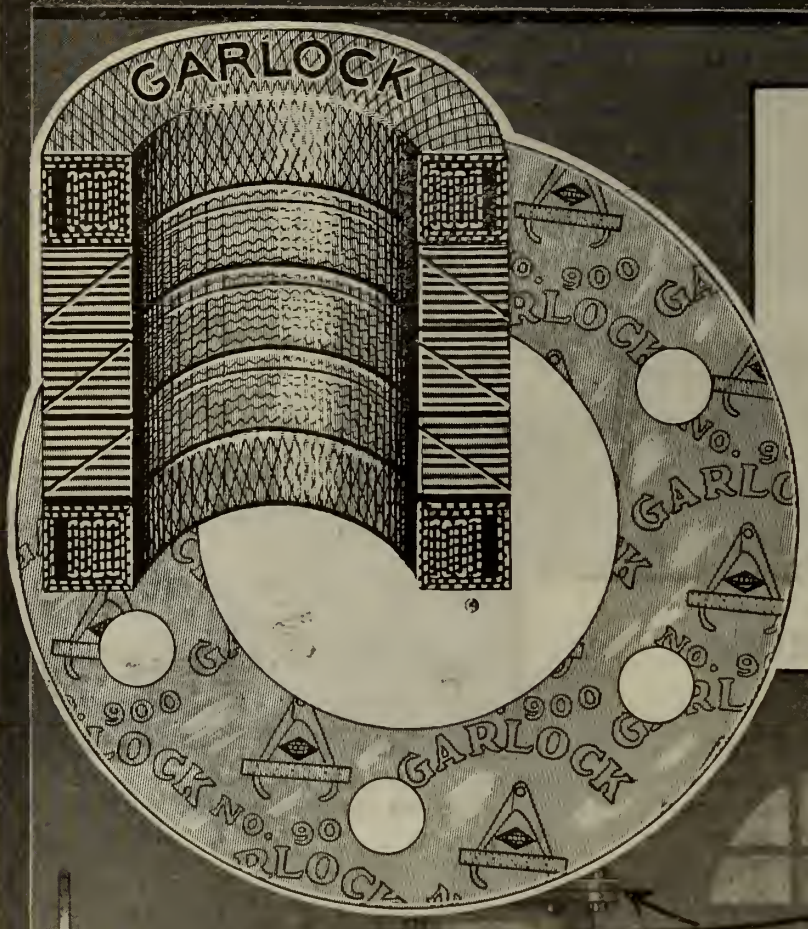
and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE
POWER PLANT MATERIALS

GARLOCK PACKINGS



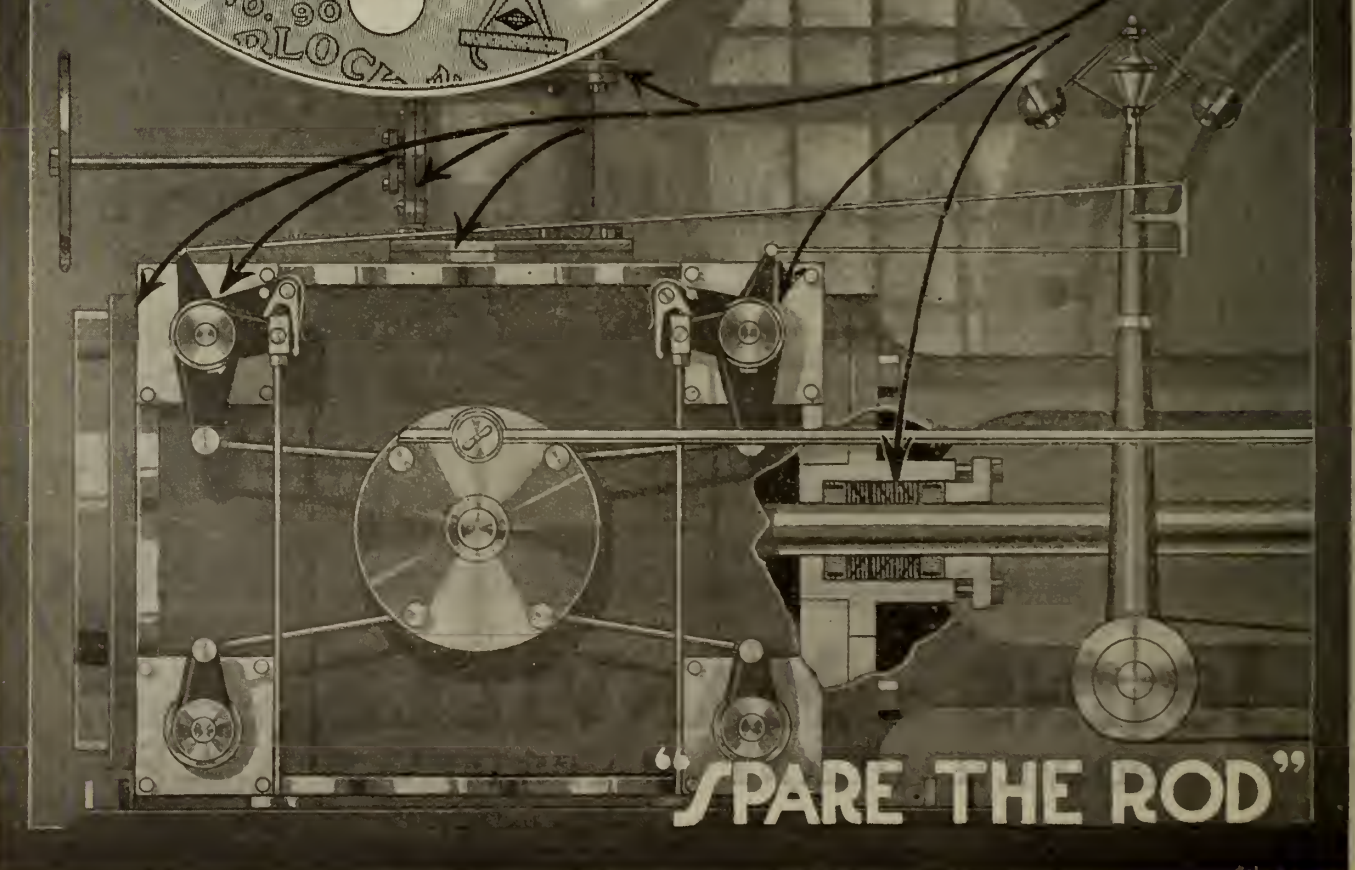
Pointers on a Well-Packed Engine

For high-pressure piston rods and valve stems, use Garlock No. 200.

For medium-pressure piston rods and valve stems, use Garlock No. 446.

For cylinder head, flange and other joints, use gaskets cut from Garlock No. 900 Sheet (No. 950).

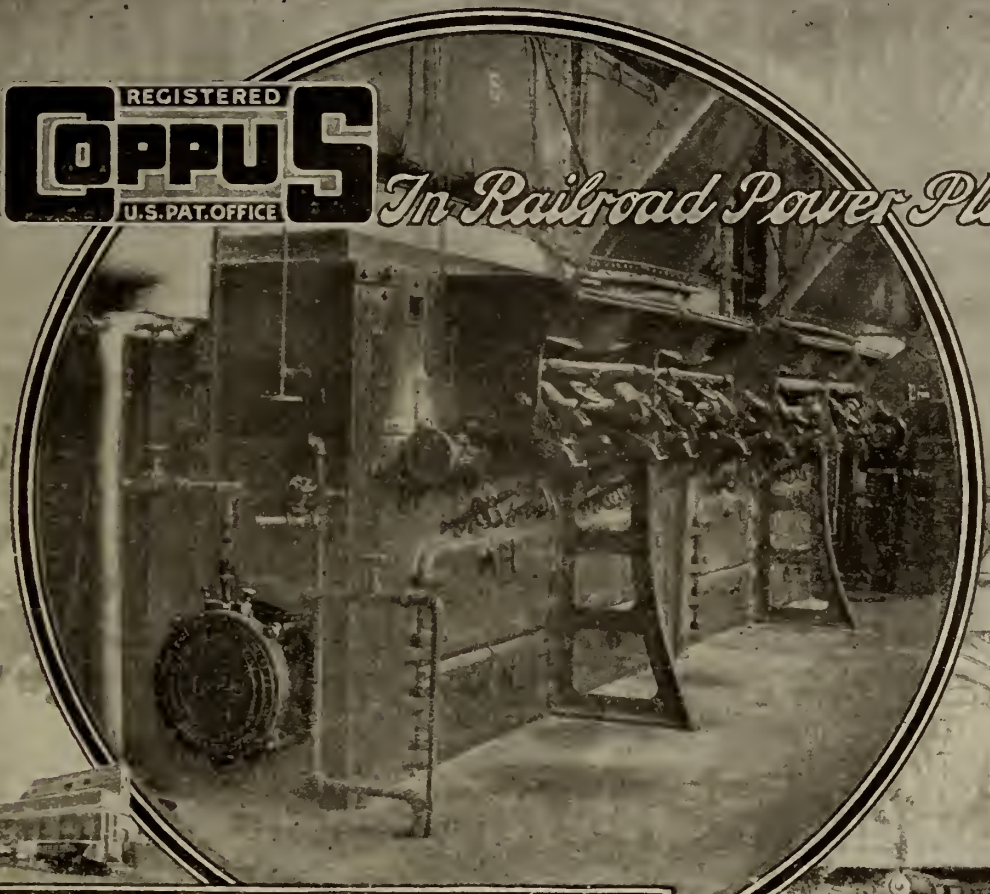
THE
Garlock Packing Co.
HAMILTON, ONTARIO
Branches in Principal Cities



"SPARE THE ROD"

REGISTERED COPPUS U.S.PAT.OFFICE

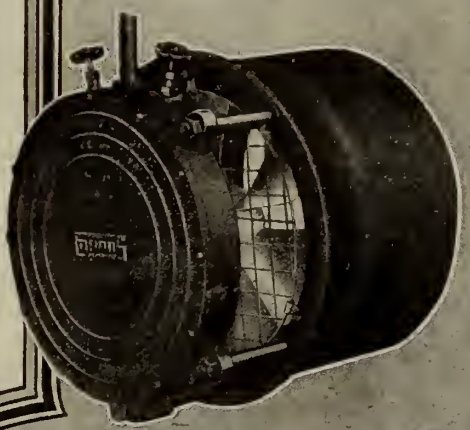
In Railroad Power Plants



Railroads are sticklers for efficiency. Equipment approved by them must produce results—save money—earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers pay.

Every one of this big battery of blowers—one of which is shown above—has cut coal costs—reduced labor charges—and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peak loads quickly—and burn cheap fuel.

COPPUS Blowers pay a profit to the Central Railroad of New Jersey. **They can do as much for you.** Why not put them on the job? Catalog H-10 will show you how "COPPUS Equipment can save you money."



THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

Manufacturers of COPPUS Turbo Feed Pumps and COPPUS Power Turbines

341 Park Ave., Worcester, Mass.

COPPUS TURBO BLOWER

LINDE
REFRIGERATING MACHINERY

Is known and recognized the world over as

The Standard Refrigerating Machine

We have carefully studied Refrigeration under all conditions in Canada for the past 25 years and know what is best for the Canadian Manufacturer.

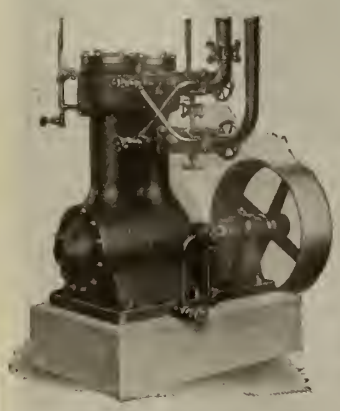
Our Machinery is "Made in Canada"

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

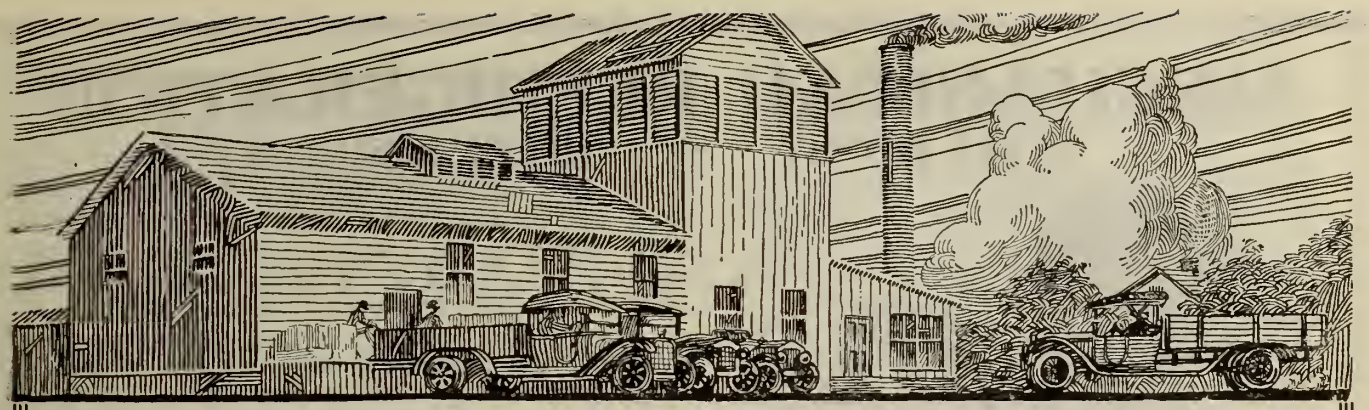
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



Ice Plant Necessities

FRICK

Filters	**Dip Tanks**	**Cranes**
Ammonia Distillers	**Ammonia Fittings**	**Pneumatic Hoists**
Ice Cans	**Can Dumps**	**Electric Hoists**
Can Fillers	**Truck Hoists**	**Float Tanks**

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of "Ice and Frost."

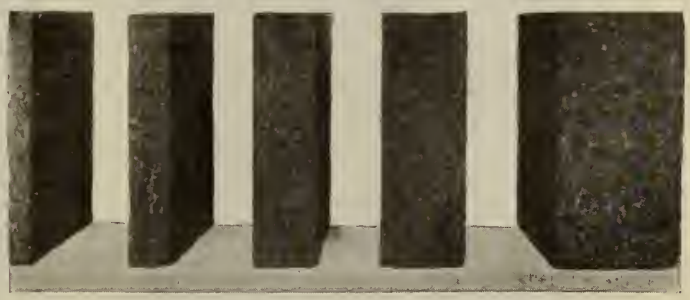
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Quadruple Inspection Means Uniform Quality

Uniform high quality, which is so necessary in cold storage insulation, does not just happen. It results only from the careful selection of raw materials, scientific manufacturing methods and the rigid inspection of the finished product. The uniform high quality of



Nonpareil Corkboard — 1, 2, 3, 4 and 6 inches thick, sawed through the middle. Notice the uniform structure in all thicknesses.

NONPAREIL CORKBOARD INSULATION
For All Cold Storage Rooms

is obtained by using only the best cork waste produced, the larger part of which comes from our own plants in America and abroad. All of the granulated cork is carefully screened to take out the fine particles, dust and other foreign matter, which decrease the strength of the corkboard. The baking is done in scientifically constructed ovens, thus insuring uniform and thorough baking in all thicknesses. This is a most important operation, since corkboard that is not properly baked will not stand up in service. The edges, ends and sides of every sheet are trimmed and sanded by machinery, making them uniform in size. Finally, each finished board is inspected four times before it leaves the factory, thereby assuring the purchaser that his Nonpareil Corkboard will have the same uniform high quality that has earned for this material the title of "The World's Standard Cold Storage Insulation."

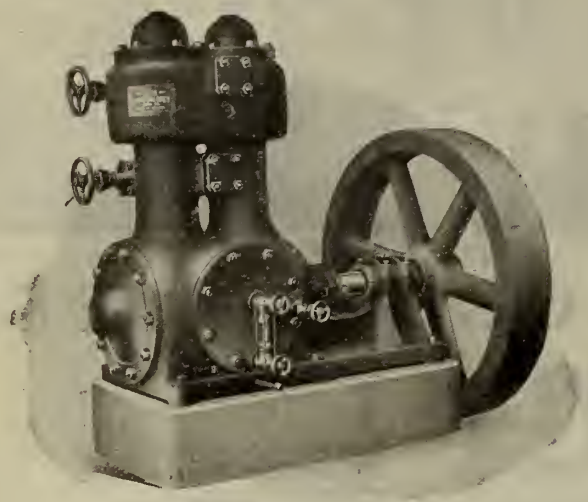
Complete stocks of Nonpareil Corkboard constantly carried in our warehouses at Toronto and Montreal enable us to make prompt shipments to any part of the Dominion. Literature and samples will be cheerfully sent on request.

Armstrong Cork & Insulation Co., Limited, 504 McGILL BUILDING, MONTREAL, QUE.

Also manufacturers of Nonpareil Cork Covering for cold pipes and Nonpareil High Pressure Covering for all steam lines

MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS



"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

YORK MANUFACTURING CO.

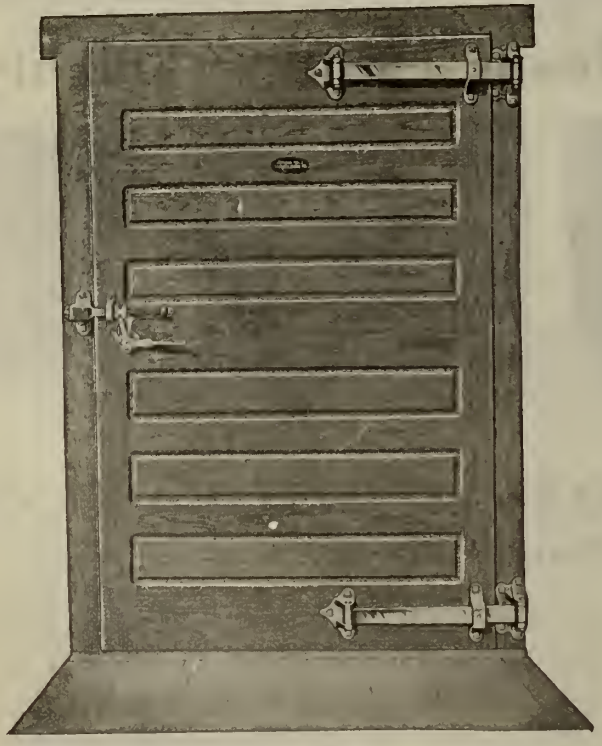
(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA., U.S.A.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 324 Craig St. West | CALGARY 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

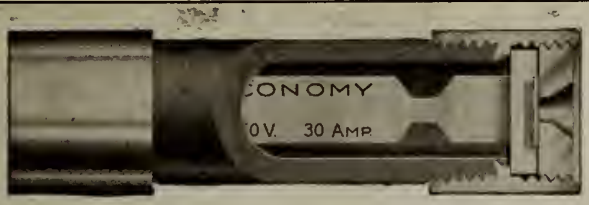
THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. HAGERSTOWN, M.D., U.S.A.



ECONOMY Renewable FUSES

are in greater demand than any other fuses because ever since their first appearance on the market their performance has proved them worthy of the trust placed upon them.
They are accurately rated—efficient in operation. They are safe in every respect—not sometimes but always.
As compared with the use of one-time fuses, they cut annual fuse maintenance costs 80%.
An inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency.
Economy Fuses and Links live up to their name. The economy they effect is considerable—too big for you to ignore. Besides, you will profit by the added measure of safety they insure.
Sold by all electrical jobbers and dealers.

Write for Catalog 24

ECONOMY FUSE & MFG. CO.
Of Canada, Ltd.
UNITY BLDG. MONTREAL
Manufacturers in Canada of S. & C. High Potential Fuses—To 150,000 Volts

UEHLING WASTE METER

COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

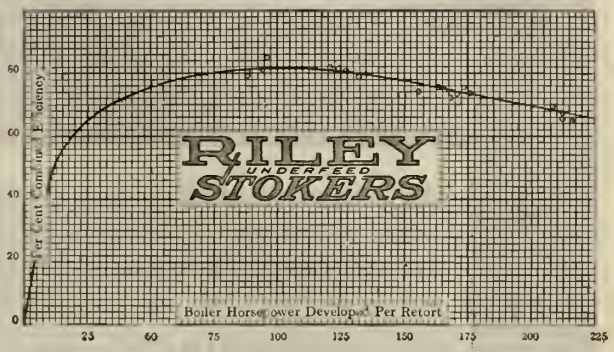
CO2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company
2008 Empire Building New York City

High Efficiency



THE high efficiency with which the Riley Stoker operates is shown by the above curve which is plotted from a series of tests conducted on a sixteen-retort stoker installed under a 1373 H.P. boiler at the Essex station of the Public Service Electric Company, of Newark, N.J. The continuous high efficiency and large overload capacity are due to two very important features:

1. **The moving grates** which keep the fuel bed open, porous and free from clinkers.

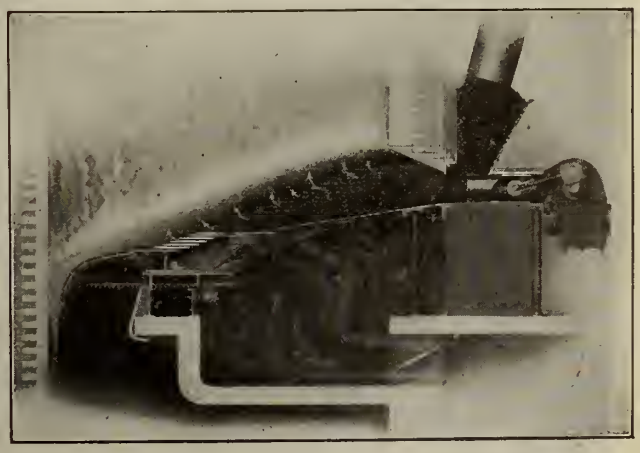
2. The continuous automatic ash discharge which removes the refuse as fast as formed.

Our catalog HR-7 explains in detail how the Riley Stoker with its live-grate surface boosts efficiency and increases capacity.

For information on the Murphy Automatic Furnace for smaller boilers, see June 20th advertisement, or send for Murphy catalog HM-7.

Sanford Riley Stoker Co.
Worcester, Mass.

British Licensees: Erith's Engineering Co., Ltd. London, French Licensees: Erith, Leroy and Cie., Paris, France.



THE SCOOP CONVEYOR

An original, distinctive and serviceable labor-saving machine for storing, reclaiming and transferring material, for loading and unloading cars, trucks and wagons.

Over 1000 Users

Our 1919 model, the result of *experience, standardization and quantity production* embodies life-prolonging and service-giving improvements. Made in six different sizes. Prices, from $390.00 to $770.00. Complete, with Electric Motor or Gasoline Engine.

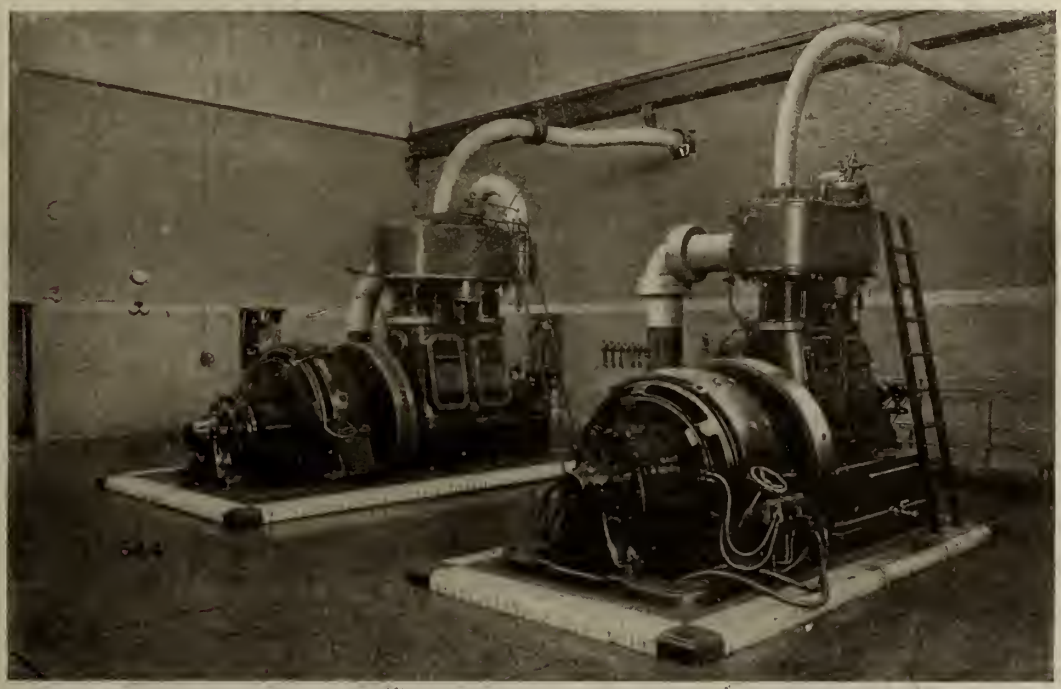
Illustrated literature showing its wide range of application mailed on request

PORTABLE MACHINERY CO., INC.
PASSAIC, N.J.

PORTABLE MACHINERY CO. INC. PASSAIC, N.J.

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss Engines at McGill University Power House

Steam and Exhaust Turbines
Diesel Engines, Air Compressors
Condensing Plants, Steam Engines

Heanan Refuse Destructors
Air and Water Coolers
Dynamometers

Paterson Water Softening Plants

Centrifugal Pumps

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.

Two Rees RoTURBo Pumps recently completed b y us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE:	WESTERN BRANCH:	QUEBEC AGENTS:	BRITISH COLUMBIA AGENTS:
Suite 1101-2, Bank of Hamilton Bld'g.	248 McDermott Ave., Winnipeg, Man.	Ross & Greig 400 St. James St., Montreal, Que.	Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 Published Semi-monthly

The Brantford Power Plant of the Massey Harris Co.

An Installation Recently Overhauled and Brought to a High State of Efficiency. New Steam Piping Has Been Installed Throughout

By W. F. SUTHERLAND

BRANTFORD'S industries have gained for her the enviable reputation of being one of Canada's foremost manufacturing centres, and the many factories require considerable power for their operation. Much of this is at present obtained from the Hydro-Electric system; some is developed locally through the utilization of the Grand River, and the remainder is generated in isolated steam plants.

The power plant of the Massey-Harris Co. is one of the larger of these and contains a number of features of interest to the operating engineer.

The shavings and other mill waste from the carpenter and woodworking shops forms a major portion of the fuel used, and the boiler-room for this reason is of interest to those accustomed to the use of coal for fuel. The three boilers at the end of the battery are fitted with shaving spouts and the shavings are fed directly onto the grate bars from the exhaust system. The remaining boilers, or such of them as are used, are fed by air-blast through cyclones.

During the night when the woodworking shops are shut down, coal is used, when the excess mill waste and shavings accumulated throughout the day is used up.

Six boilers are installed, five of them 72 in. by 16 ft., of John Inglis make, and one 74 in. by 14 ft. boiler of Goldie and McCulloch make. These boilers are connected by a common steel breeching to a radial brick stack of 6 ft. opening at the top, and 150 ft. high. The breeching, where it enters the stack, measures 4 ft. wide by 7 ft. high.

Plastic cement is used on the boilers for the elimination of air filtration.

The Engine Room

The plant is supplied with the major portion of the power required by means of a jackshaft running through the engine-room and belted to the 300 h.p. cross-compound Wheelock engine there installed. This main drive belt is a 30-in. Beardmore and has been in constant service for over 20 years.

The Wheelock engine is run condensing in the summer and the exhaust steam is used throughout the colder months for heating purposes. A Goldie and McCulloch jet condenser is installed.

An auxiliary lighting set is installed for use when needed. This unit consists of a 50 kw., 110 volt d.c. generator direct connected to a McEwen high speed engine of Waterous manufacture.

WHEELOCK ENGINE—THE BELT SHOWN HAS BEEN IN USE FOR OVER 20 YEARS.

During the overhauling of the plant recently completed, a Bury compressor, made by the Bury Compressor Co., Erie, Pa., was installed, taking the place of an older machine, which had outlived its usefulness. The new machine is of the two-stage intercooler type and supplies air for shop purposes and for the sand-blasting department.

The smithy is provided with its own engine, a 14 in. by 34 in. Wheelock engine of 125 h.p. This engine in addition to the smithy requirements also drives a Jones and Moore 25 kw. d.c. generator used for charging storage batteries, which operate the time clocks, fire alarm system and the automatic telephone exchange.

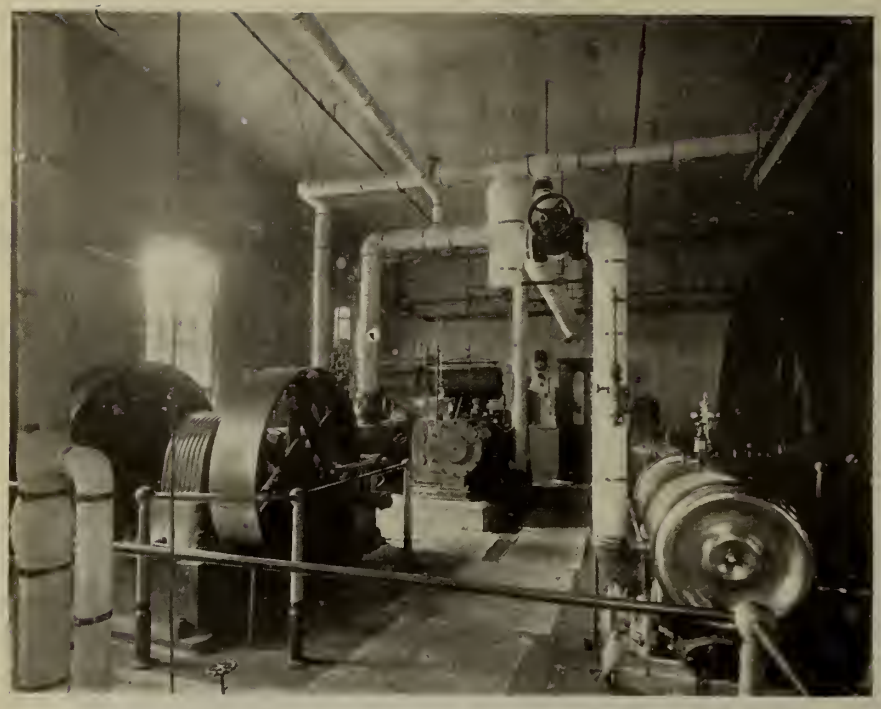
The smithy also has its own compressor, a 22 x 14 in. Bury machine with an 8 in. suction and 5 in. discharge.

The engine and compressor in this department are fed from the boiler-room through a steam header from the main engine-room.

Steam Headers

Together with other alterations which have been completed, the steam piping has been made, which greatly added to the efficiency of the plant. Purdy Mansell, of Toronto, had charge of this work and also of the alterations to the heating system, which occurred at the same time. The buildings are now heated with exhaust steam from the various engines and compressors, approximately 17,000 sq. ft. of 1¼ in. pipe radiation having been installed in the various mechanical departments.

The main steam header is 10 in. and the risers from the boilers enter it from the bottom, each riser being drained at the header and the drips lead back to a drip header, from which any condensation is removed by a trap.



ENGINE ROOM SHOWING COMPRESSOR AND McEWEN ENGINE.

From the main header separate lines are carried to the underwriters' fire pump, the engine-room and to the engine in the smithy. The main to the fire pump is of 5 in. pipe, that to the engine-room 8 in., and that to the smithy 4 in.

A four-inch exhaust line is carried through the smithy and forge shops for heating purposes.

The exhaust from the engines and auxiliaries is arranged in such a manner that it can be passed through the feed-water heater on its way to the heating mains, or the heater can be by-passed for cleaning at any time desired.

Webster traps are fitted throughout and a Tod-Atwood vacuum pump removes all condensate from the heating mains, returning it to the heater. This pump is 4 by 4 in. and is capable of handling all condensate from 37,000 ft. of 1¼ in. pipe, besides radiators.

A live steam line, 4 in. diameter, is also carried to the blast engine for the cupola in the foundry.

Lagging

All steam piping has been lagged with Philip Carey four-ply air cell insulation, and steam lines between different buildings with six-ply insulation of the same make covered with 2 ply of building paper wrapped with copper wire.

Jenkins valves are used throughout.

Feed-Water Piping and Pumps

A very flexible arrangement of the feed pumps and piping has been secured, which insures against interruption in the supply of feed-water to the boilers. Three outside packed feed pumps are connected up in such a way that they may feed either the boilers or the domestic supply. Two are usually run on the boilers, the third ordinarily being used for domestic supply, pumping water from a cold water well to a tank on the roof, and providing for all water requirements throughout the plant except for drinking. Any one of the three pumps may be connected to any one of three sources of supply, the condenser hot well, the cold well above mentioned, or the feed-water heater.

The feed line from the pumps to the boiler-room ends in a header, from which the separate feed lines to each boiler are run. Each line is provided with a valve at the header and between this valve and the boiler another connection is made to another header which supplies city water, or domestic water for filling up the boilers after washing down or for other purposes.

For washing down purposes another line is carried over the boiler settings, and is fed with city water. Outlets are provided between each boiler, and it is an easy matter to connect it up, the hose run it through the open manhole and wash down the boiler with little trouble.

The feed-water heater is of the Moffat type, made by Goldie and McCulloch.

Motor Load

A number of motors are used throughout the various shops and take their supply from outside sources. The bolt department line shafting is run by a 100 h.p. motor, the foundry clearing department by a 75 h.p. motor, the woodworking department by a 100 h.p. motor and the tool-room by a 35 h.p. motor. All these motors are of C.C.E. type, manufactured by the Canadian Westinghouse Co.

Mr. R. Simpson, of 178 Wellington St., Kitchener, Ontario, writes:

"I think it is a good thing for the engineer that POWER HOUSE is published twice a month. I have taken it for a number of years and have received some very valuable information from it. As to changing the price, personally I feel it is worth double the present price."

TELL THEM

When writing to advertisers using space in POWER HOUSE, it is desirable that our paper be mentioned as the source of information. Our advertisers appreciate this, and so do the publishers. Every time our readers do this they co-operate with us in making the real worth of POWER HOUSE known. Advertisers believe in POWER HOUSE, readers believe in it, and so do we. Let's work together to make it more effective in our general interests.

BOILER ROOM, MASSEY-HARRIS CO., BRANTFORD.

SHOWING STEAM HEADER OVER BOILERS

STORAGE OF COAL AND SPONTANEOUS COMBUSTION

Coal should be stored in small quantities as near to the point of consumption as possible. Small coal piles rarely ignite from spontaneous combustion. Coal should be stored near the point of use to avoid re-handling, extra transportation and the degradation of size which follows each rehandling. For these reasons the bureau would advocate storage, so far as possible, in the bins and yards of the ultimate consumer, thus dividing the risk of loss from spontaneous combustion. If large storage piles are necessary, certain general principles must be borne in mind. The generation of heat is the result of slow oxidation of the coal surface. The oxidation is much more rapid from freshly mined coal or from freshly broken surfaces. The oxidation rate increases rapidly with increased temperature. Different coals have different oxidizing rates. These facts lead to the following recommendations:—Where there is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known. Between two coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected.

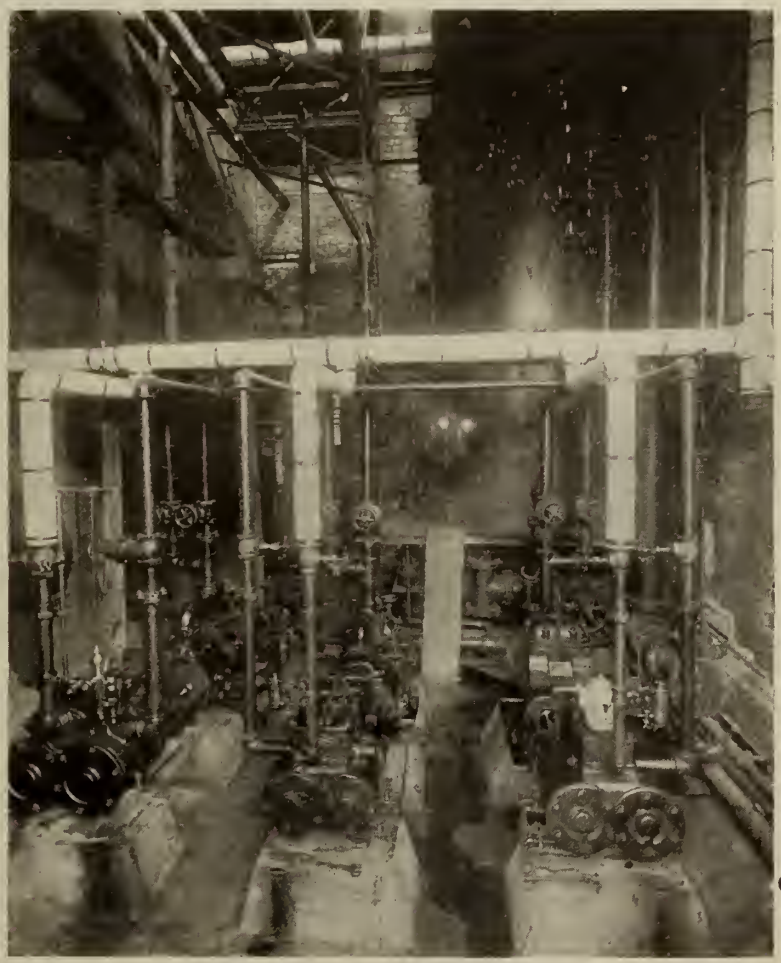
The method of handling should be such as to produce the least freshly broken coal surface. The coal should be as cool as possible when piled. Piling warm coal on a hot day is more likely to produce spontaneous combustion. The coal must be kept from an extraneous source of heat. Alternate wetting and drying of coal during piling is to be avoided if possible. The fine coal, or slack, is the part from which spontaneous combustion is to be expected. Piling of lump coal where possible is therefore desirable.

In the process of handling, if the lump coal can be stored and the fine coal removed and used immediately, the practice prevents spontaneous combustion in coals which would have otherwise given trouble. The sulphur content of coal is believed by many to play an important role in spontaneous combustion. The evidence on this point is still conflicting, but to play safe, it is desirable to choose coal having a lower sulphur content when choice is possible.

Coal piles should be made so that there is ready movement of air for ventilation throughout all parts of the coal pile. This is the condition when the entire pile is made of coarse lump coal. With ordinary coal piling this is difficult. The surfaces of coal piles should be so exposed as to allow the pile to cool; or else the coal should be so stored that air circulation within the pipe is very small. When the air circulation is reduced to a minimum, as in air-tight bin, with no opening in the bottom, the oxygen of the air is soon removed and the mass of the coal lies in an inert atmosphere, except for small local circulation near the surface. Air-tight bins are usually impracticable, but the following practice is recommended to approximate these conditions:

In making a coal pile of mixed sizes, the coal should be so handled as to make a homogeneous pile and prevent the segregation of coarse and fine coal. This frequently determines the most desirable machinery for unloading coal. It is common practice to limit the height of a coal pile, this for two reasons:—A pile too high crushes the lower layers of coal, producing more fines; the larger the pile the less the heat-dissipating surface there is exposed in proportion to the heat generating capacity of the pile. Twelve feet in height is a common limit.

Whatever precautions are taken in choice and handling of coal, provision should be made for keeping track of the temperature rise in a coal pile and for rapid rehandling of portions of a pile in case of excessive heating. In a coal pile covering considerable area, it should be so subdivided that in case of spontaneous combustion of a portion, the heat will not be transmitted to the whole pile, thus accelerating the heating of portions of the pile which normally would have remained cool.



BOILER FEED AND DOMESTIC PUMPS.

The Thirtieth Annual Convention of the C.A.S.E.

Delegates, Visitors and Exhibitors Spend a Pleasant and Instructive Three Days at Brantford—Business and Pleasure is in Equal Proportions—The New Officers of the C.A.S.E. and Exhibitors' Association

By T. H. FENNER, Editor Marine Engineering

WITH thoughts unclouded by the dark shadows of war and its attendant calamities, the delegates of the Canadian Association of Stationary Engineers met to celebrate the 30th annual convention of their order. The city of Brantford, rich in natural beauty and historical associations, was the chosen venue, and the arrangements made for the entertainment of delegates and their friends by the local lodge and the Exhibitors' Association left nothing to be desired. The only factor that fell down on the job was the weather man, who sent along a sample of his wet goods, which however much needed by the surrounding country, could have been well dispensed with, or at least postponed for a couple of days later.

However, neither delegates or exhibitors allowed a little thing like inclement weather to upset their plans. When the proposed outdoor events were banned by Jupiter Pluvius, they took up a strategic position in the capacious Brantford Armories and pulled off the hair-raising athletic programme with great success. The hardwood floor proved as good for track purposes as the greensward, and though as far as we know, no records were broken, very creditable times were made by the various contestants.

The Convention Hall

The problem of finding a suitable hall for the convention was a difficult one, but the local lodge solved it by taking possession of the emergency hospital, a one-storey wooden building adjacent to the armoury.

This gave the first requirement, space, and the advantage of a ground floor location for the various exhibits, some of which were heavy. Great credit is due to Mr. Gordon Keith and Mr. Betton of the Exhibitors' Association, who worked hard and long to give the bare interior a more pleasing appearance. With the aid of canvas, crinkly paper, and much goodwill they achieved wonders. Indeed, the citizens who visited the hall hardly recognized it as being the same building.

Monday night saw practically all the decorations completed, and the majority of the exhibits installed. Tuesday morning saw the official opening of the convention, when the big guns of the association and the exhibitors fired their salutes of welcome to delegates and visitors.

Official Opening

The official opening was scheduled for 10 a.m. and the mayor of Brantford was down for the opening speech of welcome, However, his worship failed to appear, or to send any explanation of his absence. Bro. W. Welsh, President of the Brantford Lodge, in a few direct words, declared the convention open, and was followed by E. L. Webster, Secretary of the Brantford Convention Committee. W. Cooke, President of the C.A.S.E., replied, followed by C. Z. Schrag, President of the Exhibitors' Committee; Lieut. L. Archibald, Fred W. Raven, Secretary N.A.S.E., and C. Z. Wyse, Educational Secretary of the N.A.S.E. Mr. Welsh, in the course of his remarks, mentioned that this was the second convention held in Brantford, and that but three of the charter members of the lodge were still in evidence. Lieut. Archibald, of the Dart Union Co. and past president of the Exhibitors' Association, is but lately returned from a prison camp in Germany. He enlisted in the Flying Corps and was captured when his machine was forced to descend in the German lines. He told an amusing story of the German commandant of one of the camps he was in. This officer spoke very good English, some of which was distinctly colloquial, the only trouble being he sometimes failed to realize the exact meaning of the slang he used. On the occasion of the arrival of a batch of prisoners he had them lined up in front of him while he impressed them with a sense of German superiority.

"You English think you know a few things, and so do the French, but we Germans, we know dam-all."

This last expression is very common in England to signify an absolute negation of knowledge.

Lieut. Archibald, in expressing his gratitude to his fellow members of the Exhibitors' Committee for the parcels of food sent him, told a story illustrative of the value of food to a hungry man. At the camp he was held in, the chief article of food was a liquid remotely resembling coffee. One of the English prisoners who had a good supply of money, observed a fellow-prisoner with a piece of the black bread that was occasionally issued. This was about four inches square. The Englishman tried to buy it, his final offer being a sum equivalent to $20, and this failed to induce the owner to part with the unsavory morsel.

The afternoon session was devoted to a meeting of the C.A.S.E. executive, while the ladies of the party paid a visit to some of the Brantford factories.

The evening was devoted to lectures about which more will be said later on in this report.

The Second Day

During the morning the C.A.S.E. executive were busy with association affairs, while the delegates and visitors had an opportunity of visiting the exhibits. These represented a great variety of power plant necessities, and the representatives of the firms were on hand to explain the uses and points of the articles displayed.

Following is a list of the exhibits:

James Morrison Brass Mfg. Co., Toronto.
Goldie McCulloch & Co., Galt.
Mason Regulator and Engineering Co., Montreal.
R. Sexton Fire Brick Co., Toronto.
Thomson Gordon Co., Toronto.
Allen General Supply Co., Toronto.
H. Mueller Mfg. Co., Sarnia.
Canadian Allis-Chalmers Co., Toronto.
Dearborn Chemical Co., Toronto.
Kitchen R. R. Signal Overall Co., Brantford.
Dart Union Co., Toronto.
Jenkins Bros., Montreal.
Quaker City Rubber Co., Toronto.
C. A. Dunham Co., Toronto.
Kerr Goodwin Machine Co., Brantford.
Garlock Packing Co., Hamilton.
John H. Hall & Sons, Brantford.
Dunlop Tire & Rubber Co., Toronto.
Empire Mfg. Co., Toronto.
France Packing Co., New York.
Chapman Double Ball Bearing Co., Toronto.
E. J. Philip & Sons, Toronto.
Lunkenheimer, Cincinnati.
Equipment Specialty Co., Toronto.
V. B. Anderson Co., Cleveland.
Power, New York.
Canadian Manufacturer, Toronto.
Power House, Toronto.

After lunch everybody adjourned to the Armoury and took up favorable positions for viewing the sports.

The first event on the programme was by far the most exciting. This consisted of a hockey match, between teams representing the Engineers and Exhibitors. The hockey sticks used were corn brooms, the puck being an undersized Association football. Both teams went at it in deadly earnest, and had some of the blows aimed connected with the ball, the resulting concussion would have been heard in Toronto.

However, the ball had a propensity to be a little above or a little below the spot aimed at, so all that happened was a graceful spin on the part of the swatter.

The umpire, Mr. Keith, being built, as one gentleman expressed it, "for comfort rather than speed," let some doubtful plays get by, but on the whole was satisfactory.

The Exhibitors won by one goal to nothing, which represents the play fairly well.

The combination of high heels, high speed and high polish (of the floor), proved too much for one of the contestants in the married ladies' race. She es ayed to slide home instead of running, and collected a considerable amount of dust, which liberally carpeted the floor.

The various events were well contested, and the afternoon was voted a huge success, and a fitting overture for the evening to come.

The evening's entertainment in the convention hall consisted of the prize giving to the winners of the afternoon contests, a sale of curios in aid of the local hospital, songs and speeches. Mr. E. B. Curzon of Montreal opened the musical part of the programme with "Long Live the King," following with "When the Bell in the Lighthouse Rings" as an encore. His fine baritone voice showed up well in these numbers. Miss Powell of Brantford, gave a very pleasing soprano solo, and Miss Emma Jackson, a very clever rendering of one of Mr. Dooley's soliloquies on the "Comforts of Travelling."

Mr. E. Hetherington of Galt displayed a very pleasing tenor, and Mr. Jack Armor, of New York, convulsed the audience with a snappy monologue. In the absence of W. C. McGhie, Mr. Mosely ,of the Board of Examiners of Stationary Engineers, spoke on the new licensing laws and graded certificates.

Mr. C. B. Turner had charge of the sale of curios for the Brantford Hospital, and this netted $30.80. An orchestra was in attendance and provided the accompaniments for the singers, besides playing several pleasing selections during the evening.

The Educational Side

One cannot help but feel that this side of the convention, which is one of the utmost importance, did not receive the support to which it was justly entitled. As a past member of the organization the writer recognizes the scope there is for developing this end of their activities, and was surprised to see the attendance so poor at the various lectures given. This was particularly noticeable at the lecture on turbines, which was jammed in at the end of the concert Wednesday evening, when time was extremely limited. This resulted in what might easily have been a very valuable contribution to the business of the convention, being reduced to a mere skeleton, and the writer sympathizes with the lecturer in the remarks he made at the opening of his lecture. The writer would suggest that for future conventions the subject matter of the lectures be printed, and issued to all the members of the various lodges some time beforehand. In this way the delegates would be familiar with the text, and in a position to bring up points for discussion. After all, the object of a convention is not purely the spending of a good time. It is due to the other members of the lodges that their chosen delegates shall have something to show for the expense incurred other than pleasant memories.

Ontario Government's Offer.

The Ontario Government, through Mr. McLachlan, informed the delegates that they were equipping at various centres, well-furnished class rooms. These would be thrown open for the use of the engineers, and the Board of Education was desirous of consulting with representatives of the C.A.S.E. as to the precise form in which they could best help their members from an educational standpoint. This progressive and helpful offer from the Government was well received by the delegates, and no doubt will be taken advantage of in the near future.

The Lectures

Mr. Flanagan, of the C. A. Dunham Co., gave an illustrated lecture on "Steam Heating," showing the growth of the art from the primeval fire in the cave. He also gave instances of right and wrong ways of making connections of steam heating mains and branches.

Mr. I. J. Tait spoke on refrigerating, illustrating his points by lantern slides.

Mr. D. M. Medcalf, Chief Boiler Inspector for the Province of Ontario, read a paper on "Causes of Boiler Failure." He had a choice collection of boiler plates and tubes, which had figured in accidents. These he explained in detail, making a very interesting half hour.

C. J. Porter of Hamilton, gave an illustrated lecture on various types of generators.

The lecture on turbines, by Mr. J. M. Brown of Hamilton, should have been the most interesting feature of the convention, as far as the delegates were concerned. As we said, the lateness of the hour and the scant attendance detracted from its value. Mr. Brown thoroughly understands his subject and has his heart in it, and deserved better support than he received.

The Officers.

The officers of the Grand Lodge for 1919-20 were elected as follows:

Past President, W. Cook, Belleville; 1st Vice-President, G. E. Moll, London; 2nd Vice-President, D. L. Webster, Brantford; 3rd Vice-President, Fred Harper, Kingston; Sec.-Treasurer, John Hale, Hamilton; Conductor, Ross C. Leach, Toronto; Doorkeeper, Geo. Lee, Ottawa; Delegate to N.A.S.E., W. Cook, Belleville; Alt. to N.A.S.E., S. Balmfirth, Toronto.

The next convention will be held at Woodstock, Ont.

The Exhibitors' Association officers were elected for the coming year as follows:

Past President, C. N. Schrag, Toronto; President, Jas. Mock, Montreal; 1st Vice-President, J. E. Fitzgerald, Montreal; 2nd Vice-President, Grant Cole, Toronto; Treasurer L. L. Archibald, Toronto; Secretary, Gordon C. Keith, Toronto; Asst. Sec., Geo. M. Wilkinson; Chairman Exhibits, A. Betton, Toronto; Entertainments, B. Curzon, Montreal; Reception, R. Sexton, Montreal.

COOLING-AIR MEASUREMENTS

At present no accurate method is in common use for determining the efficiency of the turbo-alternators, nor is any standardized conventional method in use in this country. Although the purchaser, since the efficiency of the turbo-alternator is usually expressed in terms of the rate of steam consumption in relation to the output of electrical energy, has little economic interest in the accurate determination of the efficiency of the alternator, the matter is of considerable interest to him, since the alternator efficiency is an indication of the quality of the materials and the excellence of the design. With turbo-alternators of even moderate size the stray loss may be as high as five or six times the ohmic loss in the stator copper, and in the opinion of some authorities may prove to be one of the factors that will limit the output of electrical energy obtainable from a single unit. The usual practice is either to ignore the stray loss or to determine it by a substantially conventional method.

Modern turbo-alternators invariably have forced ventilation, and except for the relatively small amount of heat dissipated from the external surface of the stator all the losses except the bearing losses are carried off by the cooling air. Hence if the volume of air flowing through the machine in unit time and the average increase of temperature that the air undergoes in absorbing the losses are known the total losses on load can be calculated without difficutly. This method, the principle involved in which was the subject of a paper read by Professor R. Threlfall before the Institution of Electrical Engineers in 1903, is the "air heating" method, and Professor Threlfall described the means by which sufficiently accurate measurements of the air volume and temperature can be obtained, provided certain simple precautions are taken. An alternative or "calibrated air-temperature" method which does not involve measuring the air volume consists in ascertaining the increase of temperature in the cooling air caused by a loss of known magnitude in the alternator, and deducing the total losses from the observed temperature rise of the air on load.

Economizers and Economizer Practice

This Article, One of the Series on Power Plant Management, Deals With the Economizer and Its Usefulness as an Aid to Boiler Room Economy. Features of Operation Are Also Discussed

By ROBERT JUNE, Mechanical Engineer

OF all accessory equipment in the boiler room, the economizer has the oldest history, and, in many ways the most secure position. It was in 1845 that Edward Green developed economizer design and construction to a point of practical utility, and the apparatus has been in more or less general use ever since. Curiously enough, America, with her apparently insatiable demands for industrial efficiency, has never adopted the economizer to anything like the extent which Europe has, nor has she accorded it, when adopted, the degree of appreciation and recognition to which it is entitled on merit.

For the economizer does possess merit, in ways which we shall discuss, sufficient to recommend it to the serious consideration of thousands of power plant operators, whose boiler rooms are not now equipped. But before taking up the question of what the economizer does, let us see what it is.

Economizers are of two general types.

(a) Integral, directly connected with the boiler.

(b) Independent, not directly connected with the boiler.

Fig. 1 is a good example of the integral type. The installation, which is to be found at the power plant of the Kansas City Light & Power Co., consists of six 1,300 h.p. B. & W. boilers, with economizers,built of standard drums and tubes of Sterling boilers superimposed. The use of Sterling boiler sections saved time in delivery, reduced cost, and at the same time satisfied the requirements imposed by the operating pressure, which was 300 lbs.

Figs. 2 and 3 (courtesy of Prof. Gebhart), illustrates the independent type, as exemplified by the Green economizer. The Sturtevant economizer, while differing in some details of design and construction, is of the same general type, and need not be separately described, it being understood that superior merit is not here assigned to either equipment, with reference to the other.

The independent economizer, then, consists of a series of rows of cast iron tubes, arranged vertically, in sections. The tubes are usually 9 to 10 feet high, and 4 5/8 in. in diameter. Sections of decreasing width are arranged across the main flue between the boiler and the stack, so that the gases of slow combustion must pass through the tubes on their way to the atmosphere. A bypass is provided for use when the economizer is down for cleaning or repairs, so that boiler operation need not be interfered with.

Top and bottom headers connect the various rows of tubes, and the headers are themselves connected to upper and lower branch pipes. Feed water on the way to the boiler is forced through the various sections of pipe, beginning near the stack, at the point of lowest temperature, and leaving near the entrance to the economizer, at the point of highest temperature.

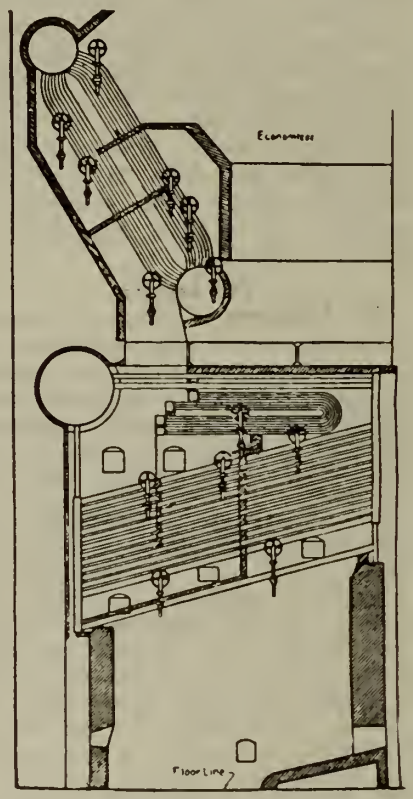


FIG. 1 INTEGRAL TYPE ECONOMIZER CLEANED WITH DIAMOND SOOT BLOWERS.

What The Economizer Does

The economizer takes in feed water at a temperature ranging from 50 degrees F. to 200 degrees F., and delivers it to the boiler anywhere from 100 to 150 degrees hotter, utilizing the heat of the flue gases which would otherwise be dispersed up the stack to the atmosphere. Off-hand, this looks like an opportunity to effect economies in operation well worth going after.

Without the economizer, the lowest limit to which the temperature of the flue gases leaving the boiler may be reduced, is, of course, the temperature of the steam, which is dependent upon the pressure, as shown in table 1.

With the economizer, the lowest practicable limit is that of the dew point of the exit gases. Under average conditions of boiler operation, only about 85 per cent. of the possible reduction between initial furnace and outlet gas temperatures can possibly be obtained. To obtain 95 per cent. it has been calculated that the boiler heating surface would have to be increased by 60 per cent. The impracticability of any attempt to gain economy in this manner is evident by a glance at the conditions of combustion.

When the combustion gases first come in contact with the boiler, the transfer of heat is very rapid, due to the great difference in temperature, but as the gases in their progress become cooler, the rate of transfer declines proportionately. If carried far enough, a point is reached where the amount of heat transferred per square foot of boiler surface is not sufficient to pay interest, maintenance and operation charges upon the surface involved. The calculation to obtain this minimum point is somewhat involved and need not be entered into here, it being sufficient to note that with coal at $3 per ton it ranges from 100 degrees difference between steam temperature and flue gas temperature if boilers are operated 24 hours per day, 365 a year, to 250 degrees difference if boilers are operated 10 hours a day, 300 days a year. We may assume 150 degrees to 200 degrees difference as the minimum in the average case. This means, finally, that our economical overall boiler efficiency is strictly limited, unless we can find some cheaper means, such as is afforded by the economizer, of transferring the heat to the water.

To take an example from actual practice, let us assume that a boiler operating at 180 lbs. pressure has been provided with sufficient heating surface, as is often the case, to reduce flue gas temperature to 560 degrees F. Assume water to enter the economizer at 90 degrees F. and water to be heated to 240

TABLE I.

Absolute pressure lbs. per sq. in.	Temperature deg. F.	Absolute Pressure	Temperature deg. F.	Absolute Pressure	Temperature deg. F.
100	327.6	160	363.4	250	400.9
110	334.5	170	368.3	260	404.4
120	341.0	180	372.9	270	407.8
130	347.1	190	377.4	280	411.1
140	352.8	200	381.7	290	414.3
150	358.2	210	385.8	300	417.4
		220	389.8	325	424.8
		230	393.6	350	431.8
		240	397.3		

degrees F. We then have average temperature of gases in the economizer $\frac{660 \text{ plus } 350}{2} = 455$ degrees, and of the water $\frac{909 \text{ plus } 240}{2} = 165$, giving an average difference in temperature of water and gases of 290 degrees. This is 1.6 times as great as the difference in temperature between the last pass of the boiler and the steam. Hence it follows that the economizer surface as a whole will recover 1.6 times as much heat per square foot as will the last square foot of boiler surface.

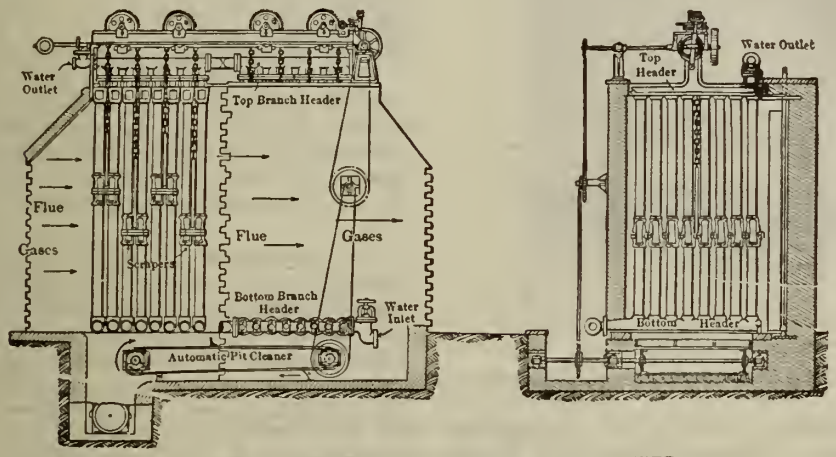


FIG. 2—CROSS-SECTION INDEPENDENT ECONOMIZER.

We may tabulate the advantages and disadvantages of the economizer as follows:

1. Fuel—a saving of 5 to 15 per cent.

2. Overall efficiency—a substantial gain where the boilers are forced and mechanical draft is employed. Highest possible gain when boilers are driven 200 per cent. or more above rating, using mechanical draft, and with electrically driven auxiliaries precluding a supply of exhaust steam, being available for feed water heating.

3. Decreased strain on boilers, due to higher entering temperature of feed water.

4. Increased flexibility. Large storage of hot water makes it easier to handle sudden peak loads.

Disadvantages of Economizers Are:

1. Initial cost—comparatively high, being in the neighborhood of $12 per boiler h.p.

2. Maintenance — comparatively high repair costs, due to soot scraper replacements. (This can be eliminated by use of mechanical soot blowers in place of scrapers.)

3. Overall efficiency—an actual loss where installation is made in connection with light chimney draft and boilers operating below normal rating.

4. Space required—the equipment is bulky, taking up considerable space. On new installations a larger boiler room than otherwise must be provided; in old boiler rooms installation can only be made at considerable expense or alterations.

Points to be taken into account when considering the installation of an economizer are as follows:

(a) Flue gas temperature—the higher the temperature the greater the economy.

(b) Boiler pressure—if 250 lbs. or over, economizers are indispensable.

(c) Boiler rating—the greater the load on the boiler the more necessary the economizer.

(d) Initial feed water temperature—In some cases an economizer is desirable even with initial temperatures of 200 degrees F.

(e) Exhaust steam—if the use of electrically driven auxiliaries eliminates exhaust steam as a possibility for heating feed water, an economizer is desirable.

(f) Purity of feed water—with impure feed water the formation of scale inside the economizer tubes may seriously affect the efficiency of heat transmission.

(g) Cost of producing draft — if chimney draft is to be depended upon, an extra height of stack, costing from 20 to 40 per cent., will be required. With mechanical draft power required ranges from one to four per cent. of main generator output.

(h) Extra cost for high pressure—cost for installation increases rapidly above 250 pounds pressure, on account of extra heavy materials required.

Some of the facts entering into successful and economical economizer operation will next be noted.

Gas Temperatures

It is important to know the temperature of the flue gases entering and leaving the economizer. Either a mercury thermometer or an electric pyrometer will answer the purpose. A recording instrument is preferable, since a permanent record is made to which reference may be made at any time. By means of this record the losses caused by air infiltration and dirty tubes may be determined at any time.

In inserting the pyrometer tube locations at the entrance and exit points of the gases should be carefully chosen. Do not place the tube behind the damper or anywhere else where there is likely to be a pocket of dead gas. Choose a point in the middle of the flue, and be sure that the hole through which the instrument is inserted is sealed tightly about it, so that there will be no air infiltration at this point, with consequent error in records, as well as loss in efficiency.

Water Temperatures

Mercury thermometers placed in the inlet and outlet pipes will show the water temperatures. Recording thermometers are preferable for this service, both from the standpoint of accuracy and efficiency of operation.

The function of the economizer is to heat the feed water and without continuous temperature readings the operator in charge has no idea how well results are being secured. It is not desirable from a mechanical standpoint to operate an economizer under such conditions as would cause steam to form in the economizer itself, yet this condition might arise with either a slight increase in the temperature, or an increase in the weight of the waste gases passing through the apparatus.

Air Infiltration

Due to the peculiar construction of headers, dampers, section walls, etc., the economizer offers many opportunities for air infiltration. Frequent checks should, on this account, be made of the entrance and exit temperatures of both gas and water, and frequent analysis should be made of the CO_2 in the entrance and exit gases. A drop of 1 to 2 per cent. in the CO_2 through the economizer may reasonably be expected, but where the drop exceeds this amount something is wrong and rigid in-

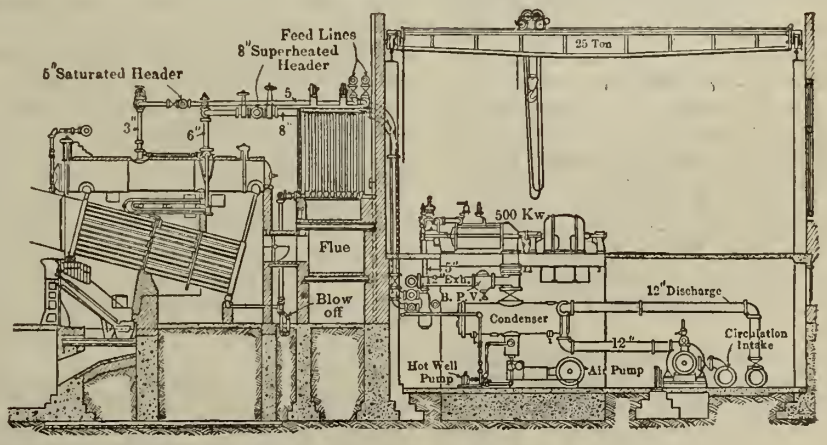


FIG. 3—LOCATION OF INDEPENDENT ECONOMIZER IN TYPICAL POWER STATION.

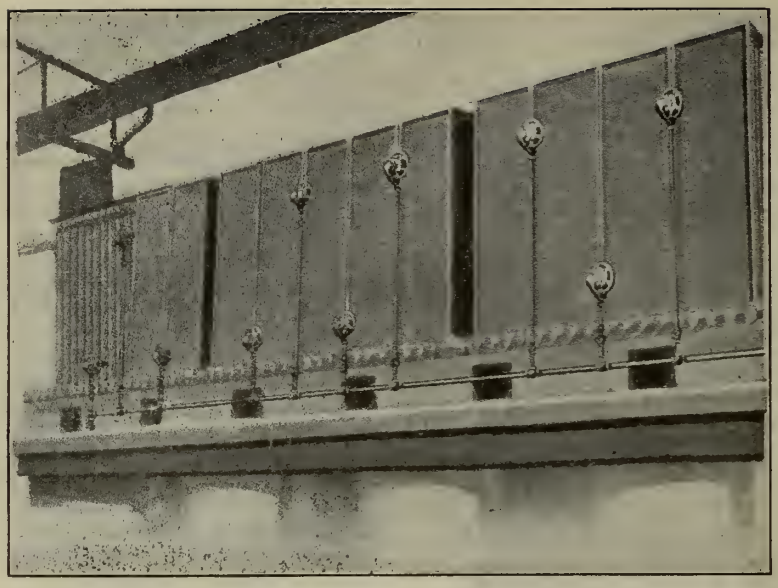


FIG. 4—INDEPENDENT TYPE ECONOMIZER CLEANED WITH DIAMOND SOOT BLOWERS.

vestigation should also be made.

In searching for air leaks, use a torch or candle, paying particular attention to cleaning doors, damper shafts, and the walls of the gas flue between the economizer and the boiler. Do not take it for granted that low gas temperatures mean efficient economizer operation. Constant checking, particularly of CO_2, is your only safeguard.

How Shall The Economizer Be Cleaned?

This question, until a few years ago, was always answered in one way, as far at least as the independent type of economizer was concerned. This answer is no longer always given, but before considering the alternative let us examine scraper construction.

Due, perhaps, to lowered temperatures and slower movement of the gas there is a great tendency toward soot deposit on economizer tubes. As soot is the best preventative of heat transference known, being several times more effective than asbestos in this respect, it must be removed. In scraper construction each tube is encircled with a set of triple overlapping scrapers which travel continuously up and down the tubes at a slow rate of speed. The apparatus for working the scrapers is placed on the top of the economizer, outside of the chamber, and the motive power is supplied either by a belt from some convenient shaft or small independent engine or motor. Power required for operating the gear is approximately one h.p. per 1,000 square feet of economizer surface.

Now, there are three important disadvantages to the use of scrapers which have led engineers to look elsewhere for a solution of the soot problem in economizers. These disadvantages are:

(a) Heavy initial cost of scraper mechanisms.

(b) Constant repairs required due to wearing out of scrapers and other moving parts.

(c) Cost of continuous power to move scrapers.

In addition to these disadvantages the scraper construction does not permit a thorough cleaning of the tubes. The scrapers embrace two tubes, and clearance is required, consequently there is a certain thickness of soot accumulation which is never scraped off the tubes. Investigations have proved that the scrapers frequently glaze this accumulation into a hard, enamel-like scale that can only be removed by tapping.

As an alternative to the scraper, engineers have been turning in increased numbers to the standard cross-element, revolving type of mechanical soot-blower. As far as the integral type of economizer is concerned, the mechanical soot blower has been the only type of cleaning device considered.

Fig. 1, which shows the integral type of economizer at the Kansas City Light & Power Co., illustrates the application of Diamond soot blowers for cleaning purposes. Each economizer has six soot blower units, with 19 nozzles each, on each side. Six minutes actual blowing time is required to blow the soot from the economizer, and the steam consumption is about 2,600 pounds of steam.

Fig. 4 shows the adaption of mechanical soot blowers to the independent type of economizer. With revolving units permanently installed between the tubes and regularly used several times each day, the heat-resisting soot is given no opportunity to collect. The tubes are kept perfectly smooth and clean at all times, and consequently the general efficiency of the economizer is very greatly improved.

Where new installations are being considered, it should be remembered that mechanical soot blowers can be installed at the outset, thus entirely eliminating the cost of scrapers. Furthermore, it is possible to plan on the use of horizontal tubes in the economizer, thus permitting the installation of baffles to hold gases in contact with tubes for a greater length of time.

The Solvay Process Co. reports the following results of a test made to determine the actual comparative value of mechanical soot blowers and scrapers on their economizers:

	Entrance gas temperatures	Exit gas temperatures	Difference
With scrapers	437 deg.F.	383 deg.F.	54 deg.F.
With mechanical soot blowers	437 deg.F.	320 deg.F.	117 deg.F.

This test fairly indicates the very marked advantage of mechanical soot blowers over scrapers, and it is to be anticipated that economizer practice of the future will tend more and more toward the use of mechanical soot blowers.

The Booth-Hall Company, designers and builders of electric furnaces, announce the removal of their executive and sales offices to rooms 1007-8 Hearst Building, 326 West Madison Street, Chicago. This change was necessitated by new arrangements in connection with the manufacturing of their electric furnace equipment. Increased facilities for turning out standardized furnace equipment has been provided with a large manufacturing company located in Chicago.

Furnace Installation.—The Electric Furnace Construction Co., Finance Building, Philadelphia, reports the following orders received for "Greaves-Etchells" electric furnaces; Lancia Co., Turin; Bresciana Co., Brusche. They have also successfully started up new furnaces at the Daimler Motor Co., Coventry; at the Tyne Electric Steel Foundries, Ltd., and also a furnace for Kayser-Ellison & Co., Ltd., Sheffield, designed for up to 15 tons cold metal or 20 tons hot metal process.

Explosion an Accident.—The case of the explosion that occurred at the Davie Shipbuilding Co. plant, Lauzon, Levis, Que., that resulted in the death of one of the employees named Robert Henley, and serious injury of another named Xavier Levesque, was cleared up and found to be an accident. It appears that among the scrap recently purchased by the Davie Shipbuilding Co. included some piping that had been purchased from one of the Dominion munition plants. The pipe that caused the accident was placed on a bench to heat the T that could not be loosened, and naturally the workmen or no officer in connection with the works had the least idea that there was cordite or guncotton in the pipe. The pipe did not, however, burst with the force of the explosion. It appears from the investigation that fireman Henley was in the act of passing the mouth of the pipe lying on the bench, when the heated pipe went off, and he caught the full force of the contents, which stripped him of his clothing, and knocked him heavily against the wall, which resulted in his death.

Municipal Electrical Engineers Meet

Recent Convention in Niagara Falls Notable for Opportunity Given to Members for the Inspection of Power Developments Now Working and Contemplated

THE annual convention of the Association of Municipal Electrical Engineers of Ontario was held at the Clifton Hotel, Niagara Falls, Ont., on the 19th, 20th, and 21st of June. Within sight of the majestic cataract that has made possible the power development and the industrial supremacy of the Niagara frontier, these members of the electrical profession, with the dull roar of the falling waters ever resounding in their ears, compared notes and discussed ways and means of extending still further the already tremendous business of power production and distribution made possible in the province of Ontario by the existence of the giant cataract, truly regarded as one of the most famous of nature's marvels.

In selecting the Clifton Hotel as headquarters for the convention the officers of the association no doubt had in mind the fact that of all the accomplishments wrought by the brain and hand of man in the last century, none are exceeded by the significance of Niagara harnessed. They no doubt had in mind the idea that no man is able to measure what this turning of the waters into turbines for the production of electrical energy can mean to this or succeeding generations. They were undoubtedly impressed with the fact that this development did much to initiate, and is chiefly instrumental in maintaining this electrical age.

While the members of the electrical fraternity attending the convention were intent on exchanging professional experiences, and making such recommendations and changes in electrical practice as wider experience always demands, they by no means neglected to contemplate and admire the grandeur of the spectacle lying constantly before their eyes, and this is not strange since Niagara has caused the mighty of many lands to ponder over its majesty. Sovereigns and rulers of many lands, persons high in official position, characters of celebrity in art, in literature and in science, from almost every land on the face of the earth, have stood in awed silence at Niagara's mighty brink.

On Thursday, June 19th, the members of the association and their friends registered at the convention headquarters, and after hearing the presidential address by Mr. O. H. Scott of Belleville, Ontario, they gave attention to a paper on Routine Handling of Consumers' Accounts, by Mr. R. C. McCollum, Auditor Municipal Accounts, Hydro-Electric Power Commission of Ontario. Mr. McCollum presented to his audience the results of a careful survey of the practice in this connection of Public Service Corporations in Canada and the United States, leading to the conclusion that a card system gave the most concise and satisfactory results, and such system he stated was in general use in the Hydro Electric system's various offices.

On Thursday evening the convention dinner took place in the dining-room of the Clifton, and several members and guests were called upon for a few remarks. Mr. A. Monro Grier, K.C., President of the Canadian Niagara Power Co., was the speaker of the evening, and his most interesting address, tinged throughout with a philosophical and advisory strain, received at its conclusion the well-deserved and extended applause of the gathering.

Mr. Grier in his remarks endeavored to impress his audience with the idea that they might draw many lessons from their contemplation of the great cataract, especially from the idea of the strength of unity that it conveyed He directed attention to the fact that the power development in Ontario was primarily due to the fact that a vast number of individual drops of water were continuously falling over the brink of a gigantic precipice, and that in their unity lay their power, so also he pointed out the greatness of any nation lies in the unity of purpose of its people. His address throughout its entire length was conceded by all present to be most interesting and instructive in its relation, not only to the electrical field, but to the Empire and Canada as well.

On Friday morning Mr. W. L. Goodwin presented his plan, describing the correct relation the various electrical industries held to each other. He dwelt upon the many anomalies that existed in the electrical field, particularly between the manufacturer, the jobber and the contractor and dealer, and his remarks were followed by an extended discussion by the members of various aspects of the plan in its relation to general practice among the trade.

On Friday afternoon Mr. C. E. Schwenger, Engineer of Distribution, Toronto Hydro Electric System, presented a paper on "Overhead Distribution Systems." in which he described the problems of distribution encountered in the City of Toronto. His paper was full of technical data of interest to the electrical engineer, and brought forth some lengthy discussion on the part of the members, who expressed in their numerous queries the appreciation they felt for the labor entailed in the preparation of a paper of so technical and instructive a nature.

On Saturday morning the members of the convention were transported en masse to the Chippewa Development Scheme now being worked out by the Hydro Electric Power Commission. Here again they were impressed by the details of the installation of one of the greatest hydro-electrical power developments yet attempted, which will upon its completion some years hence, result in a further development of the remarkable industrial progress that has taken place in the Niagara and Ontario district.

After an inspection of the Chippewa project the visitors hied themselves away by motor car and lake steamer to the more monotonous scenes of their daily avocations, which they doubtless perform with renewed energy because the thought of the resistless and ceaseless current of one of Nature's greatest wonders has charmed their senses, putting new vigor and spirit into their minds and hearts.

FIREPROOFING MATERIAL

Coating or impregnating with precipitated double borate of zinc and aluminium in a colloidal medium is a new method of fireproofing. A mixture of zinc sulphate and aluminium sulphate is dissolved in hot water, the double borate being next precipitated by adding a suitable proportion of borax, and the precipitate is then suspended in a colloidal solution such as that formed by dissolving 4 oz. of gelatine in a gallon of water at 90 degree C., and adding 12 oz. of ammonium chloride. On strongly heating, the compound is converted into an amorphous glaze, very resistant to high temperature and flame.—M. E.

Graphite and kerosene are most often used in America for the purpose of removing scale which has formed in boilers. Their action seems entirely mechanical. Opinions as to the desirability of their use vary from enthusiastic commendation to absolute condemnation. Their use seems generally approved by practical men, but a warning against the practice is given in a leaflet published by the United States Bureau of Mines, in which it is pointed out that neither should be used in boilers in which there is already a heavy deposit of scale, as the loosening of this material and its accumulation in the bottom of the boiler is apt to lead to blistered and bulged plates. Both graphite and kerosene should be used very cautiously. Kerosene, if used in excessive quantity, is apt to distil over and attack gaskets.

A New Prime Mover; the Still Engine

The Following Article Abstracted by "The Engineer" From a Paper by Frank D. Acland Read Before the Royal Society of Arts Gives Some Interesting Information Relative to a New Development in Prime Movers. The Combination Here Described Gives Promise of Remarkably High Efficiencies

THERE are two methods of producing power by the combustion of fuel—either under boilers or within the main cylinders of combustion engines. The greater part of the world's power is still derived from steam, which, owing to its proved reliability and greater adaptability to the services demanded of it, holds the field in competition with its rival, the internal combustion engine, but the latter shows a far higher heat efficiency. Yet it cannot start itself; cannot develop its full power, except at full speed; is a poor performer at low speeds; can only operate on moderate overloads for short periods; and may cease to operate, owing to a small defect, without warning. So combustion engines have as yet made little progress in competition with steam in locomotive work, and have supplanted steam, but to a limited extest, in marine and stationary engines.

The maximum ideal efficiency of a heat engine is obtained where the difference existing between the highest and lowest temperatures of the working fluid is greatest in proportion to the maximum temperature, and here the internal combustion engine, with an initial temperature higher than the furnace temperature of the boiler, and even higher than the melting-point of cast iron, is capable of realizing better thermal conditions than any other form of heat engine; but in its turn it suffers from two disadvantages—it ejects its working fluid at a temperature too high for ideal conditions, and it loses heat energy to a regrettable extent in the cooling of its cylinder.

The possibility of combining in one engine the superior thermal cycle at the high temperatures and pressures of the combustion engine with the low thermal cycle of steam to deal with its rejected heat, and, in the same engine, to add the superior working advantages of the steam engine is the basis of work carried out by Mr. W. J. Still.

The Still engine is an engine capable of using in its main working cylinder any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine, and reduces the consumption of the fuel per horse-power developed.

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so ensure the maximum efficiency from the fuel burnt within it, diminishing, as a consequence, the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder, and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam which can be generated per horse-power developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

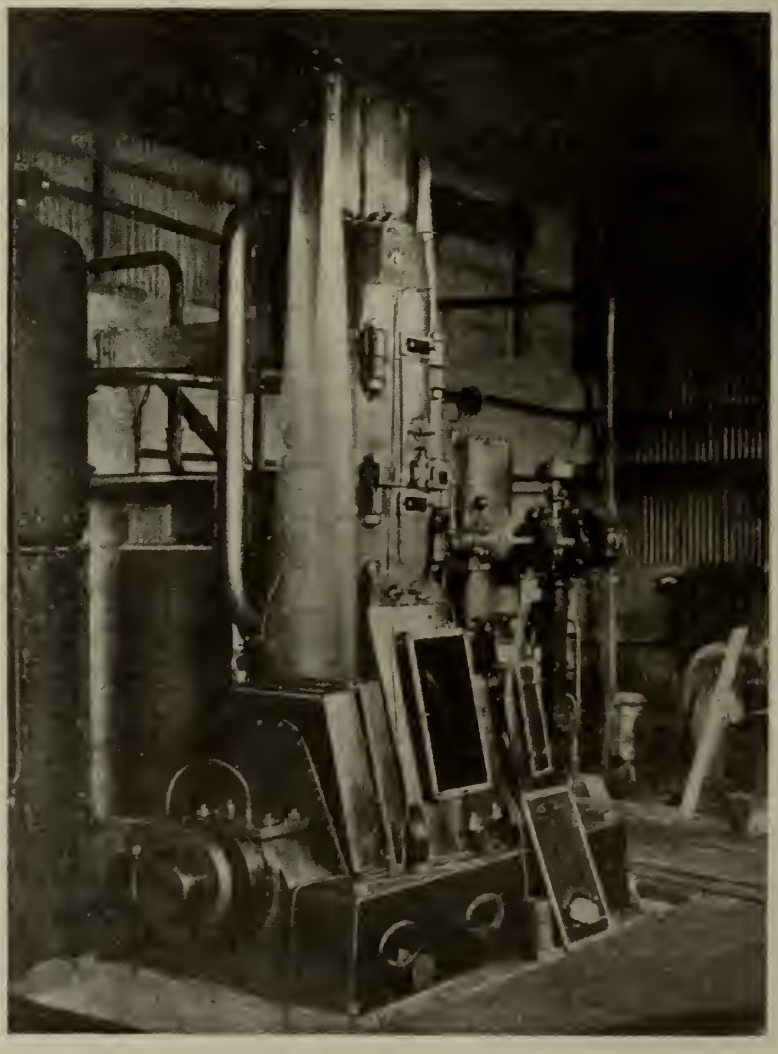


FIG. 1.—VIEW SHOWING STILL ENGINE IN OPERATION, RUNNING WITHOUT FLYWHEEL.

In the Still engine—see diagram—the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of the steam; the cooling is effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion, and expansion—is diminished.

During compression, owing to the walls being at steam temperature, the incoming charge picks up heat instead of losing it during the greater part of the stroke, an advantage of the greatest value to the heavy oil types of Still engines, where an air charge is taken in at the full outstroke, and is compressed to a pressure where its increased temperature ensures the certain ignition and combustion of the fuel which is injected into it.

During combustion and expansion the uniform and higher mean temperature of the walls reduces the heat lost to

the jacket water. Some of the heat thus economized adds to the useful work on the piston, the balance passing out in the exhaust gases for recovery.

To ensure the maintenance in a practical and reliable manner of the temperature conditions which produce this efficiency during the combustion cycle, a departure from the design and construction of the cylinders of normal internal combustion engines is imperative. The cylinder of a Still engine consists of an inner liner, which is approximately one-third to one-fourth of the usual thickness; it is ribbed externally so as to add to its conducting surface and provide suitable passage for the cooling water, and it is reinforced by an outer hoop capable of withstanding the highest pressures to be met with in working. No failure of a cylinder of any kind has occurred, even under most severe, even abnormal test conditions, e.g., with mean combustion pressures of 180 lb. per square inch in a two-stroke engine, to which was added overload steam mean pressures of 70 lb., i.e., a total mean effective pressure per revolution of 250 lb. per square inch.

The Still engine may be of the constant volume or constant pressure type, or a combination of both; its losses to the cooling water are not the same as in a normal engine of either type, except in so far that they vary with the type, with the cycle, with the efficiency of the combustion stroke, and with the load. At normal and full loads, such heat units, in a Still engine, as pass into the jacket water, which is at steam temperature and pressure, are lessened and are wholly recovered without loss —radiation excluded—in overcoming the latent heat of the water and give off their steam in the steam space in proportion to the heat flow at these loads. At lower loads less steam is produced, until at still lower loads no steam at all is measurable. In other words, the jacket losses are practically eliminated.

The exhaust gases take a subsidiary, but important, part in the cycle; their usefulness in ordinary combustion engines, in raising steam, is limited to the amount of heat recoverable between the initial temperature of the exhaust and that of, say, 50 deg. Fah. above the steam temperature, after which the whole volume passes away to atmosphere at a still useful temperature, less a small percentage available for feed-water heating. But in the Still engine the exhaust gases, after raising their quantum of steam, are employed in preheating all the water required for the steam generated in the jacket water and in the generator. Trials at full efficiency over long periods and steady loads show terminal stack temperatures as low as 150 deg. Fah. The heat efficiency of the combined cycles is therefore exceedingly good, with an initial temperature of over 2,000 deg. Fah. and a final exhaust to atmosphere at 150 deg. Fah.

The quantity of steam capable of being generated from "waste heat" depends upon the efficiency of the combustion cycle, and on the load. Some years of experimental work prove that the weight of steam recovered may vary from a maximum of about 7 lb. per brake horsepower hour developed by the combustion cycle of a four-stroke constant volume engine at full load to a minimum at light loads which is hardly measurable, and which only balances the loss due to radiation.

The engine used for this research was of constant volume type, four-stroke. It first underwent a series of tests, so as to arrive at its "initial horsepower" as an explosion engine, i.e., without any power added by the steam cycle, and was carefully checked in this connection by comparison with well-known and authenticated trials carried out by the late Professor Bertram Hopkinson, F.R.S., and others. Though it was a single-cylinder unit with automatic inlet valves, its "initial horsepower" was rated on a par with the power given by four-cylinder sets with mechanically operated valves deduced from tests over very short periods under their best conditions.

The quantity of steam generated per "initial brake horsepower" from the jacket alone averaged 3.28 lb. per brake horsepower hour, and from the jacket and exhaust together 6 lb. per brake horsepower that, this being the average of the whole of the trials over periods varying from 20 minutes to over six hours. The final six hours of a 7½ hours' continued test gave a total recovery of 6.9 lb. of steam per initial brake horsepower. A whole series of these early trials was carried out under the supervision of C. Vernon Boys, F.R.S., whose sympathetic interest and encouragement is gratefully acknowledged as having largely contributed to the progress made since the inception of the system.

Normal load.—The average mean effective pressure from the combustion stroke was 90 lb. per square inch. The steam evaporated by the "waste heat" gave 14 lb. per square inch mean effective pressure on every return stroke.

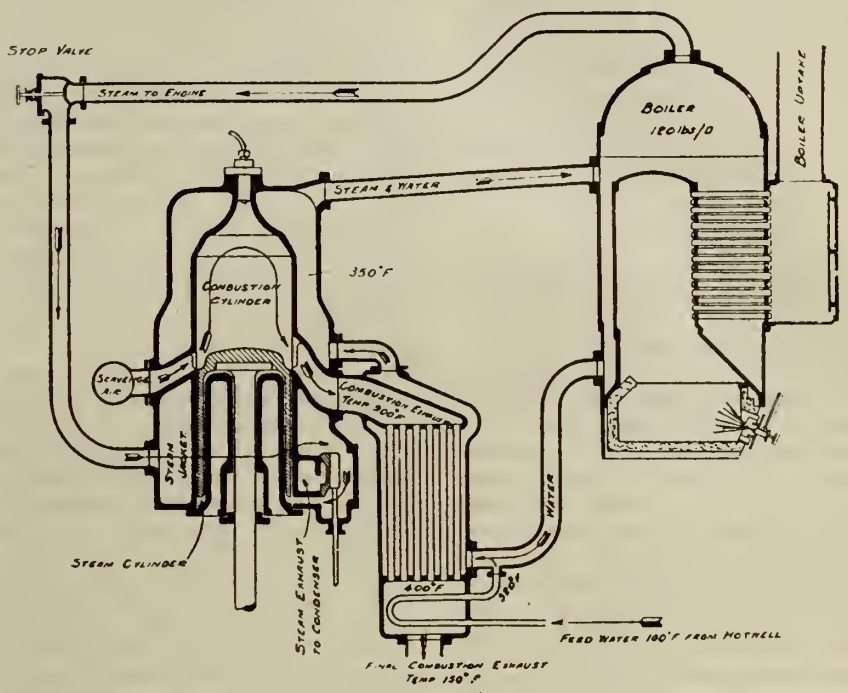


DIAGRAM ILLUSTRATING PRINCIPLE OF OPERATION.

This is equivalent to 90 + 28 = 118 lb. per square inch mean effective pressure in a normal four-stroke engine.

Overload.—By admitting additional steam generated by fuel under the boiler, the steam mean effective pressure was raised to 72 lb. per square inch; the total mean effective pressure was therefore equal to 90 + 144 = 234 lb. per square inch mean effective pressure in a normal four-stroke engine.

Gas Engines

The first experimental engine constructed was a two-stroke engine capable of developing 590 brake horsepower from three cylinders at 400 revolutions, bore 8 in. It was a high-speed engine, designed with special regard to obtaining data about the recovery of steam from waste heat (jacket and exhaust). It was first operated on town gas—540 B.Th.U.'s, and subsequently converted for oil fuel. Its efficiency was not high, owing to its being a two-stroke engine with a short stroke, but its consumption per brake horse-power was 15 cubic feet per hour (31.3 per cent. efficiency), a very promising result.

The outbreak of war prevented much progress being made in the design and construction of gas engines; but the

results achieved give great promise of future development, for with a combustion indicated efficiency of 36 per cent., radiation 4 per cent., boiler loss 10 per cent., there remains 50 per cent. for recovery; allowing 10 per cent. efficiency for the steam cycle, a gain of 5 per cent. is assured, and the total indicated efficiency of the engine will not be less than 41 per cent. If 20 per cent. efficiency is obtained from the steam cycle, as appears possible, the total indicated efficiency will be 46 per cent.

A gas engine which can give a brake thermal efficiency of 30 per cent. better than its predecessors, and which, by governor control alone can meet any demand up to and over 100 per cent. overload, while maintaining a good efficiency at that increased output, cannot be neglected.

Petrol and Oil Engines

Four-stroke engines for petrol and similar fuels have been built and tested ashore and afloat.

A three-cylinder set (marine type) capable of developing on its three small cylinders at 600 revolutions per minute 12.5 shaft horse-power at 90 lb. combustion mean effective pressure, without power from the steam stroke, gave on continuous running 16½ shaft horse-power under "waste heat" conditions, maintaining from the "waste heat" a steady boiler pressure of 100 lbs., with sufficient reserve for manoeuvring in narrow waters or bringing up. It would pick up very rapidly when ignition recommenced, and bring up the boiler pressure to normal in a few minutes.

With the addition of a burner below the boiler it would run continuously and develop 38 shaft horsepower at 750 revolutions. Monetary overload in proportion to the capacity of the boiler reached 60 indicated horsepower (51.5 shaft). Under steam alone the engine is a most satisfactory performer, but not economical.

The Still oil engine starts with the cylinders and pistons preheated. The air charge, from the moment of its entry into the cylinder, picks up heat from the containing walls and continues to do so during at least 70 per cent. of the compression stroke, with the result that the temperature necessary for firing with certainty the first injected charge of fuel is reached with a compression pressure 50 per cent. less than that required in a Diesel engine.

This fact is far reaching in its importance, for it gives to the designer great elasticity and freedom of application, for a Still heavy oil engine can be designed for constant pressure or constant volume, or both can be employed in the same engine by correct timing of the fuel injection. It claims for its combustion cycle an efficiency higher than that of the Diesel, less weight and space per horsepower, and for its combined cycle an efficiency not less than 20 per cent. higher than any prime mover which uses fuel as its source of heat.

The first engine designed for the use of heavy oil was of the opposed piston type, 16 in. diameter, 32 in. total stroke, revolutions 150, the combustion taking place between the two pistons with the steam generated by the jacket water and exhaust gases expanded at the back of both pistons—the steam passed from the auxiliary boiler through high-pressure and intermediate-pressure cylinders, and finally to the Still engine as a low-pressure cylinder—and thence to the condenser.

In a special engine subsequently constructed to meet special conditions—where the maximum power in minimum space was the main desideratum — the dimensions of the cylinder were:—Bore, 13½ in.; stroke, 22 in.; two-stroke cycle, opposed pistons; steam side as for low-pressure cylinder. It forms the basis of a six-cylinder set, two of them using high-pressure steam, which is compounded into the other four as low pressure.

The combustion takes place between the pistons, the steam acting on the return stroke at the back of both pistons. After a series of preliminary tests under steam alone, in which data was obtained for the various mechanical adjustments, the scavenge, compression pressures and temperatures, at various speeds, oil was injected for the first time. The engine fired its first charge without hesitation, and completed a series of tests of over two hours' continuous running, without adjustment, giving an output by gradually increasing the weight of oil admitted of 100, 150, 200, etc., up to 400 indicated horsepower at a maximum speed of 380 revolutions per minute, for which she was designed.

This unit has been subjected to many long and varied tests by representatives of various Governments, as well as to constant research work under severe conditions. Its best consumption of fuel —Admiralty shade oil—has been as low as .302 lb. per brake horsepower—scavenge pump not included—over a test of one hour's duration under normal waste heat conditions. It developed 330 brake horsepower for six hours at 360 revolutions per minute—a single cylinder—under waste heat conditions. It will develop 400 brake horsepower continuously with added steam, and has developed 540 brake horsepower at 380 revolutions over short periods. (Combustion mean effective pressure 128.2 lb., steam mean effective pressure 57.9 lb., total mean effective pressure 186.6 lb.) The thermal brake efficiency from below quarter load to full power is maintained at approximately 40 per cent. over the whole range.

With added steam from the boiler 5,000 brake horsepower would be obtained from two six-cylinder sets, with a weight of about 70 tons, including all auxiliaries and water, and extreme overloads up to 6,000 brake horsepower could be obtained.

The application of the Still system to commercial marine work is being developed in this country and abroad, the two-stroke single-piston type, in powers of 100 horsepower per cylinder and 400 horsepower per cylinder, having been adopted.

Engines of this type at 120 revolutions per minute, with a cylinder 22 in. diameter by 36 in. stroke, giving 4,200 shaft horsepower on two shafts, with all auxiliaries and water, would approximate 600 tons. A geared turbine plant in a similar ship would weigh 20 per cent. more, and would consume approximately 2,000 tons more fuel for a double journey lasting 1,000 hours.

Locomotives

The success already achieved in proving the principles to be correct, both in theory and practice, has led to a careful study, both here and abroad, into the application of this system to locomotive work. No high-powered locomotive engine, using heavy oil or gas in its cylinders, has been produced capable of economical haulage of heavy loads.

A Still engine designed for locomotive work would be capable of giving an efficiency at the rails of 30 per cent. over 90 per cent. of its running time—in other words, six times as good as the present locomotive; while during the accelerating period its efficiency would be at least 15 per cent., or three times as good. In surmounting long inclines with heavy loads, the engine would be capable of developing about four times the power which it develops at its most efficient or normal running load.

It is surely not unreasonable to expect that the application of the system here described should be put, without delay, to practical test for locomotive work, and especially so in view of the development and enormous expenditure contemplated in the electrification of railways. To give up the unit system of traction where the failure of one unit does not involve the failure of the whole, and to rely on what is, after all, a delicate and easily dislocated source of energy from central power stations, merely to gain a problematical 6 per cent. increase of fuel efficiency, seems to involve a risk far greater than the encouragement and development of novel forms of engines, which, whether gas or oil, may be evolved at the present rate of progress before the country is too far committed to such a gigantic and possibly dangerous experiment.

Discussion

The discussion was to a certain extent disappointing, in that it largely took the form of questions, and time did not admit of a reply by the author. Emphasis should, however, be laid on the point that the paper was confined to the setting forth of the principles of the Still engine, and from the remarks made it would seem that their correctness is beyond dispute. Sir Dugald Clerk reminded the audience of the previous attempt of Simon in 1878 to utilize the

waste heat of an internal combustion engine by converting it into steam, failure being due to the admission of the steam into the combustion chamber along with the explosive mixture. An interesting comparison was quoted by him of the Castner Kellner gas engines, which produced, when working on continuous full load, 2½ lb. of steam per brake horsepower at 100 lb. pressure, as compared with the 7 lb. per brake horsepower produced by the Still engine. Incidentally Sir Dugald mentioned that the efficiency of the solid injection submarine engines used in the British Navy was 36 per cent. The only criticism raised by Sir Dugald was that the reduction of the compression pressure from the 500 lb. per square inch in the Diesel engine to 300 lb. in the Still engine, while giving certain advantages, would cause the loss of a certain amount of the efficiency due to the higher compression.

Professor Watkinson had doubts as to whether the steam produced would be sufficient to cool the pistons if the engines were made in larger sizes than those already tested, and the author's reply on this point will be of great interest. He made a suggestion which appeared also to be in the minds of other speakers, that a higher efficiency could be obtained if the steam were to be used in a separate uni-flow engine or a turbine, but such a vital alteration would appear to eliminate some of the important advantages of the present plan. Professor Boys, who has been closely associated with the development of the engine, was interesting in his remarks about the inventor, who he said had foreseen all sorts of possible difficulties and experimented on each one at a time—a very important point—so that when it came to actual construction he was fully armed with facts and results and the course of the experiments ran smoothly. Professor Boys drew attention to the fact that the steam in the Still engine was used under even better conditions than in an ideal steam engine.

Mr. Stokes dealt chiefly with the political aspect of the new principles set forth, and urged the necessity of the Government examining fully into all prime movers before going ahead with their electrical schemes. Mr. Frank Bailey, following somewhat on the same lines, stated that the great economy of the Still engine might make it worth while to install comparatively small power units in factories, and so seriously interfere with the load factor of large central stations and vitiate the whole idea of the Government plan.

Mr. Martineau, who also had been closely associated with the Still engine, showed that the I.H.P.-B.H.P. efficiency of an ordinary internal combustion engine could be increased by 17 per cent. by converting it to the Still system.

Mr. Still, answering a question, said that lubrication of the Still engine had been effectively carried out by a mixture of oil and graphite, adding that the maximum steam pressure he had used was 250 lb. per square inch.

Sir Charles Parsons, in concluding the discussion from the chair, amused the audience by stating that in order to obtain the maximum power for a large cruiser before the war the design would call for 150 cylinders on four shafts.

POWER GAS

As power gas is likely to come largely into use in the near future it is interesting to recall that the first apparatus for its manufacture from coal dust and for the recovery at the same time of sulphate of ammonia, was designed and patented by Ludwig Mond, and built at Brunner Mond and Co's. Northwich works.

The advantages of using power gas can be summarized as follows: The cheapest quality of coal, even pit-head refuse, can be used, and, consequently, power can be obtained in addition to valuable by-products without the use of expensive steam coal. Very little labor, and that of only an unskilled character, is required. The heating value of the gas is equal to roughly, about 86 per cent. of the total heat energy contained in the fuel from which it is produced, and it can be obtained on a large scale for a mere fraction of a penny per 1,000 cubic feet. What this means will be realized when it is mentioned that one ton of rough slack will provide upwards of 150,000 cubic feet of power gas having a calorific value of at least 140 British thermal units per cubic foot. The quantity of gas required to produce an indicated horse-power-hour in a large gas engine varies, but may be taken as being about 50 to 60 cubic feet. One ton of low grade coal, gasified, and used in a modern gas engine, will produce at least 2,500 indicated horse-power-hours, or 2,500 horse-power for one hour. That is to say that a ton of this coal converted into power gas, will produce about 500 per cent. more power than it would were it burned under a boiler in the ordinary way and the steam used to drive an ordinary reciprocating engine. Taking the price of slack at as high a figure as 12s. per ton, delivered, the fuel cost of an indicated horse-power-hour obtained by power gas would not exceed one-twentieth of a penny.

It has been pointed out, and rightly, by the advocates of the use of power gas that in every steam plant working with a variable or intermittent load a considerable percentage of the fuel is wasted. Some loss under this head is unavoidable, but it was early realized that the employment of power gas reduces such standby losses to a minimum.

In the early forms of producer the apparatus was provided with a water seal so arranged that the ash, which is the only residue, descended into the water, from which it could be easily removed. The process of combustion was carried out at a comparatively low temperature, which not only prevented the formation of clinkers but provided against the destruction of any of the by-products. This was accomplished by blowing a blast of hot air and steam into the producer. The quantity of steam required when it was desired to recover the ammonia was equal to about 2½ tons for every ton of fuel gasified. Of this about two-fifths was afterwards recovered. When the process was first used comparatively little attention was paid to the recovery of the ammonia, and the quantity of steam used in such case was about one ton for every ton of fuel.

In connection with the plant a regenerator was used, through which the gas passed. In this part of the heat was transferred to the blast of air and steam on its way from the air-heating tower to the producer, the gas being cooled to a corresponding extent before it was delivered to the mechanical washer. Here a system of rapidly revolving dashers kept a fine spray of water passing through the gas, which not only reduced its temperature, but cleansed it from dust and particles of carbon. From this washer the gas passed into an acid tower, where the ammonia content was removed by a weak solution of sulphuric acid with which it was brought in contact, forming sulphate of ammonia. This solution was passed continuously through the stream of gas until it contained about 35 to 40 per cent. of sulphate. In order to provide for continuity fresh acid was introduced periodically and corresponding quantities of the sulphate liquor removed. This was then evaporated into solid form, after which it was crushed and sold as fertilizer, whilst the gas was passed into a cooling tower in which it was again thoroughly washed. Modern methods have improved to some extent on this process, but substantially it remains much as it did when it was first brought to the notice of engineers by Mr. Mond.—M. E.

Samuel F. Joor, a well-known consulting engineer of Chicago, has joined the American Steam Conveyor Corporation, Chicago, in a capacity of sales engineer. Mr. Joor has had wide experience in the conveyor field, at one time being western manager and sales engineer of the Jeffrey Manufacturing Company, and previous to that, with the Link Belt Company.

ERRATUM

Owing to an unfortunate error on the part of our composing room, one of the illustrations of the article on The Boiler Room of the Sheet Metal Products in the June 20th issue was shown inverted. The illustration referred to is at the bottom right hand corner of page 246 and shows the interior of the furnace looking towards the stoker.

English and American Water Softeners

A Description of Several Types of Water Softeners From Which a Good understanding of Their Operation May be Obtained—The Article Describes Several Types

By F. C. P.

THE accompanying drawings, Figs. 1, 2 and 3, show the carburetor of Wright's improved water softeners, developed from the designs of Player and Weddell at Tipton, England. The drawings, Figs. 2 and 3, show the details of the automatic gear and trip gear of this English water softener, considering the automatic inlet valve "A", Fig. 2. The float rod is adjusted so that the water is cut off below the overflow level. The dividing box, "B", is set level so that the water flows over it in a film of uniform thickness. It divides the water into two or more parts. The division is controlled by an adjustable slide, "C", so that any amount of water can be caused to flow through the wheel. This is what controls the exact proportion of re-agent passing into the softener.

It will be noted that the water wheel, "D", is mounted on ball bearings, "E", which are kept well packed with grease. There are two chain and wheels, "F" and "G", one on either end of the shaft. One of these is geared to a chain wheel driving the stirrers, "H", in the re-agent tank, which keeps the mixture stirred. The other chain wheel is geared to drive a bevel gear.

The re-agent supply measure, "J", is clearly shown; the water wheel, "D", gradually lowers the re-agent supply pipe by means of the screw, "K", and allows the mixture of lime and soda to overflow in proportion to the quantity of water entering the plant. The bevel pinion, which operates this screw gear, slides on the spindle and is controlled by the position of the trip gear as shown on drawing, Fig. 3. As the screw lowers, the trip gear comes into operation at a certain point, withdrawing the pinion from the bevel wheel, so that when this has been withdrawn the water wheel no longer operates the screw. This should be adjusted by means of the nut, "L", so that the pinion is withdrawn before the bottom bracket "M" comes into contact with the agitators, and also before the long screw, "N", has been unwound off the nut, "O". When the overflow pipe has reached this point it is very near the bottom of the tank, and it is time to recharge it.

In charging, the first thing to do is to wind the screw by the handle provided, so as to lift the overflow pipe to the top of the tank. During this time the pinion is held out of gear as it will be impossible to wind against the water wheel. The oil lever is examined, and it will be noticed that the screwed spindle, "N", is hollow. When the screw is at the top of the tank, it is filled with oil to the top of the spindle, by pouring oil down the hollow shaft. In starting the plant to work a definite number of pounds of lime and soda per inch deep in the re-agent tank is determined upon. The lime and soda are weighed and placed in the lime-slaking box, and sufficient water added to dissolve the soda and make a thin limewash, which is passed through the strainer, down into the re-agent supply tank, and the latter is filled to the necessary level with water, to produce the standard solution. The overflow pipe is then lowered until the re-agent is just commencing to overflow, when the water is turned on again and the plant is put into ordinary work.

The bottoms and bits of lime which pass into the re-agent with the charge

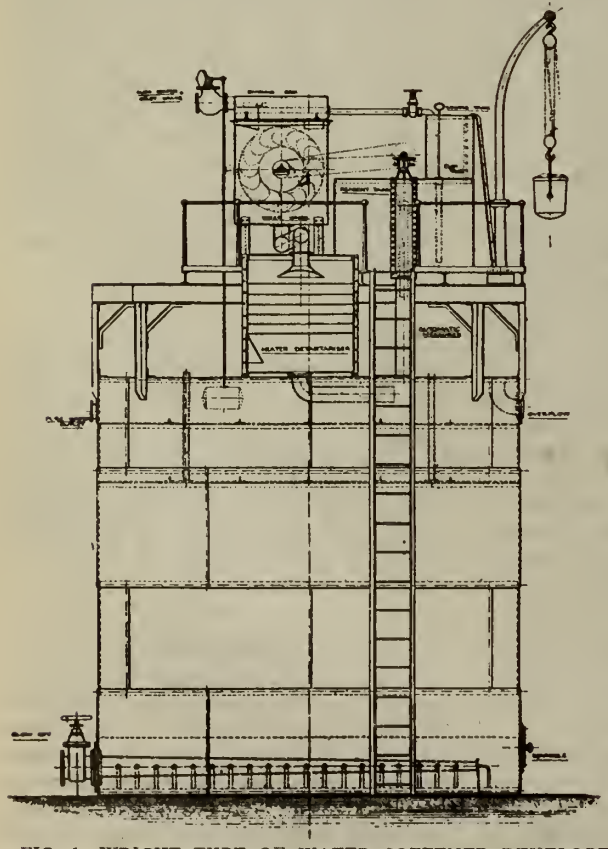


FIG. 1—WRIGHT TYPE OF WATER SOFTENER DEVELOPED AT TIPTON, ENGLAND.

DETAIL OF AUTOMATIC GEAR.

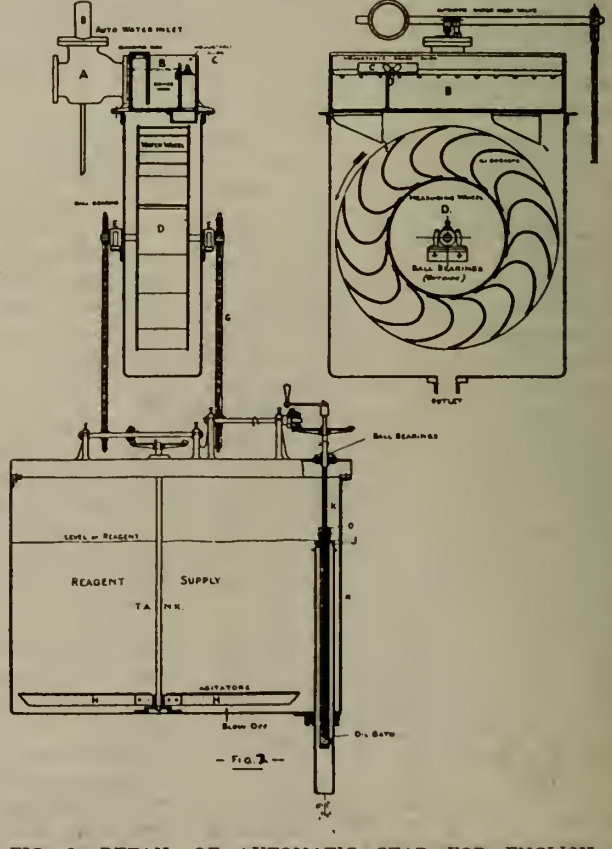


FIG. 2.—DETAIL OF AUTOMATIC GEAR FOR ENGLISH WATER SOFTENER.

are not allowed to remain in the supply tank indefinitely. This is emptied and swilled out at frequent periods. Particular care is taken that any accumulation around the rising and falling pipe is removed. The gland in the bottom of

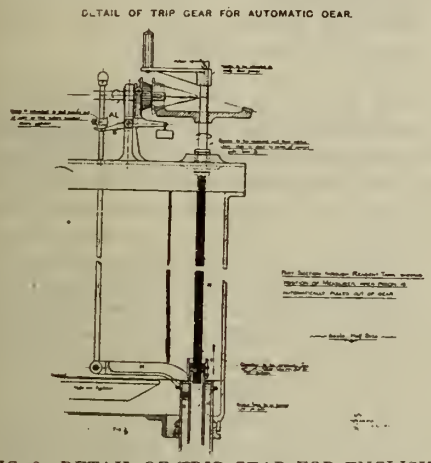


FIG. 3—DETAIL OF TRIP GEAR FOR ENGLISH WATER SOFTENER.

the tank through which this pipe works also receives attention.

In working the plant a constant feed is maintained so far as is possible. The re-agents are carefully added and this is done whenever necessary. Frequently water softeners are very badly neglected and allowed to run sometimes for hours, and even days together, without any re-agents being added to them. Another very common fault is to tip re-agents in in indiscriminate quantities. They should be accurately weighed and great care should be exercised in doing this.

In testing the hardness of the water the apparatus required is a 70 c.c. pipete or measure, two buretes to hold about 25 c.c.'s, an 8 oz. stoppered bottle, a white dish to hold not less than 150 c.c., and a small glass stirring rod. The re-agents required are Clarke's soap solution, decinormal sulphuric acid, and small bottles of silver nitrate and methyl orange. The water to be examined should be quite clear. If it is not it should be passed through an ordinary filter made from blotting paper in a glass funnel. Assuming the test to be of the softened water from the plant, three tests are required. To a few drops of the water on a white tile one drop of silver nitrate solution is added. There will always be a precipitate formed, but if it is white it will intimate that there is sufficient lime being used. If it is the palest tinge of yellow it will intimate that the quantity of lime being used is correct; if it is deep yellow or brown, too much lime is being used. In testing it is pointed out that to a fresh sample of 70 c.c. of water in an 8 oz. bottle it is necessary to add solution to a little at a time and shake vigorously after each addition until a permanent lather is formed. If 6 c.c's of soap solution will produce the lather, the water will be softened to 5 degrees. Clarke (i.e., it is always 1 degree softer than indicated by the soap itself). If a smaller quantity of soap is required the water is softened below this degree. If a larger quantity of soap is required the water is imperfectly softened and more re-agent will be required. The lather should hold for a considerable time when the bottle is at rest. If it disappears in two or three minutes, it is not permanent and more soap solution should be used. Another 70 c.c. of water should be filtered through a paper filter and run into a white dish. One drop of methyl orange should be added and decinormal sulphuric acid added a drop or two at a time until the sample just commences to turn pink. The number of c.c's of acid used should be noted. This should be multiplied by 5 and the result is the total alkalinity of the water in grains per gallon. This should not be much in excess of the hardness indicated by the soap test. If it is, re-agent, usually soda, is being added in excess and consequently wasted.

In the accompanying illustrations, Figs. 4, 5, and 6, may be seen several

FIG. 4—12,000-GALLON PER HOUR "EUREKA" WATER SOFTENER WORKING AUTOMATICALLY IN CONNECTION WITH A 50-000 GALLON STEEL STORAGE TANK.

American water softeners of the Eureka type, developed at Mishawaka, Ind. The photograph, Fig. 4, shows a large water softener of a capacity of 12,000 gallons per hour, working automatically in conjunction with a 50,000 gallon steel

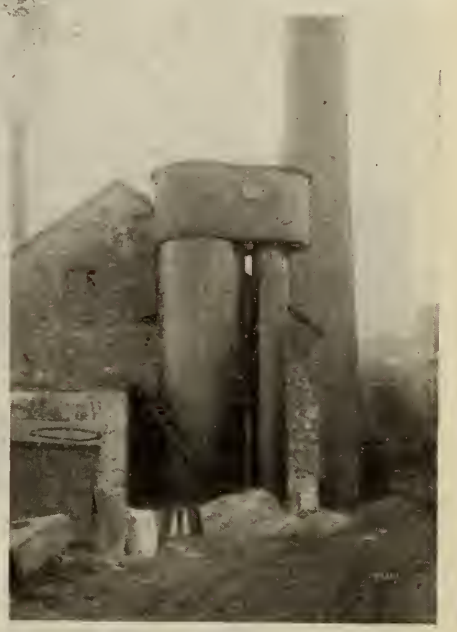


FIG 6—6,000-GALLON PER HOUR EUREKA WATER SOFTENER TREATING WATER. THE LOCKPORT PAPER CO.

storage tank of the Felters Co., of Lestershire, N.Y.

Two smaller American water softeners, of 3,000 gallons and 6,000 gallons per hour, may be noted in photographs, Figs. 5 and 6, the former being used for treating canal water for the Lockport Paper Co., at Lockport, N.Y., and the latter at the Lehigh Valley Silk Mills, at South Bethlehem, Pa.

The American automatic water softener and purifier is arranged so that the water may be supplied to the inlet valve in the tank either by pressure or gravity. A constant head is maintained in this tank, and the weight of the water falling on the wheel furnishes all the power required to actuate the plant. A portion of the raw water is diverted from the tank to a saturator where a clear lime solution of constant strength is manufactured. In this method none of the impurities in the lime come in contact with the water to be treated, thus there are no lime particles to go over into the piping and boilers. The alkalinity of the purified supply is practically nil so that there is not only no danger of foaming in the boilers, but the water is eminently suitable for all kinds of high-class work such as in laundries, wool-scouring, dyeing, etc.

There are provided a series of spiral plates to accelerate the precipitation of the impurities as the water travels upwards after the chemical reaction has oc-

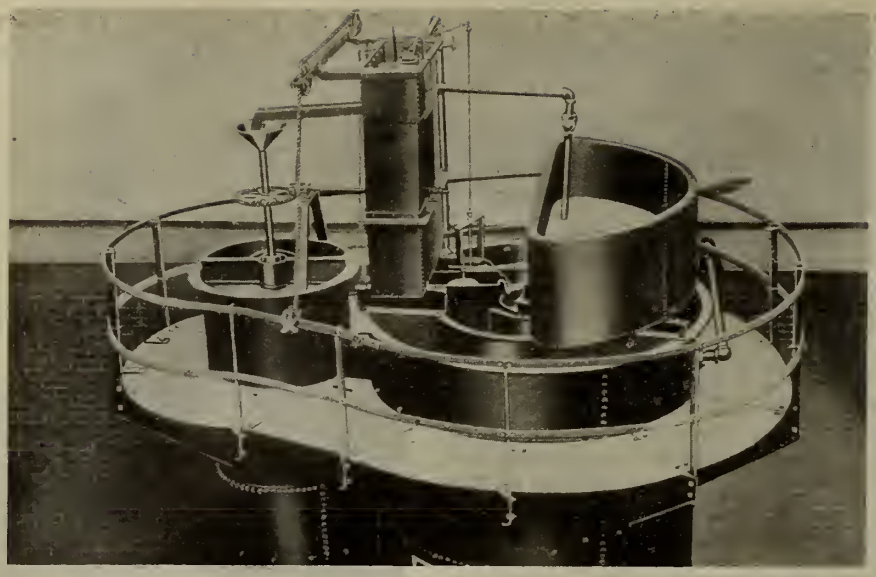


FIG. 5—DETAILS OF MECHANISM OF 3,000-GALLON WATER SOFTENER.

curred. The sludge deposited on these plates gravitates into the cone, from whence it is flushed to the sewer by simply opening valve for a few seconds daily. After leaving the spiral accelerators the water passes through a wood fibre filter into a reservoir, from which point it is drawn off for use, all scale forming matter and mud having been removed. The machine starts and stops automatically as water is required and will supply any quantity up to the rated capacity. The only attention necessary is about 20 minutes daily, which can be given by the engineer or other responsible employee without interference with his regular duties. It is never necessary for any purpose whatsoever to enter the machine.

In considering the water question, it will be stated that in converting water into steam there is, under the most favorable conditions, a great waste of heat energy. To minimize this loss has been the aim of mechanical men and inventors ever since the adoption of steam as a motive power. Heaters, stokers, economizers, pipe coverings, all tend to conserve the energy produced by combustion and to convert it into a potent factor. Manufacturers recognize these accessories as modern developments in steam engineering and consider them good investments.

Even at this age of advanced economies, when every department is closely scrutinized by experts to discover leaks and methods devised to lessen the cost of manufacture, it is marvellous that until the present day the very essence of economical steam generators, a non-scale-forming feed water should have escaped scientific treatment. Practically all natural waters are impregnated, to a greater or lesser extent, with soluble metallic salts, which tenaciously attach themselves to the boiler tubes and shell as the water is evaporated into steam, thus forming a cement coating that not only persistently resists removal but is also a non-conductor of heat. The extent of this non-conductivity is better appreciated when it is understood that most feed waters contain (in addition to other solid matter) considerable quantities of magnesia, which is extensively employed in pipe coverings to prevent the transmission of heat.

In many cases, after poison in the form of impure waters has been injected into the boiler, antidotes (boiler compounds) are administered in a vain endeavor to offset or neutralize the action of the poison. The compound cannot keep the impurities out of the boiler, and its most perfect theoretical action would only convert the solids into sludge, but it does not even do that, as engineers will testify. Aside from many of these, medicines have a baneful effect, causing leaky tubes, foaming.

Mechanical cleaners are expensive to operate, both as to power and labor required, and the more inaccessible parts of the boiler are never reached. In many plants a force of men are continually at work drilling out tubes. Exhaust steam feed heaters can remove from water only the carbonates (lime) as these are held in solution by carbonic acid gas, which is expelled by ordinary boiling at atmospheric pressure, and the carbonates, being thus released, are partially precipitated in the heater. The sulphates, however, which form the hardest kind of scale, are not affected in the heater, and pass on into the boiler, where they are precipitated by the high temperatures attained under pressure.

It is maintained that the utilization of waste steam for heating feed water is of vast economic value, but the supplying of non-scale-bearing water to the boiler is of much greater importance. The manufacturer is eternally studying how to reduce operating expenses, and scrutinizes with microscopic care every department in his factory. He is now tackling the power centre and must recognize that economy and efficiency in the boiler room must be of the most approved design.

WHAT A STEAM PUMP WOULD SAY IF IT COULD TALK

Please do not gorge me with oil, as it will give my steam chest indigestion. What I like is a steady diet which will enable my valves to work smoothly and with durability. A very small amount of oil fed to me steadily is the thing—it saves oil and repair bills.

Two or three times a year give me a good dose of coal oil to clean out any obstructions that may have accumulated in the passageways of my steam chest, or on the face or working parts of the valves and valve seat, or on the chest piston.

Do all you can to help me make a full length of stroke, as it means that I will use less steam and do better work. The adjustable collars on the valve rod will allow you to regulate the length of my stroke to a nicety.

By allowing me to make short strokes, you prevent my steam piston from getting in its proper cushion, which it would do if it could complete its full stroke. My steam piston is supposed to run up to the end of the cylinder and pass across the exhaust port, cushioning all the confined steam between said port and the cylinder cover. The hand wheels on the side of my steam cylinder are for controlling the amount of this cushion. For slow speeds these cushion valves should be shut tight. When running at ordinary speed or a high rate of speed, these cushion valves should be slightly opened.

Once in a while take a look at my water cylinder. See that the packing of the water piston is not set up so tight that it makes me grunt, producing unnecessary friction and wear. Or, perhaps the packing is too loose a fit, or is worn out and needs renewing.

Please see that my water valves are seating properly, because if they are not tight I cannot pump as much water as I ought to do for a given speed. Sometimes the springs on the back of my water valves need renewing or looking after. If you have not already provided a good suction air chamber for my water cylinder, you ought to do it, because it will prevent the water column in the suction pipe from slapping the face of my water piston at the end of each stroke in a harsh manner and so produce "water hammer." A good suction air chamber properly located, saves wear and tear, and makes a pump quiet running.

Please keep me nice and clean. I may not be of as much importance as your big engine, but there is no reason why I should not be kept free from dirt and grease. I hate to have oil slobbered all over my steam chest, or my stuffing-boxes left leaking.

You will find it pays to keep me in good condition, like a well-groomed horse. Treat me well and I'll serve you well and long.—"The Darling Digest."

Canadian Electrical Association Convene

Annual Convention Held at Alexandria Bay—Co-operation With Standards Committees in the Promotion of Engineering Standards Agreed Upon—Resume of Recent Progress in Electrical Engineering and in the Field of Prime Movers

THE Canadian Electrical Association held their annual convention at Alexandria Bay on June 27th-28th. With the cessation of war activities, interest centres around the improvement and standardization of equipment, better operation and other features rendered possible. Those connected with the electrical industry may well take a particular pride in the part played by it in the prosecution of the war to a successful conclusion, and while such has been the case many difficulties had to be surmounted and much deferred to a more favorable time. Such being the case the present time of reconstruction offers many opportunities for creative work and it was noticed throughout the papers and discussions as well as in the address by the president, A. Munro Grier.

Prime Movers

During the period of the war one of the features in the manufacturing life of this country was the plentiful supply of electrical energy available through the development of water power resources and the consequent conservation of fuel. This was brought out in the report of the committee on prime movers read by R. J. Beaumont.

The necessity of conserving the fuel supply of the country during the period of the war has turned the minds of all engineers and manufacturers to the necessity for economy in operation of steam plants. Recent progress has been to some extent concentrated on this phase of development. Considerable progress has been made in late years in the science of generating steam due to a better understanding of the combustion of fuel and the transmission of heat in boilers.

Boilers

Present day tendencies favor high steam pressures and temperatures, concentration of power and large unit capacities. The shell boiler has been practically eliminated for this class of service and modifications have been made in the setting and rating of water-tube boilers.

The application of insulating brick in boiler settings is now becoming better understood. It is generally accepted that the walls of a boiler furnace should be built of as few different kinds of material as possible and walls should be well bonded and homogeneous. Recent tendency has been to build walls of solid fire brick.

In order to preserve the furnace, side and bridge walls various expedients have been tried. Which is required is a furnace lining capable of withstanding the high furnace temperatures and blow-torch action; the constant heating and cooling effect and the abrasive action of the fuel bed.

Ventilated walls. special refractory materials, steam jets on side walls and high temperature cements have all been used with varying success.

The present tendency is towards higher boiler ratings. One of the principal factors involved in high boiler ratings is the coal burning capacity of the grate, or, in other words, stoker and furnace design. Draft loss at high boiler ratings is an important item to be considered and the character of the boiler feed water may readily become a factor in boiler ratings.

Power dump grates and clinker grinders seem to be coming into use. The Westinghouse Co. and the American Engineering Co. have these on the market, as well as several other concerns. The forced draft type of chain grate is now being used more extensively and with success in burning low grade fuels high in ash.

Higher steam pressures have been tried out in one or two plants in the U. S. The Buffalo General Electric Co. have recently placed in service a plant operating at 275 lbs. boiler pressure and 275 degrees super-heat, giving a total temperature of 689° Fah.

The Public Service Co. of Northern Illinois have an installation operating at 315 lbs. boiler pressure, 225 degrees super-heat, giving a total temperature of 615° F.

The general impression seems to be that the question of higher steam pressures is a boiler problem, and that turbines can be easily designed for operation at the higher steam pressures.

Steam Turbines

In recent years there has been a marked tendency towards the installation of units of large capacity, and during the past two years there has been a marked increase in the United States in units of the horizontal shaft type of approximately 30,000 k.w. capacity in order to meet the rapidly increasing density of the load.

The main source of trouble in large steam turbine units seems to be in the labyrinth packings and thrust bearings, which are apt to cause excessive vibration of parts, the breaking of buckets and dangerous rubbing of stationary and moving elements, which in extreme cases may result in permanent deflection of shafts.

The General Electric Co. states that new development work has been rendered difficult by war conditions, but a great deal of development work has been carried on nevertheless, to meet the requirements of the navy and Emergency Fleet Corporation. The loss of skilled labor has been felt very severely and to some extent has been reflected in the workmanship of the turbines built under war conditions. Another handicap has been felt in the difficulty of securing suitable quantities and qualities of materials required for the manufacture of turbines.

Considerable attention has been paid of late by many companies to the matter of fires originating within the generator shell of turbo-generators of the enclosed type, with the object of determining the means of minimizing the occurrence of such fires, limiting the extent of the damage and providing fire fighting equipment which can be quickly applied where it can do most good.

The origin of fires in turbo-generators during the past year seems to be fairly evenly divided between those external to the insulation surrounding the copper conductors, and those internal from the conductors themselves. The greater proportion of fires originating from sources external to the insulation seems to have occurred on three-phase systems operating without a grounded neutral.

The inspection and cleaning of turbo-generators at more frequent intervals would seem to be very desirable and to have a direct bearing on the liability to fires external to the windings. Every precaution should be taken to limit the amount of dirt and oil which may enter the generator, and many campaigns have standardized the installation of air

washers. Even with the best possible condition of cooling air it is evident, however, that dirt will lodge within the generator, and if a certain amount of oil vapor is also carried into the machine the coils and other surfaces may become smeared with grease. Good practice, therefore, would seem to dictate that machines should be opened up periodically for thorough cleaning and painting.

The extinguishing media which have been used in the past for turbo-generator fires are principally water, steam and carbon tetra-chloride (Pyrene). Practically only water and steam are looked upon at present with favor, inasmuch as large volumes of carbon tetra-chloride are required for any but very small fires, thus involving great expense and possible injury to operators from fumes.

Up to the time of the installation of permanent fire extinguishing apparatus for generators, water had been the principal medium used. With the advent, however, of permanently installed fire-extinguishing apparatus in generators the use of steam has received very serious consideration, and there is at the present time a wide difference in opinion as to the relative merits of steam and water in this connection.

The principle of operation in using steam differs from that in using water, in that displacement of air in the generator by steam is very largely depended upon to smother the fire. It is extremely important, in using steam, to shut off the supply of air to the generator as completely and promptly as possible. The wetting of the generator windings from condensed steam is probably also helpful.

Protective Equipment

It is rapidly becoming standard practice, particularly on larger units, for the manufacturer to bring out both ends of each phase winding to the generator terminal boards, so as to permit of the installation of current transformers between the terminals of the phase windings and neutral, which can be connected differentially with respect to instrument current transformers in loads between main oil switches and generator, so that in the event of a fault in the generator or its leads the balanced relay will immediately open the main oil switch, the neutral switch (if closed), and after a slight delay the field switch.

Before proceeding to fight any generator fire it is, of course, absolutely essential that the unit be disconnected from the line and the field opened. With the balanced system of protection this is done automatically in fires involved from breakdown of the conductor insulation on a grounded system. On other occasions these operations must be performed by hand as soon as it is evident that the unit is in trouble. It would seem very desirable to have a pilot light on the turbine gauge board connected across a generator potential transformer to indicate when the unit was generating, and also, perhaps, a red lamp to light on the operation of the balanced relay.

It will, of course, be necessary upon application of water to the generator windings to dry out the same on short circuit before again placing in operation. Experiences after floods have demonstrated that electrical generators may be immersed in water for some time with no serious damage resulting when thoroughly dried out before being placed again in commission.

Water Power

During the four or five year period prior to the war the manufacturers of hydraulic turbines made great strides in developing units of high efficiency and simple design. This was primarily obtained through the introduction of high specific speed single runner units. During this period a great number of low head plants were built, using single runner units of larger size than anything previously attempted. During the last four years, however, the activities in hydro-electric developments were greatly lessened and few new features of design have come out.

Efficiencies of 92 to 93 per cent. of runners have already been obtained in several plants, and it may be assumed that this is very near the maximum efficiencies that can be expected. To obtain a maximum over-all efficiency engineers are now carefully looking into the design of all passageways from headrace to tailrace. Particular attention is being paid to the design and efficiency of draft tubes for high specific speed runners. The tendency is towards the use of deeper draft tubes, with the idea of making the turn from the vertical to the horizontal direction at lower velocities than was previous practice.

There seems to be a difference of opinion as to the number and size of units to be installed in a projected plant; the tendency has been to look upon the water turbine as an almost fool-proof piece of apparatus; consequently plants have been equipped with as few and as large units as possible, thereby making a considerable saving in first cost, as well as in operating expense. Considering, however, that the reliability of a unit does not only depend upon the water turbine, but also upon the generator and auxiliaries, some designers of power plants incline towards comparatively small units, with less chance of breakdowns.

The single runner vertical shaft turbines for low and medium head plants have proven to be such a success that practically all new plants under this category are now being equipped with this type of unit.

Thrust Bearings

With the increase in size of large vertical water wheels and the consequent increase in weight of the rotating parts, the importance of satisfactory thrust bearing cannot be exaggerated, and a great deal of progress has been made in recent years.

The General Electric Co. has developed a spring supported thrust bearing which automatically adjusts itself to inequalities in loading, due to inaccuracies in workmanship and alignment. The bearing is not affected by the wobbling of the shaft. The rubbing surfaces are in a bath of oil, and the quantity of oil circulated depends upon the losses and cooling conditions.

Two of these bearings have recently been installed in the Cedar Rapids Plant of the Montreal Light, Heat and Power Co. in connection with the last two 10,800 h.p. units. These bearings are designed to sustain a load of 550,000 pounds during continuous operation at a normal speed of 55.6 rev. per minute. The Kingsbury thrust bearing has been adopted by the Hydro-Electric Power Commission of Ontario for the Westinghouse generators on the Queenston development. They are designed to carry a load of 900,000 lbs. at 187½ rev. per minute. The turbines for these generators have been awarded to the Wellman-Seavor-Morgan Co., and the two units will develop 52,500 h.p. each at the point of maximum efficiency, and 60,000 h.p. at full gate. The net head on the turbines will be 305 feet, and they will be of the single runner vertical type with a cast steel spiral casing.

Electrical Apparatus

In the report presented by the committee on electrical apparatus, emphasis was laid upon the advisability of standardizing lead markings and other features of designs of apparatus, such as transformers, and co-operation should be maintained and increased between the various operating companies, manufacturing companies and societies to this end.

The three-phase transformer is becoming more popular in many installations, and the general practice seems to be to instal transformers of just sufficient capacity for rated load, and to resort to water cooling for overloads.

The automatic sub-station for direct current is growing in popularity. There are at present on d.c. railway service seven sub-stations of 1,000 k.w. or over, and 49 between 300 and 600 k.w. All

have been operating automatically or semi-automatically for some time, and engineers would, it seems, be well advised to investigate the automatic substation as an economical proposition. D. C. sub-stations operating automatically are in continuous operation also, and some of these are of the straight outdoor type. Apparatus in automatic sub-stations should be more liberally rated and should be of the most rugged construction.

As sub-station apparatus the rotary converter with a capacity of 4,000 kw. appears to be about the upper limit of size. With the extension of the use of 60 cycles as a system frequency, the 60 cycle rotary has come more into prominence, although at times on railway service flashing is troublesome. The use of flash guards, arc cooling devices and high speed circuit breakers is expected to bring them upon a par with 25 cycle machines.

The general policy of operating all banks of transformers and distribution feeders on one bus with an auxiliary bus provided is maintained. The capacities so connected are running considerably higher than 10,000 kw., and this brings up the rupturing capacities of oil switches. To avoid considerable expense in changing over apparatus, as well as possible switch destruction, the use of reactors seems desirable. Attention is called to the neglect which usually falls to the lot of the air break switch. It is pointed out that the abnormal temperatures which are liable to be caused by oxidation create bad contacts.

Accident Prevention

The committee on accident prevention, Wills McLachlan, chairman, drew the attention of the association to the necessity for the elimination of tools with insulated handles. These tools are purchased from various manufacturers, and the insulation is oftentimes depended upon for the protection of life, where it is more a case of good luck than good management that fatalities are avoided. It was recommended that so far as possible tools with insulated handles be not used except for very high voltages where special tools are required, but that dependence be placed upon rubber gloves tested according to specifications. For some years past the Canadian Electrical Association have collaborated with the N.E.S.A. on the question of specifications for the purchase of rubber gloves and linemen's belts. These specifications have been completed and will form a tentative basis for further improvement or for adoption.

Lighting and Power Sales

Industrial lighting has shown considerable development, due no doubt, to the pressure of war work in the extensive production of munitions. In certain places in England and the United States it has been found that surprising results have been obtained in increased production, due to correct and improved lighting.

The sale of power during the period under consideration has been more or less normal. In almost every case where large systems are used it was found that the decline in load, due to the signing of the armistice, did not assume serious proportions, and that in some cases, where a wide service of large capacity was delivered, the amount of power delivered was practically only reduced for the period between the signing of the armistice and the end of 1918.

The present time is one of development, stabilization and return to prewar conditions. Numerous projects covering a wide variety of productions are under consideration and to meet this coming demand most of the larger power companies in Canada are either constructing plants or are preparing designs for future expansion.

The use of the electric stove is more than ever rapidly increasing. The effect of an electric range load on a distribution system is now rapidly becoming known, and has been found to be very satisfactory from the viewpoint of diversity.

The question of the cost of a range forms an interesting study, and there is no doubt that a need exists for what might be termed the "Ford of the electric range business." If a range could be sold for $60.00 it would add a great stimulus to their rapid introduction amongst people of very moderate means.

Synchronous motors are rapidly coming into popularity. This particular type of motor is, of course, more practicable, broadly speaking, in the larger sizes, owing to the somewhat more complicated operating features. A motor of medium size, say three to five hundred horse-power, has great value in correction of power factor on a system of fair size.

Service at Cost

In a paper read by E. P. Fredericks an outline was given of the many advantages of the "service at cost" plan as applied to public utility companies. These companies, and particularly those having to do with the distribution of electrical energy and city transportation, have been affected very materially by increased costs, and in many cases have been operating at a loss. As a means of offsetting this condition, and to insure that the municipality served will be receiving maximum advantages with the minimum of expense and the cheapest possible cost for fares, this plan has not only been proposed, but put into effect in a number of cities, with marked advantages. Cleveland, Des Moines, Cincinnati, Chicago, Philadelphia, and a number of other cities have already put the plan into force, and many more have been considering it very favorably.

Briefly, the service at cost plan provides that a public utility operating under it shall provide service at its actual cost, including operating expenses, maintenance, depreciation, taxes and 6 per cent. interest on the investment value. Investment value shall be money prudently and honestly invested, and this has been interpreted to mean money that has been invested as reasonably necessary for lawful purposes. It should be noted that 6 per cent. on the investment value does not limit the return on any particular security to 6 per cent. If the bonded debt should carry a lower rate of interest, more than 6 per cent. might be available for stock, but it is generally conceded that 6 per cent. is a fair return on the investment value. The actual value of each company accepting the plan is usually stabilized by some properly constituted authority, so that there may be no criticism as to inflated valuation.

The municipality or general public is protected by having its representatives on the operating board, and the advantages both to the municipality and to the company may be outlines as follows: It calls for close public supervision, it demands an improved service and the maintenance of the service at tis best standard. It demands efficient and honest administration, it provides for charges sufficient only to pay the actual cost of good, adequate service, and at the same time guarantees the integrity of the investment with the restoration of the credit of the utilities affected.

The Utilization of Off-Peak Energy

One of the most interesting papers read before the convention was that prepared by F. G. Clark, Chief Engineer Toronto Power Company, and read in his absence by Wm. Volkmann. Power Companies in many cases have considerable off-peak power which could be utilized to good advantage and which could be produced at a considerably lower cost than during peak loads.

The Toronto Power Co. operates one of the hydraulic plants at Niagara Falls, on the Canadian side, and a steam plant at Toronto. In 1915 this company established a research department having for its purpose, among other things, the increasing of the load factor of the system.

Finding that the manufacture of the gases oxygen and hydrogen by the electrolysis of water offered possibilities and that there was no apparatus on the

Continued on page 28

THE ELECTRICAL DEPARTMENT

Distribution System Nomenclature

An Article Dealing With the Proper Nomenclature of the Various Parts of a Distribution System and Explaining Their Relationships by the Aid of Diagrams

By TERREL CROFT

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CONSIDERABLE confusion exists as to the precise meanings of the terms which are used to designate the different components of an electrical-energy distribution system. In the following paragraphs definitions are given for some of the terms most commonly used. These definitions are, it is believed, in line with the generally-accepted meanings of the words involved. Fig. 1 shows diagrammatically the important elements of a distribution system.

A transmission line comprises the arrangement of conductors over which electrical energy is transmitted from a generating station to a substation. In general, the distinguishing characteristics of transmission lines are that they operate at relatively-high voltages and extend for long distances. At B in Fig. 2 is shown the transmission line.

A tie line is a set of conductors used to interconnect two substations. A tie line may also operate at a high voltage and extend for a long distance, but is distinguished from a transmission line in that neither of the ends of a tie line originate in a generating station.

A transmission system is one over which electrical energy is transmitted from a generating station at relatively-high voltage to a distributing system, or to distributing systems

A distribution system is one from which electrical energy is distributed to consumers. As a rule a distribution system operates at a lower voltage than does a transmission system. However, it is very difficult to distinguish between a transmission and a distribution system, because (as P. H. Thomas states): "In any large system the functions of transmission and distribution merge into one another, because the principal consumers will ordinarily be many miles apart. Furthermore, there usually are several sources of energy feeding into the system at different locations. The transmission and distribution systems then resolve themselves into a net-work of high-tension lines to which are connected consumers and generators at certain locations."

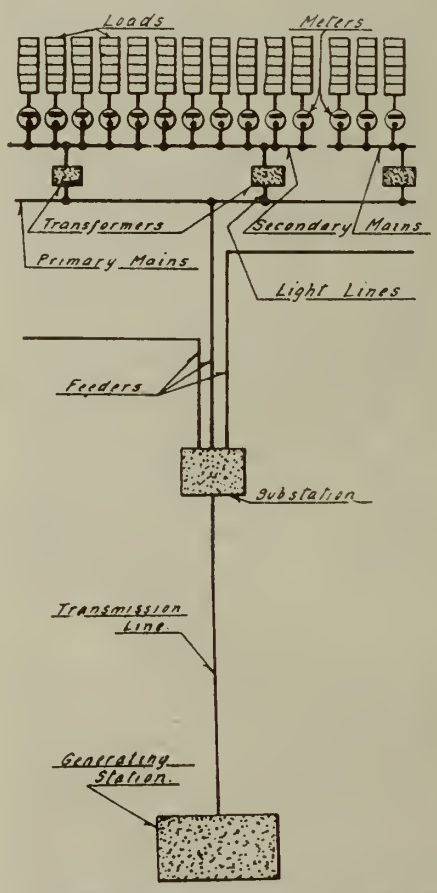

FIG. 1—THE ELEMENTS OF A DISTRIBUTION SYSTEM.

A feeder or feeder circuit is the set of conductors in a distributing system extending from the original source of energy in the installation to a distributing centre and having no other circuits connected to it between the source and the centre. The source may be a generating or substation. Feeders are indicated by the letter D in Fig. 2.

A sub-feeder is an extension of a feeder from one distribution centre to another, and having no other circuit connected to it between the two distribution centres.

A main (E and G, Fig. 2) is any supply circuit to which other consuming circuits—sub-mains, branches, or services—are connected through automatic cut-outs—fuses or circuit breakers—at different points along its length. Where a main is supplied by a feeder the main is frequently of smaller wire than the feeder which serves it. An energy utilizing device is never connected directly to a main, a cut-out always being interposed between the device and the main.

A sub-main (ES, Fig. 2) is a subsidiary, main fed, through a cut-out, from a main or another sub-main and to which branch circuits or services are connected through cut-outs.

A service (or a service connection, H, Fig. 2) is the set of conductors constituting an underground or overhead connection between conductors (usually belonging to a public service corporation) in a thoroughfare—street—and the conductors of an interior or isolated wiring system. A "service" provides a path over which electrical energy is delivered to the consumers.

A branch or branch circuit is the set of conductors feeding, through an automatic cut-out, from a distribution centre, main or sub-main to which one or more energy utilizing devices are connected directly, that is, without the interpositions of cut-outs. The only cut-out associated with a branch is the one through which the branch is fed at the main, sub-main or distribution centre.

A tap or tap circuit (Fig. 2) is a circuit, serving a single energy-utilizing

device, connected directly to a branch without the interposition of a cut-out.

A distributing or distribution centre in an electrical energy distribution system is the location at which a feeder or sub-feeder connects to the subordinate circuits which it serves. The switches and automatic cut-outs for the control and protection of the sub-circuits are usually grouped at the distribution centre. In interior-wiring parlance, a distribution centre is an arrangement or group of fittings whereby two or more minor circuits are connected at a common point to another larger circuit. A

CANADIAN ELECTRICAL ASSOCIATION CONVENES

Continued from page 283

market suitable for use on a large scale, having regard to economic features, research work was begun on the development of a type of cell which would prove satisfactory.

The result was the development of a type of electrolytic cell in which the electrodes operated at high densities and temperatures. Cells have been in operation at the company's Toronto plant for over two years, and have in this time fully demonstrated their commercial feasibility.

In the production of oxygen now so necessary in welding work and other mechanical arts, this step marks a considerable advance, enabling as it does, its generation to be carried on at a very much smaller cost than heretofore has been possible.

Officers

The following officers were elected for the coming year:

A. Munro Grier, K.C., President, 801 Dominion Bank Bldg., Toronto, Canadian Niagara Power Co., Niagara Falls.

E. A. Dunlop, M.P.P., 1st Vice-President, Pembroke Electric Light Co., Pembroke, Ont.

P. T. Davies, 2nd Vice-President, Southern Canada Power Co., Montreal.

A. P. Doddridge, 3rd Vice-President, Quebec Rly., Light, Heat and Power Co., Quebec.

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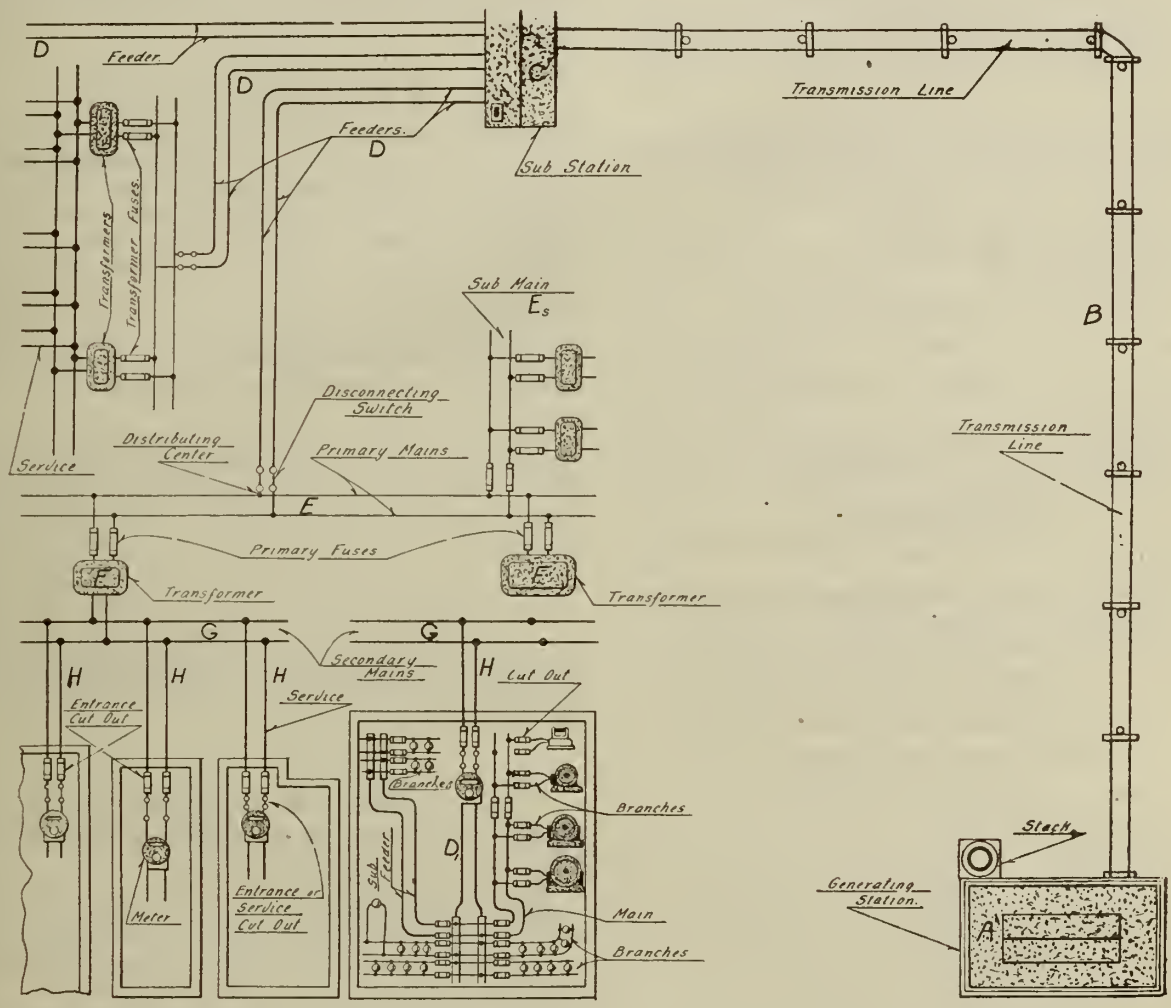

FIG. 2—PICTORIAL DIAGRAM INDICATING THE ELEMENTS OF AN ELECTRICAL ENERGY DISTRIBUTING SYSTEM

panel box is one form of a distribution centre.

The nomenclature of interior-wiring-system circuit elements is similar to that for an outside distribution system. The subject is treated in more detail in the author's "American Electricians' Handbook," page 109. The terms feeder, sub-feeder, main, sub-main, branch, tap, and distribution centre are defined diagramatically in the wiring layout shown in the lower part of the centre of Fig. 2. From inspection it is evident that these interior-wiring system elements can also be defined in essentially the same words as recited for the outside distribution system elements recited above.

Managing Committee

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Mr. John Melville, of Vancouver, B.C., says that semi-monthly POWER HOUSE is beneficial, especially to the engineer who is studying any particular course which may be in the issue—as a a month is too long to wait between articles.

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Opportunity

THE Annual Convention of the C. A. S. E. this year held in Brantford is a thing of the past. It marks the close of a particularly strenuous four years in the life of the stationary engineer. Many of the features of war-time conventions were still noticeable and will exist for years to come. Economy in operation is still a most important feature and this phase of power plant operation was well exemplified in the various exhibits arranged by the Exhibitors' Association.

Economical plant equipment in itself will not ensure efficient operation and if the operating engineer wishes to keep abreast of the times and to bring the steam plant to such an efficiency as will meet the cheapness of outside power he will have to do a bit of self-improvement and must avail himself of the many opportunities offered for self-improvement.

It is to be regretted that more advantage is not taken of the educational features of conventions by the stationary engineers delegated thereto. Entertainment especially of a mediocre sort can never lend itself to personal advancement, while the exhibit shown by manufacturers are most excellent educational features and the technical papers presented form every valuable means of keeping abreast of the times, not only through the subject matter treated of but also through the opportunity for discussion presented. Indeed more is gained in discussion following after the reading of papers than in the papers themselves.

A New Prime Mover

ELSEWHERE in this issue is presented an account of a hybrid prime mover worthy of an engineering Burbank. By crossing a steam engine and an internal combustion engine a mechanism is produced for which very high efficiencies are claimed. It is a well-known fact that the internal combustion engine is one of the most efficient prime movers and that the majority of heat wasted goes into the jacket water. By using this heat for the production of steam and by using this steam on the underside of the piston an increased efficiency is obtained, a remarkable efficiency when compared with the older forms of heat engines.

The Still engine is perhaps as yet too little developed to hazard any guess as to its commercial feasibility, but should it come up to the expectations of its inventor, great changes can be expected particularly in the use of the internal combustion engine for ocean transport. Other applications will arise through the extreme flexibility of the mechanism and the powerful torque obtained at full loads.

The conserving of the world's fuel supply will render an invention such as this very attractive, the more so as the increasing cost of fuel will automatically force one to look around for cheaper and more efficient means of producing power.

Don't be a Tinker

DON'T be a tinker. If you are going to do anything in life, do it well.

Do one thing better than any person else can do it.

Ever see a handy-man? You know the kind. He's not particularly skilled at anything particular, but he can catch on quickly. He makes a great stop-gap in the shop—and he generally sticks right there.

Ever meet the chap who can play a few chords on the piano, and who can sing a couple of old songs to his own playing? He gets through all he knows in a few minutes, and if he has to do anything more, he's up against it. As a matter of fact, he's only a tinker. He can neither play nor sing, and yet he imagines he can do both.

You have seen the average clerk in operation in a store. No matter whether it's groceries, dry goods, boots and shoes. In a general way he can get you what you want if you have a pretty fair idea of what you want before you go in. But he will never sell you anything else. He will never size you up as you enter the store, or as he talks to you as a prospective customer for some new lines of goods that the store carries or is going to carry. He is just an average, garden variety. In fact, he's a tinker in his line of business.

Don't be a tinker. Do something, well—much better than any person else. Then there will be a demand for your services that will shove you head and shoulders past the tinker class.

The Millionth of an Inch

SOME folks is always hankerin' for to do some foolish thing, to say some startlin' statement or 'sassinate a king. They seem to have a mania for things what's strange and queer, you wouldn't think they had a brain tucked in behind their ear.

And then there's other things they do that seem to me most strange, they're clean beyond my vision, ten miles outside my range.

Now, take the chap what took an inch and carved the thing in two, I guess he thought that was a trick to puzzle me and you. And then some prune, he come along and split the thing in four, and them what watched the show that day they hollered out "encore!"

Well, time went on and bye-and-bye these choppers whacked away, until the chiefest of the lot rose up one day to say, "I've took that inch and by the use of hammers and of charts I've sliced the thing, by heck I have, into a thousand parts!"

Well, folks they donned their goggles for to see the bloomin' speck; it weren't no bigger than a hair what sprouts upon yer neck.

Well, not content with that there stunt, they started in once more, and sliced and rubbed that thousandth right down unto the core, until we read in words what make my fists go in a clinch, about there being in measurements the millionth of an inch.

Oh, I'd like to lay my husky hand upon that whiskered guy, who caused my head to swim about when I went out to spy, to gaze upon the millionth part of that there inch of ours, I've looked until my eyes most bust, I sweat for hours and hours.

I rise to say out good and loud so all your folks can hear, no matter if you dub me odd and just a trifle queer, "There ain't no such a thing about—to me that is a cinch —as that there atom that they call the millionth of an inch!"—ARK.

The Future of the File

A WELL-KNOWN Canadian firm, making files, has sent out word with its shipment that a file is a fine tool, and as such should be protected from rough usage. The notice even goes on to claim that better results can be secured from a well-preserved file.

As a matter of fact, this manufacturer is right, but we hate to believe him. The general acceptance is that a file is a utility tool, and that it can stand hard usage. Therefore, it is the duty of the man who gets a file to give it hard usage.

Ever use a file as a hammer? Not as a sledge, perhaps, but just as something handy at the time.

Ever pry the lids off cans with a file? Sure. Great thing for all such odd jobs.

Ever use the tang end of a file to dig a hole in a brick? Handy for this sort of work.

Ever turn over a heap of tools to find the file you want away at the bottom, where everything else in the box has had a chance to have a kick at it? Own up now, you have.

Most people have had about as much regard for a file as they have for a crow bar. Its cutting edge is regarded about the same as the family razor that shoots father's whiskers, pares mother's corns and when no person's looking sharpens the youngsters' lead pencils. The file is sort of a family instrument. Every house has one in the kitchen table drawer—that is every well-regulated household. And there are more hanged things done with and to that family file than ever happened in a bang-up three-ring circus. It pulls corks out of a bottle, it hammers tacks, it sits around on call when the carpet is being laid on the back stairs, and it comes into active service when the old man is wondering why under the sun the elbow from the kitchen range will not slide into the stove pipe hole like a reamed out cylinder and piston. It is the family file that crawls in beside that stubborn pipe and stays there too while the old man administers the final heave that puts the smoke stack in action.

Well, to be sure there may be better times on ahead for the file. It surely has had a whale of a time in its day, and when the day is over it generally gets its whiskers shaved off and does service as a screw driver, a chisel, a scraper, a centre punch, a drift or what not.

This process of education may do much. Certain if it does anything at all it must be for the better. It may even be that in years to come the file will get decent treatment in the shop and occupy, in the home, the place on the piano that is now given over to a picture of John Henry, taken in the suit he wore when sticking the point of a bayonet into the breeches of one Fritz.

OCCASIONALLY one sees a stork in the Zoo, but there must be a stack of these things some place in the woods, for there were 1,352,792 births in United States last year.

* * *

WHAT'S become of the shop joker who used to be sending the apprentice out to look for a left-hand monkey wrench and a flat-faced hammer?

* * *

A TRACTOR was being demonstrated at Richmond, Mich., when it became unmanageable and ran through a drug store. Being of the caterpillar type, there was doubtless something in the drug store to meet its case.

* * *

A CALIFORNIA man left $19,000 to his son. The only string is that the son has to earn $30,000 clear before he can get the $19,000. Chances are that by the time he piles up that sum he'll have cut enough wisdom teeth to know how to handle the smaller amount. It looks as though that fond parent knew a thing or two that the average chap never thinks about.

THE SLACKER B.T.U.

Behold the nimble B. T. U.
Now hastens toward the lofty flue;
He dances from the coal so black,
Around, across and up his track.
Along the furnace fiery walls
He dives and jumps, but never crawls;
Elusive, he, and small in size,
He's seldom seen by human eyes.
But hastening through the sooty tubes
In countless numbers—moves and moves
On through the baffles up and down
Against the shell so smooth and round,
Pushing and crowding here and there,
And mingling with the excess air,
Some holding back, a select few
Exclusive with the CO2,
To do their bit and turn to steam
The seething water, hot and clean.
But all the rest, now rushing, go
On through the breeching to and fro,
Pushing in haste to reach the stack,
A crowd of slackers, a lazy pack;
Up through the stack and to the air,
On, on they go; do we despair?
Ten thousand strong to every pound,
The work of ages in the ground;
Now and forevermore they're lost,
Into the great unknown they've crossed.
Quick! Plaster the brick work, close the cracks,
Change the draft, and raise the stack,
Level the fires, shovel the coal
A scoop at a time if you'd reach your goal,
And if it's too hard to think again,
Get a stoker that needs no brain,
Or the nimble heedless B. T. U.
Will prove much more than a match for you.

—Charles Brossman, in "The Combustion Chamber."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

29.—Explain the purpose of the steam dome. (b) How are steam drums connected to the boiler and what provision is made in the latter case for expansion?

30.—Explain the purpose of the mud drum.

31.—What is the purpose of manholes, and how should they be placed so as not to weaken the shell unduly?

32.—How are steam domes attached to the boiler and what are the advantages of properly constructed dome bases?

33.—Explain the purpose of nozzles as applied to boilers?

34.—Explain the purpose of stays or braces.

Questions Answered

Question 24.—(a) Name the various forms of rivet heads used in boiler construction; (b) How are rivet heads formed? (c) In what respect has machine riveting advantages over other processes of riveting?

Answer.—(a) Countersunk head, button head, conoid head, oval head, flat head, oval countersunk head, cone head, and steeple head; (b) By hand, snap, pneumatic and machine riveting; (c) The pressure applied in machine riveting causes the shank of the rivet to upset thoroughly, thereby filling the hole completely, consequently a tighter joint is made than is possible with hand, snap, or pneumatic riveting.

Question 25. (a) What is a lap joint?; (b) What is a butt joint?; (c) Distinguish between single and double-riveted joints; (d) Distinguish between chain riveted and staggered riveted joints.

Answer.—(a) A joint formed by two plates that overlap each other and are joined together with one or more rows of rivets.

(b) A joint formed when two plates are placed edge to edge and are connected with covering straps.

(c) In a single riveted joint the force tending to tear the joints asunder is resisted by a single row of rivets, and in a double riveted joint by two rows of rivets.

(d) In chain riveting the rivets in the different rows are placed in line, in staggered riveting the rivets are placed zigzag.

* * *

Question 26—.Which is the strongest type of the ordinary riveted joints?

Answer.—The type of butt joint having double butt straps with the inner strap wider than the outer, and having part of the rivets in double shear and part in single shear.

* * *

Question 27. What precautions are taken in locating the longitudinal seams of externally fired boilers, and also of cylindrical furnace flues of internally fired boilers?

Answer.—In externally fired boilers care is taken to have the joints as far from the fire as possible; in cylindrical furnace flues the joint is placed just below the grates, where it is not exposed to the fire and does not interfere with cleaning the lower part of the flues.

* * *

Question 28. What objection can be urged against constructing the fire-door hole of a locomotive type boiler by flanging the inner and outer sheets to a single curve?

Answer.—Owing to the rigidity of the construction, the inner sheet is liable to crack in use, from the calking edge to the rivet holes and also in the curved part of the flange.

Readers' Queries

The Editor,—I beg to submit what appears a more practical solution of Question 11 than that appearing on page 167 of May 5 issue:

Area of piston, 452.39 sq. in.

Total pressure, $452.39 \times 100 = 45{,}239.$

Area in studs required $\frac{45{,}239}{5{,}000} = 9.05$ sq. in.

Assume 16 studs $\frac{9.05}{16} = .5656$ sq. in. per stud.

1 in. studs would be ⅞ in. at bottom of thread.

Area of ⅞ in dia. = .6013 sq. in., which is a little stronger than required.

Regarding pitch circle. I would make it 27½ in. diameter, which would allow a full inch between counter bore and studs.

Pitch of studs to be 5.4 in.

W. C.

WHO IS BLIND?

Will every person who reads this notice, and knows a blind man or woman anywhere in Canada. kindly send the name and address of that blind one to the Canadian National Institute for the Blind, 36 King St. East, Toronto.

The institute is conducting work for the blind along the most modern scientific lines and desires that each blind resident of Canada should have the opportunity of availing himself or herself of the benefits represented by this work.

The immense task of registering every case of blindness can only be accomplished successfully by the earnest cooperation of the public generally. That is why we ask you to send the names and addresses of blind people you may know.

The following departments of work are being actively prosecuted by the institute:

Industrial Department for Men.
Industrial Department for Women.
Department of Field Work.
Department of Home Teaching.
Department of Prevention of Blindness.
Library Department.
Department of After Care.
Residence and Vocational Training Centre for Blinded Soldiers.

To send information or obtain information, address the General Secretary, Canadian National Institute for the Blind, 36 King St. East, Toronto.

Progress in New Equipment

THE RILEY TWO-SPEED GEAR BOX

THE Riley two-speed gear box differs from stoker gear boxes in that it contains in addition to the worm gearing a double set of spur gears. These gears are so arranged in the bottom of the gear box that by shifting the lever from high to low speed position, or vice versa, the coal feed may be retarded or accelerated. It means that on large units the fire can be levelled, thinned, or thickened as required.

When a number of stokers or gear boxes are driven by a single prime mover, any stoker or the retorts on any gear box can be operated practically independently of all other stokers or gear boxes. This effects a saving in fuel, since there is no necessity for carrying over coke when trying to divide the load equally among a number of stokers. or when building up thin sections of the fuel bed in a wide furnace.

With the stokers driven by an ordinary engine or motor, double the usual range of speed is obtained. This is an advantage at high ratings (300 to 350 per cent.). The stoker counter-shaft at these loads usually has a speed of from 400-450 r.p.m. Suppose, for example, the load is suddenly reduced to about rating on the boilers; an engine to handle this would need to operate from 100 to 150 r.p.m. Such low speeds are not only liable to stall the engine but are extremely wasteful of steam. Shift the two-speed gear box lever from high to low speed and the engine can operate from 200 to 300 r.p.m., an efficient speed for economical operation.

The installation of the two-speed gear box makes the slip ring induction motor more suitable for stoker drive. A 2 to 1 reduction in speed is all that can be obtained electrically, but with this new device an over-all range of speed of 4 to 1 is obtained. A multi-speed motor with four speeds, 600, 900, 1,200 and 1,800 r.p.m. can now give the equivalent of 300, 450, 600, 900, 1,200, and 1,800 r.p.m. If the motor operates at a maximum of 1,800 r.p.m. during peaks—then a sudden change in steam requirements does not necessitate feeding an excess amount of coal to the boiler. A single throw of the shifter lever from left to right cuts the coal supply in half. This is done without a change in the speed of the motor.

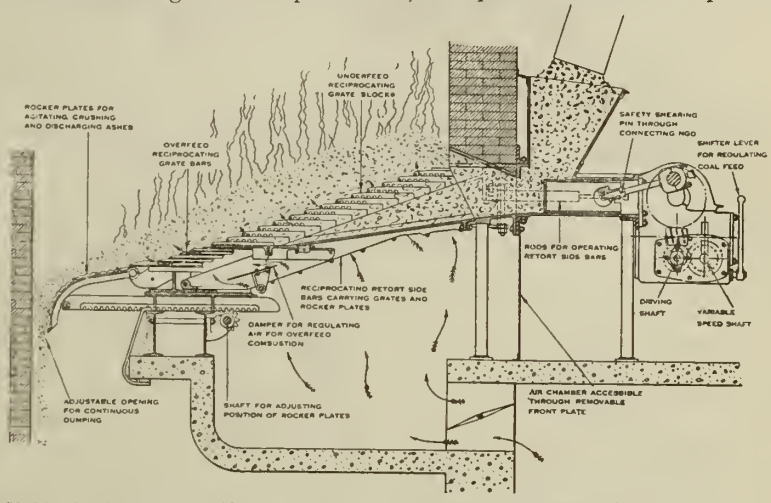

ROCKER PLATES FOR AGITATING CRUSHING AND DISCHARGING ASHES
OVERFEED RECIPROCATING GRATE BARS
UNDERFEED RECIPROCATING GRATE BLOCKS
SAFETY SHEARING PIN THROUGH CONNECTING ROD
SHIFTER LEVER FOR REGULATING COAL FEED
RODS FOR OPERATING RETORT SIDE BARS
RECIPROCATING RETORT SIDE BARS CARRYING GRATES AND ROCKER PLATES
DAMPER FOR REGULATING AIR FOR OVERFEED COMBUSTION
DRIVING SHAFT
VARIABLE SPEED SHAFT
ADJUSTABLE OPENING FOR CONTINUOUS DUMPING
SHAFT FOR ADJUSTING POSITION OF ROCKER PLATES
AIR CHAMBER ACCESSIBLE THROUGH REMOVABLE FRONT PLATE

FIG. 2—CROSS-SECTION THROUGH RILEY UNDERFEED STOKER SHOWING THE OPERATION OF THE TWO-SPEED GEAR BOX.

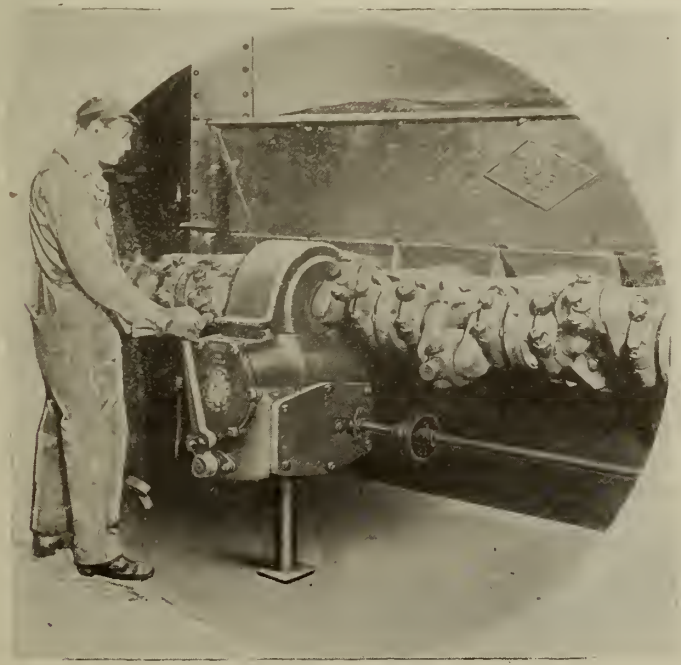


FIG. 1—RILEY TWO-SPEED GEAR BOX AS APPLIED TO 14-RETORT RILEY STOKER AT THE WORCESTER ELECTRIC LIGHT COMPANY, WORCESTER, MASS.

The illustrations shown in Figs. 1, 2 and 3 show the simplicity of an installation. The makers call attention to Fig. 3 and point out how all gear boxes are driven from one through shaft. It is therefore obvious that all sprockets and chain connections, chain guards, countershafts and bearings usually required for each gear box are eliminated. Each stoker with the new Riley two-speed gear box has but one chain connection. With large units this saves a great deal of mechanism underneath the stoker.

At the Camden plant of the Public Service Electric Co., of New Jersey, it was found that by using the two-speed gear box the stokers could be set much lower. In fact the bottom of the box can be set directly on the floor. This is an economical advantage with low set boilers, since it enables the stoker to be set low, giving maximum space for the gases.

The use of this additional regulating feature does not interfere in any way with the continued use of any automatic regulating device; in fact, it allows a more intelligent use of any automatic regulator on the stoker drive.

The Riley two-speed gear box is so constructed that it may be applied to

any type of Riley stoker. It is manufactured by the Sanford Riley Stoker Company of Worcester, Mass.

LEAD BURNING TRANSFORMER

The most modern method of burning terminals in place on storage batteries, removing old connections, cutting off or building up posts, or in fact almost

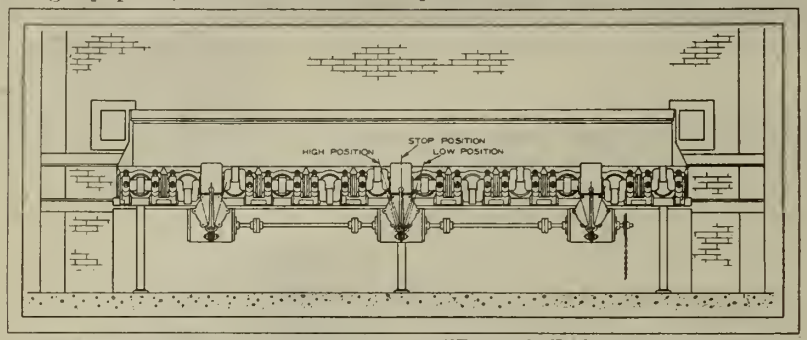


FIG. 3—FRONT ELEVATION OF 12-RETORT STOKER SHOWING THREE 2-SPEED BOXES. NOTE THE CONTINUOUS LINESHAFT UNDERNEATH THE STOKER AND THAT THERE IS ONLY ONE CHAIN CONNECTION PER STOKER.

any form of lead work, is to do it electrically—by the electric welding process.

The General Electric Company has recently developed a lead burning transformer to meet this need, an illustration of which is shown herewith.

This transformer is designed to be connected to the ordinary 110 volt alternating current lamp socket, a 10-foot cord with plug being provided for this purpose. This attaching cord is protected by a special rubber covering against the hard wear, dirt and acid with which it may come in contact. Connection to the transformer itself is made by means of a plug and socket connection so that this plug can be used in place of the snap-switch in the lamp socket for turning the current on and off.

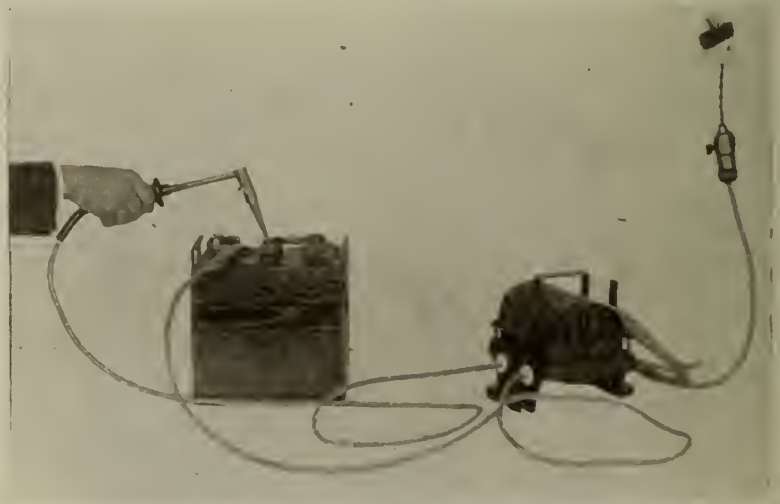
Two separate rubber-covered terminal leads are used to convey the low voltage heat producing current to the parts of the battery to be welded (see illustration). The lead having the "Big Brute" clip is for fastening to the battery plate or posts which is to be worked on. The other lead has at its end a carbon holder which is arranged with a heavily insulated handle so that the operator's hand is guarded from the heat. The carbon holder takes any ordinary arc welding carbon, this carbon forming the second terminal.

When the pointed arc welding carbon is brought into contact with the lead the pointed end of the carbon becomes intensely hot, so hot that it melts the lead over a restricted area quicker than a pointed gas flame will do it. The welding or burning operation is carried out by a sort of pudding process, the carbon terminal being manipulated to flow the lead where it is needed.

Among the advantages of the electric lead burner, is that repair work in hard-to-get-at corners can be done more easily as the heat is always right at the point of the carbon, the device is readily portable, weighing approximately 25 pounds; joints do not have to be developed by the Westinghouse Electric cleaned as the dirt and slag automatically rise to the surface of the molten lead and the surfaces are joined while cleansed; when properly used, there is no glare to injure the operator's eyes, as he looks down on the cool end of the carbon in such a way that the bright point where the carbon touches the lead is hidden from view; there is no danger from electric shock because of efficient insulation.

On the basis of 10 cents per kilowatt hour, it costs about 8 cents per hour for current when the device is operating steadily. The instant the carbon point is removed from the work, the current consumption practically ceases as the device then takes only 4½ watts from the line.

Owners of these transformers have found an increasing field of application. The device is said to be especially valuable to automobile owners in reconstructing and repairing batteries; while in the shop and foundry it has been used where all kinds of odd soldering jobs must be done. The device has also been found applicable in plumbing, roofing, tank building, etc.



SHOWING THE USE OF THE LEAD BURNING TRANSFORMER IN BURNING THE POSTS ON A STORAGE BATTERY.

METERS FOR WIRELESS AND HIGH-FREQUENCY WORK

A high grade hot-wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a metal strip which is heated by the current to be measured has been brought out. The slight sag in this conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature coefficient of expansion as the conducting strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The instruments are furnished in two forms, for flush mounting and portable. Similar instruments for switchboard mounting are supplied.

The flush-mounting form, known as type EH, is of the round open-face type; the face is 3 inches in diameter and the diameter outside the flange is 3¾ inches. It has a black rubberoid case and rim, with white dial.

The portable form, known as type PH, is mounted in a morocco leather covered wooden case with heavy glass over the dial. The case is 3¾ by 4⅜ inches by 2 inches thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅜ inches long.

METER FOR HIGH FREQUENCY WORK.

The type EH meters have a guaranteed accuracy of 2 per cent., while the type PH, with hand-marked scale, can be expected to show an accuracy within 1 per cent. of full scale. Standard meters are for 1, 2 and 5 amperes. Care must be used not to subject the instrument to more than 200 per cent. load.

Illustrations

Cut No. 115338, Type EH, switchboard ammeter.

Cut No. 116016, type PH, portable ammeter.

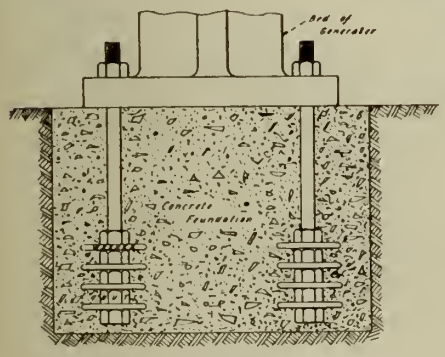
The Operators' Point of View

ANCHORING FOUNDATION BOLTS IN CONCRETE

By TERRELL CROFT

THE effectiveness of the adhesion between an iron rod and the concrete in which the rod is embedded does not appear to be appreciated by many men who instal concrete foundations for machinery. For example, the arrangement shown was used in a certain instance to provide an anchor for the foundation bolts of a machine. The series of nuts and washers on the lower ends of the bolts was entirely unnecessary, as will be demonstrated.

The maximum adhesion between a round iron rod and concrete amounts to between 250 and 400 lb. per sq. in. of contact area. A safe value for this adhesion may be taken as 75 lb. per sq. in. These values have been verified many times by actual tests. Working from these data, it can be shown that if a round iron rod is embedded in concrete to a depth equal to 30 times its diameter the rod will break before it pulls from the cement, if force is applied to effect its withdrawal. Therefore, if a 1-in. diameter foundation bolt with its surface perfectly smooth be set in concrete for a depth of 30 in., the rod will break before it can be pulled loose from the concrete. Roughening the rod by threading it or by chipping or by cutting fins in it has very little effect, one way or the other. However, as a matter of precaution it is always well to use for a foundation bolt a rod threaded and having a nut on the lower end. On this nut a cast iron building washer or a square piece of wrought-iron plate can rest, which will insure against withdrawal if the bolt is not set 30 times its diameter in the concrete.



ANCHORING FOUNDATION BOLTS IN CONCRETE.

ONE METHOD OF COLORING INCANDESCENT LAMPS

By J. C. Lupton

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The lamps may be connected in a circuit with the current turned on so that the filament is at its usual brightness. Then they are dipped in white shellac, thinned with alcohol. This shellac coating will give the lamps the appearance of frosted glass. The current should be going through the lamps while they are being dipped so that the shellac will dry quickly and not run. If different colors are desired, such as red, blue, green and the like, dyes or pigments of the required shades can be mixed in the shellac in which the lamp is dipped. This is not necessarily the method which is used in lamp factories, but in practice it has been found very satisfactory.

HOW AN ELECTRICAL MACHINE IS RATED

By Clarence L. Fleet

The universal practice in rating all electrical apparatus is to rate it on the basis of its electrical output. That is, the name plates on generators, motors, transformers, and the like indicate the safe output capacities of the equipment. Motors have, in the past, been rated on the basis of their h.p. outputs, but the best practice now dictates that they should be rated on the basis of their kilowatts output.

ION AND IONIZATION

By Alfred Long

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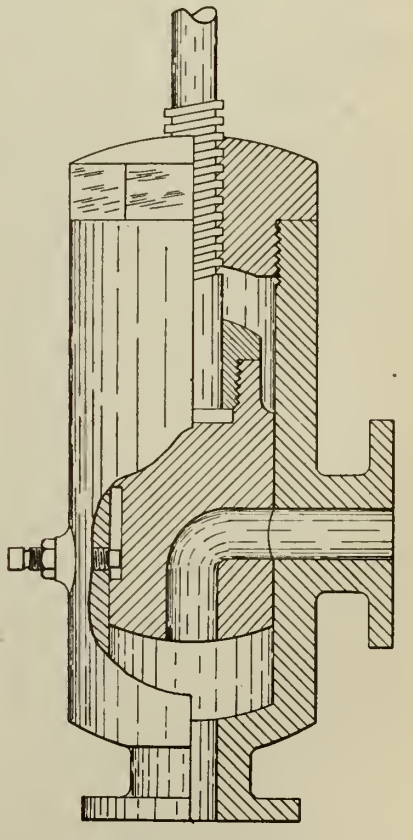
The terms "ion" and "ionization" are now used frequently in electrical literature. There are really two kinds of ionization; first, the ionization of solutions or electrolytes, and, second, the ionization of gaseous substances, like air, for example. In an electrolyte, an ion is one of the electrified particles into which a molecule is supposed to divide in a solution. In a gas, an ion is one of the small electrified particles into which the molecules of a gas may be broken up under certain conditions. In general, then, ionization is the breaking apart of the molecules of a substance into positively and negatively-charged particles.

ANGULAR BLOW-OFF SUGGESTION

By K. Walsh

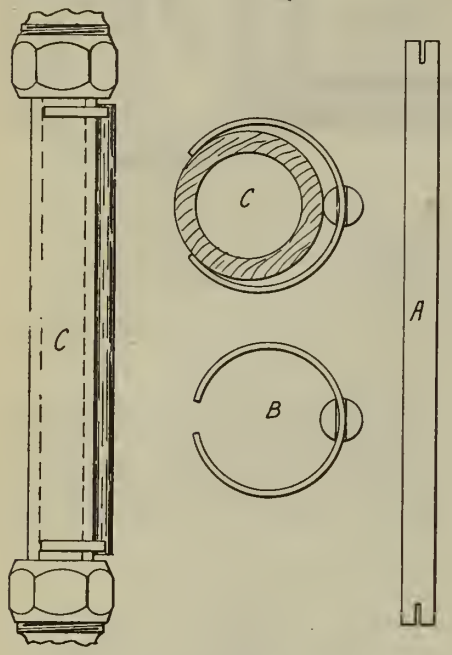
The accompanying sketch illustrates the angle type of blow-off valve of the design shown in the April 5th issue of the POWER HOUSE. It will be noted that the plunger that forms the valve is cored out to divert the flow at right angles. The port is closed by lowering the valve spindle, which is held to the plunger by the retaining nut shown. The plunger is close fitting so that packing the stem is unnecessary, and by its construction scale troubles are eliminated. To prevent the plunger turning in the valve body, it is guided in its movement by the screw on the left, the point operating in a slot cut in the plunger opposite to the cored passage.



BLOW-OFF VALVE.

IMPROVING THE WATER GAUGE

I have a gauge glass in a location where the water level is not easily discernible and after trying several suggested stunts for making it plain,



ATTACHMENT FOR GAUGE GLASS

I have evolved one of my own, which, in my case at least, beats them all.

Take a piece of steel rod about ¼ inch in diameter, smooth and straight and of a length that will be up against the side of the glass and not pinch between the packing nut. Hack-saw slots in each end of it as at A, and into these slots insert a loop of steel spring cut from a window-shade roller, as at B, fastening them by pinching up the slots with hammer or vise. Take a ribbon of emery cloth and saw it about the rod unitl it is highly polished and then attach it to the glass as at C and C. The rod will lie tight against the glass directly opposite the viewpoint; and with an electric light in front of the glass the water will look like milk. This device can be snapped on and off instantly for cleaning of the glass or rod; and can be swung about the glass to face any direction for best results from the viewpoint.

R. MANLY ORR.

FLYWHEEL DATA

By J. G. Noble

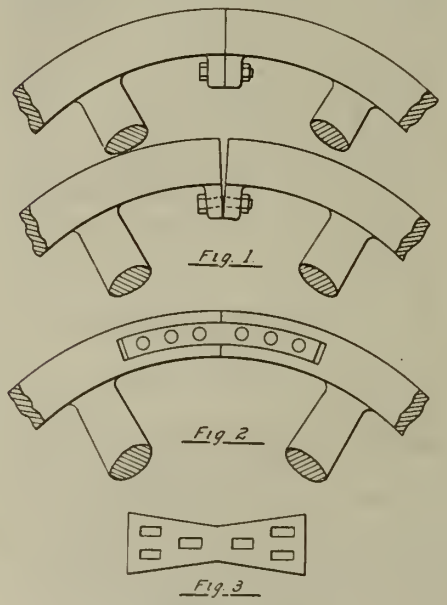
A great deal of information is written about steam boiler explosions, even when no explosions are taking place. Seldom, however, do we see any quantity of printed information about flywheel wrecks, unless it be some description of a recent accident. A simple explanation of this kind of a smash-up was given some time ago in a London paper somewhat as follows:

The tension upon the rim of a revolving wheel augments as the square of the velocity—that is to say, supposing for the moment that we had a wheel with a rim a foot square, revolving at the rate of 100 feet per second, the material being cast iron—the total resolved forces tending to tear the rim asunder would be, say, 144,000 pounds.

Now, imagine this velocity to be increased by the failure of the governor to act, or otherwise, to 150 (feet per second, or one and a half times as fast as before—a perfectly possible case—and we have 324,000 pounds to deal with. Double the original speed and we have 576,000 pounds.

Supposing the wheel to break up under the stress due to the last-named speed, 200 feet per second, there is energy resident in that rim sufficient to throw any part of it which might happen to be tossed vertically, 600 feet into the air.

This will give some idea of the potential force lying dormant in a flywheel. Perhaps some readers will remark: Well, there is nothing new to us in these London paper extracts; maybe not, but still engineers will block their engine stops



FLYWHEEL DATA.

when they get out of order instead of having them put right.

There is just as much danger in a faulty engine governor as there is in a leaky steam boiler. The day will come when it will be compulsory to have the engine governor and flywheel examined by a trained inspector, employed by the insurance companies, as steam boilers now are.

The bursting speed of a solid cast iron rim, that is with no joints, is about 425 feet per second.

Many flywheels, even the smaller sizes, are built up in sections, especially is this so in many of the old machines.

I remember seeing one, years ago, with internal flanges as shown in Fig. 1; of course the centrifugal force tends to open the joints in such a wheel as shown in the sketch. In thin rim wheels bolted together in this manner the stress would be much less than in the thick or deep rim wheel. A much better way to clamp a deep rim wheel is shown in Fig. 2, one of these clamps being at each side of a joint. A clamp in the form shown in Fig. 3 has been used, the piece fitting into a space of the same shape on the wheel rim. Every joint on a flywheel should be placed as near as practicable to one of the wheel arms.

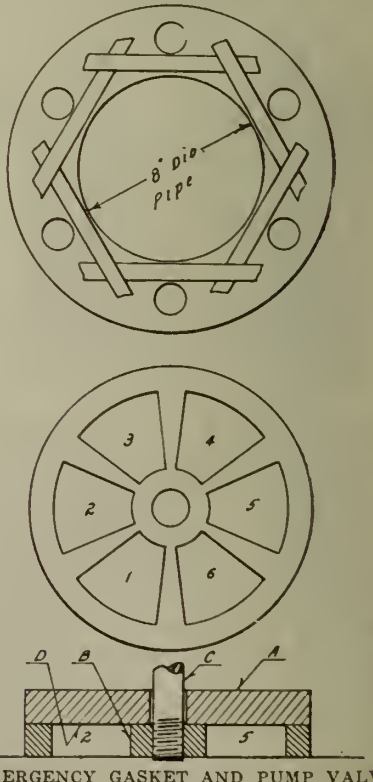
WHICH ARE BEST: PLUGS OR CAPS?

I notice that J. E. McCormack, on page 233, June POWER HOUSE, tells the poor engineer that a cap is better than a coupling and a plug. Sure, J. E., right you are. But what about the rest of it? It is just as easy to remove a coupling as it is to remove a cap, and it is often necessary to put a thread on a piece of iron rod and saw off the end, to use when there are neither caps nor plugs on hand. Anyhow, do not burn or scald your fingers removing a plug; unscrew the coupling.

JIMMIE JAMES.

A POWER PLANT KINK AND A QUESTION

The sketch, Fig. 1, shows how one man overcame a problem. He had a joint to make on an eight inch pipe flange and only had a few scraps of sheet packing. However, he succeeded in getting a few narrow strips from the scraps and put them to use as shown. After the bolt



EMERGENCY GASKET AND PUMP VALVE PROBLEM.

nuts were drawn tight the steam pressure was turned on slowly and the nuts followed up; the steam pressure carried was 100 pounds gauge. The reason for following up on the bolts is on account

of the laps on the rubber strips, where they cross each other. On Fig. 2, A is a pump valve, rubber, brass, or any other material. B is the valve seat, and C is the bolt.

If the pump is delivering water at 100 pounds pressure per square inch, that will be the pressure on the top of A. Also there is likely to be the pressure of a spring.

The area at D will only be equal to the openings at 1, 2, 3, 4, 5, 6. If there is a pressure gauge above the valve and one below, it will then show a difference in pressure until the valve lifts from the seat.

My only reason for writing the foregoing is because I have never noticed the matter in print or heard it discussed, and I thought it might prove of interest.

JOHN THORN.

FIXING THE OIL FEED

Occasionally the engineer has a somewhat large bunch of things happen to try his temper or his patience, one of the least of these is the tendency of the oil feed from a lubricator tube slumping over in a careless, don't give a hang if I do work style, and taking a grip on the inside of the sight feed glass. gradually covering it over until as an indicator it is "nix." Numerous remedies have been suggested, by correspondents, to overcome this trouble, such as soldering one or more wires to the bottom feed tube to guide the oil drops to the outlet at the top of the glass, or soldering a wire to the inside of the plug at the top of the glas, allowing it to extend down to near the opening of the feed tube, so that the oil drop will touch it and therefore follow it to the top. Another suggestion is to make a small groove with a fine file around, and close to, the top of the oil feed tube, the idea being that it will have a tenddency to hold the oil until the drop forms large enough to take its upward trip. However. some oils are so "doped," or artificially thickened that any of these schemes might prove ineffective. One idea which has given fine results is as follows:

Carefully clean the inside of the sight feed glass. Next take a mixture of one part water and three parts glycerine and fill the glass with it.

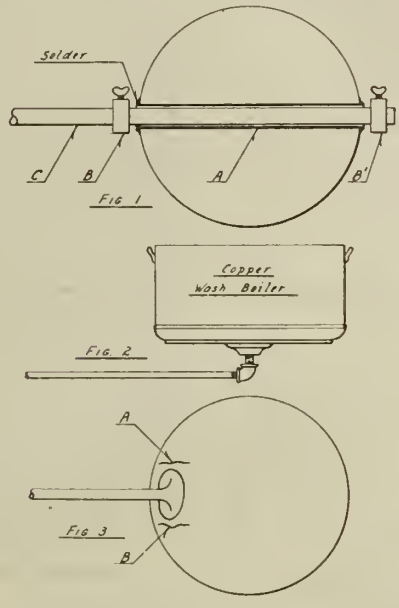
I have never heard a kick from any engineer who used this plan.

Glycerine has a specific gravity of about 1.26 with water 1—this will cause the oil to travel somewhat slower than if water alone is used, but the oil feed can be cut down to a "snail's pace," but the oil feed will remain positive no matter how low the cut. This is a big improvement over the water, as, when the feed is very slow in the latter case it has a bad habit of stopping altogether.

JAMES ELLETHORN.

REPAIRING COPPER FLOATS

In large water tanks supplied from city mains or private pumping outfits there is usually a ball cock on the outlet end of the feed pipe in the tank. These cocks are controlled by a copper float varying in diameter from 10 inches



to 20 inches; usually the floats are of light sheet copper, and very often they crack or tear open at A and B, Fig. 3. One engineer got free from this trouble by using an ordinary copper wash boiler as in Fig. 2. The old float was about beyond repair and there was no new float in the town's supply house. By connecting the lever to the bottom of the boiler the force of the lift was distributed over a large surface. By connecting the lever on a ball float in the same way it will give it a longer life. One way used often is shown in Fig. 7. A piece of tube, A, is run through the ball and soldered at the ends; the lever C is run through the tube and held in position by the thumbscrews and collars B B'. Sometimes the lever is run through the ball and soldered at each side and the tube dispensed with.

J. JAMES.

POWER PLANTS

It would be difficult to find an engineering subject better calculated to set the controversial ball a-rolling than that of the comparative working costs of the principal types of prime movers; and Mr Oswald Wans, in reading his paper on the subject before the Institution of Mechanical Engineers of Great Britain was, no doubt, fully prepared for the animated and even contentious discussion that followed. As was only to be expected, faults were found with some of his assumptions, and not a few of figures were challenged by members connected with firms specializing on engines of particular types. Yet the central proposition of his paper —that commercial advantage, not technical superiority, is the ultimate criterion of an engine's worth—was not for a moment in dispute. It is, of course, a truism, but it is none the less worth reasserting from time to time. The right choice of prime mover depends upon the correct balancing of innumerable factors which vary according to time, place, conditions, and particular power requirements. To say that a certain type of engine possesses a high thermal efficiency does not necessarily establish its superiority. That is one factor, it may be overcome by a dozen others. The total working cost of a powerful plant is compounded of capital charges in the shape of depreciation, insurance and interest, and of running charges in the shape of fuel, lubricating oil, water supply, sundry stores, labor and repairs, and before one can say which is the best type of power plant for a particular purpose all these factors have to be taken into account. The object of Mr. Wans was to give data likely to be of service in estimating capital expenditures and working costs, and in establishing the relative commercial value of the principal prime movers. For this purpose he took typical examples of the five types of prime movers—suction-gas engines, and plants burning anthracite, coke and wood refuse; gas engines of the solid injection, high-compression type; Diesel engines, and steam engines, and reduced a mass of information, the collection and analysis of which must have entailed great labor, to a series of comparative curves plotted for each item of capital and running expenditure. The conclusions to be drawn from these curves are useful, though fairly commonplace. Thermal efficiency has its importance, but the overruling factor is the relative prices of fuel in the locality. The advantage of the steam engine rests largely on cheap coal. If the price of coal exceeds on the average one-fifth the price of fuel oil the advantage passes to the solid injection oil engine; if it exceeds one-fourth the price of fuel oil the Diesel engine comes into effective competition. This is for engines of 250 h.p. and over; for smaller plants coal must be relatively cheaper still. Between these extremes stands the suction-gas plant, for which the prices of coal and coke may be respectively twice and 1½ times the price of coal for steam engines of the larger powers. The use of town gas engines is clearly confined to the few cities in which gas can be obtained at about 1s. 1d. per 1,000 cu. ft., and the refuse section-gas installations to industries in which there is an ample supply of suitable waste material. In relegating thermal efficiency to its proper place in the scale of factors, Mr. Wans passed over one very relevant matter; that the importance of thermal efficiency increases with every rise in the cost of fuels generally, and the value of his paper would have been enhanced if he had added to the excellent series

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in..	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 25
Steel bars, base, Toronto ...	4 25
Steel bars, 2" to 4" base...	5 50
Best grades	15%
Iron bars, base, Montreal ..	3 75
Steel bars, base, Montreal..	3 75
Reinforcing bars, base	4 50

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 55	$ 6 00
Sheets, Black, No. 10.	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 20
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.		7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.....	16
Cylinder oil, Capital.....	58
Cylinder oil, Acme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....	$2 20
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

Small shapes	5 75

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers.....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less...	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square blank .....add	$0 75
Nuts, square, tapped ....add	1 00
Nuts, hex. blank.....add	1 00
Nuts, hex. tapped.....add	1 25
Copper rivets and burrs, list less	15
Burrs only list plus	25
Iron rivets and burrs 40c	05
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above.. 8	40
Wood screws, flat, bright..	75
Wood screws, O.&R., bright	77½
Wood screws, flat, brass....	55
Wood screws, O.&R., brass..	55½
Wood screws, flat, bronze..	50
Wood screws, O.&R., bronze	47½

MISCELLANEOUS.

Solder, strictly 0	34
Solder, guaranteed 0	39
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums..... 6	75
White lead, pure, cwt. 17	80
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk ... 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D." per lb..... 0	03
Rosin "G." per lb..... 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$	0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard ..... 10% extra.

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. .....add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper .....$	22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided ....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila..	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb

of plotted curves one illustrating this tendency.

In comparing the rival merits of the leading types of engines, Mr. Wans gives prominence to a point which, though it greatly affects capital expenditure, fuel economy, and reliability, often receives far too little consideration—that of over-load capacity. For every engine there is a load at which the engine works at its highest efficiency. That is the rated working load. But it adds greatly to the utility of an engine if it can be made, at a pinch, to carry a considerably higher load. In this respect the steam engine shows an elasticity far greater than any of its competitors. as the following figures for the maximum over-load that can be relied upon with different types of engines shows:

Installation.	Percentage of Mean Working Load Below Rated Working Load	Increase in Consumption due to Underloading.
Steam	Nil	Nil
Oil engine	14.5	2.5
Diesel engine	14.5	2.5
Suction-gas engine	18.5	12.0
Town-gas engine	18.5	8.0

The effect of this upon capital expenditure where fluctuating and peak loads have to be reckoned with is apparent. Take the case of an engine required to work at a mean load of 100 b.h.p., but to be capable of meeting an occasional demand for 135 h.p. In such a case a steam engine of 100 b.h.p. rated working load would answer the requirements, but if a gas or oil engine were being installed, a gas engine rated at 123 b.h.p. or an oil engine rated at 117 b.h.p. would be required to meet the overload demand of 135 b.h.p. Thus a larger engine would be needed, and the initial capital cost would be large in proportion. But even more important would be the effect on fuel economy. At the mean load of 100 b.h.p. the steam engine would be working at its maximum efficiency, whereas the gas or oil engine would be working under load, and, consequently, at a reduced efficiency. The following table shows the increase in fuel consumption due to the underloading necessitated by an overload of 35 per cent.:

Steam engine	35 per cent. above rated working load
Solid injection oil engine	15 per cent. above rated working load
Diesel engine	15 per cent. above rated working load
Gas engine	10 per cent. above rated working load

A further allowance must be made for stand-by losses, which will depend upon the frequency and length of the stoppages. The loss, of course, applies only to suction gas and steam installations, and the amount may vary considerably according to the care exercised.

CERAMIC ENGINEERING

Interest in the subject of refractory materials has been growing very considerably recently, and important developments may shortly be expected. There is a movement on foot to start a refractories society, or to inaugurate a joint refractories committee of the societies and institutions interested, possibly on lines similar to those adopted in the case of the Engineering Standards Committee; whilst another proposition is that to the existing Ceramic Society there should be attached a section dealing with refractory materials.

As regards the latter suggestion, the idea appears to be that the papers read before the refractory section would be published in the transactions of the Ceramic Society, the latter thereby coming to rival in utility the similar German society known as the Verein Deutscher Fabriken Feuerfester Produkte. It appears to be doubtful, however, whether the existing metallurgical institutions which are so closely associated with the use of refractory materials, would be willing to see their interests in this connection taken charge of by a society which has hitherto dealt practically entirely with the question of pottery clays, and has not particularly identified itself with refractory materials as they are understood by engineers and metallurgists.

It ought to be carefully borne in mind, however, by those who are inclined to throw cold water upon any possible extension of the Ceramic Society or on the proposal to form a new organization to deal with refractories, that the subjects to be covered are increasing daily in importance as the war progresses, and that after the war they will be still more important in Great Britain.

In the United States of America so vital are the ceramic industries held to be that the University of Illinois has just spent over £100,000 on a department of ceramic engineering, the buildings of which were formally opened recently. The occasion was one of great interest to the clay workers in the United States and the opening ceremonies were attended by many representatives of the architectural, structural, mining, geological, chemical and manufacturing interests. In connection with the inaugural ceremonies an industrial conference was held, in which a number of topics of current interest to the ceramic engineer, the clay worker, and the manufacturer were discussed by well-known experts. Already the number of students entered for the course of ceramic engineering in the University of Illinois is forty-six, which would appear to be a very satisfactory figure wherewith to inaugurate a totally new branch of university study, one of which more is bound to be heard of also on this side of the Atlantic.

When comparing the merits of refractories diatomaceous brick and slag wool, it has been assumed that the temperatures afforded a relative measure of the efficiencies of these two materials from the standpoint of thermal insulation, instead of which they were given merely to indicate the range of temperature over which experiments were made. Owing to the various other factors involved, the figures which have been published from time to time did not give a direct indication of the relative merits of diatomaceous brick and slag wool. If the two samples had been of exactly the same thickness and the cold faces had been allowed to radiate freely, the deductions would have been quite legitimate. In the experiments, however, it was desired to determine the heat transmitted in absolute measure, consequently a calorimeter was cemented on the cold face. A comparison between the two materials may be effected by means of the data in the table given below:

Mean Temperature of hot and cold faces.	Diatomaceous bricks.	Slag wool mats
300 deg. Fah.	0.92	0.48
600 deg. Fah.	0.11	0.72
900 deg. Fah.	1.31	0.96

* The thermal conductivity is the heat transmitted in B.Th.U.'s per sq. ft. per hour per lin. thickness for 1 deg. Fah. difference of temperature between the faces.

Of these materials which were chosen as illustrative of two distinct classes, the one a solid brick, the other a compressible packing material, it is indicated quite clearly above that slag wool —an entirely British invention and product—is really the better heat insulator.

BOOK REVIEWS

"Automobile and Aero Engines," by Rene Devillers, translated by Wm. John Walker, E. and F. N. Spon, Ltd., London and New York. Price 16/10.

Industrial progress and technical literature follow closely parallel lines,

Western Association of Mechanical and Electrical Engineers

Edmonton District Loop No. 5

This Association would be pleased to receive correspondence from any engineers who would like to associate with us with a view of getting better conditions for the craft in general. We would also be pleased to have communications from any other society or societies of engineers who are endeavoring to secure these conditions. Address all communications to

The Secretary,
Western Association of Mechanical and Electrical Engineers.
P.O. Box 991, Edmonton, Alberta, Canada

and where marked progress has been made in any branch of science it is necessary that recent knowledge gained by the few should be widely disseminated if stagnation is not to result. The war has witnessed a phenomenal advance in the theory and construction of the internal combustion engine as applied to land and aerial transport, and the author of the present work has achieved a high degree of success in the arrangement and choice of his material and in the bringing of the technical literature of the subject up to date. It may be mentioned at the outset that the work is not a mere collection of half-tone engravings and descriptive matter but is a well thought out treatise on actual design. Mathematics is necessarily called into extensive play, and indeed forms the groundwork of the whole structure. Much of the analysis comprised within the pages of this volume has as yet received little or no attention in any published textbook or periodical dealing with the subject, due, no doubt, to the restrictions placed upon such publications by war conditions. Calculus has necessarily been introduced into the many formulæ, but the treatment is exceptionally clear and lucid. Particular attention is drawn to Chapters IV, XII, XXIII and XXIV. The first two, on the subjects of inertia forces and cams respectively, are dealt with in a manner which compel admiration for the author's lucidity of exposition. The expressions obtained in Chapter IV for piston velocities and accelerations although not new, are elegantly obtained and their connection with the corresponding expressions for the Desaxee engine, given in Chapter X are readily apparent. Chapter XXIII deals with the adaptability of power available to the power required for aeroplane sustentation and propulsion. This, besides opening up in excellent fashion

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
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FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
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Turbo Generators

1—1000 K.W. Rateau 50 cy., 3 ph., 525 v. surface cond.; Elect. Pumps, complete. Immediate delivery.
1—400 K.W., 60 cy., 3600 R.P.M., steam 160 lbs. Cond. Multi Jet; Elect. Pumps.
1 each 50-35-10-15 K.W. with generators.

Pumps, Engines and Boilers, etc.

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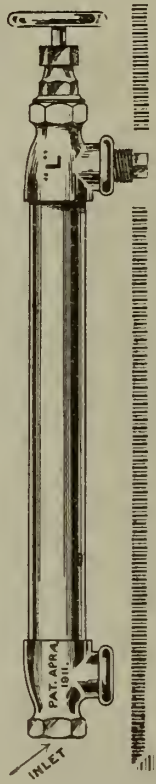
Use The LONG for STEAM TRAP SATISFACTION



Automatically drains jacket kettles, separators, steam mains. Works against 1 to 200 pounds pressure. Has two outlets and is installed in any position. DOESN'T FREEZE.
The Hamilton Powder Works, Beloeil, P.Q., use them with great success. Read this letter: Dear Sir: We have used one of your steam traps for a long time and have found the same to answer the purpose as well as any seen in operation. We were so pleased with the working of this steam trap last winter that we ordered six more this season and have fitted them up at various points in the works where live steam is used for heating purposes.
(Signed) J. Murray Wilson, Superintendent
Our trap will give you the same satisfaction as recorded above. Investigate and you'll be satisfied, too.

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If your dealer does not sel it, write direct.
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Stand in a Class by Themselves for Quality, Efficiency and Economy
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For sale, complete patterns and drawings for 35 and 50 P.H. heavy duty gas engine suitable for producer gas, city gas and natural gas. These engines were designed for an American concern by an English engineer and are the type most popular in Canada. The present owners bought these at a bankrupt sale and will dispose of them at a very low figure. Write us for drawings and details.
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FOR BOILER FEED AND
ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

a comparatively new field for future investigation, is interesting as a record of recent progress made in France in the economics of aeroplane power supply.

In Chapter XXIV, on the principles of super compression and super charging, analysis of these problems are given which will appeal strongly to the student interested in such matters. All French units have been transformed into the corresponding English units. For those wishing a sound and intimate knowledge of the design features of aero and automobile engine design the book is commended. The following gives a synopsis of chapters not mentioned above: The Working Mixture—The Laws of Gases and Their Application to the Working Mixture—The Four-Stroke Cycle—The Engine Turning Moment—The Cylinder—The Piston, Piston Rings, and Gudgeon Pin—The Connecting Rod—The Crank Shaft—Valves and Cam Distributor Gear—Induction and Exhaust Passages—Engine Power and its Variations—The Cooling System—The Crank Case and Lubricating System—Speed Regulation—Engine Starting—The Two-Stroke Engine—The Rotary Engine—The Laws of Similarity—Engine Testing and three Appendices, giving derivation of formulæ and table of atmospheric constants.

TRADE GOSSIP

Leather Prices High.—Owing to the depletion of stocks of tanners in Canada, caused by the lifting of the British embargo to Canada, while the American embargo continued, prices have advanced materially. Tanners are exercising extreme caution, as they feel that the high prices may come down materially during the next few months, and are, therefore, unwilling to speculate on the future values. They are, therefore, keeping operations down, and this combined with the scarcity of raw materials, tends to keep the prices firm at their present levels.

Business Change — The Monash line of pressure reducing valves and pump governors, formerly manufactured and sold by the Monash-Younker Co., of New York and Chicago, has been acquired by the Harrison Safety Boiler Works, of Philadelphia. The purchase includes a stock of manufactured parts and valves, drawings, patterns, trade mark, and goodwill. The Harrison Safety Boiler Works will manufacture and market the valves under the trade name "Cochrane-Monash," and will supply repair parts for valves now in use.

His many friends throughout the country were grieved to learn of the death at St. Michael's Hospital of J. Frank Brown, following an operation for appendicitis. Deceased was the second son of J. F. Brown, 143 Dowling avenue, Toronto, was 21 years of age, and before enlisting with the 1st Tank Battalion was metallurgist chemist at his father's plant. Brown's Copper & Brass Rolling Mills, New Toronto. He received his education in the Separate and Technical Schools, was well known in athletic circles, and was an accomplished musician.

Large Foreign Order.—Armstrong, Whitworth of Canada, Ltd., with works at Longueuil, Quebec, have just completed one of the largest individual orders for steel tires placed this year, covering 3,000 tires, placed by the Netherlands Government, New York office, for shipment to the Dutch Indies. These tires were manufactured from raw materials at this company's works at Longueuil. The steel was made in Heroult electric furnaces, and the tires were manufactured with the equipment installed early in 1918 when the tire and wheel plant was added to the present works at Longueuil. This is a concrete example of what Canadian manufacturers can do to secure foreign trade, and the success with which this order was handled by this company has acted as an impetus to further developing foreign trade. Needless to say, the Netherlands Government assured themselves of the very high quality of steel tires which this company are making before placing the order in their hands, and it should be a source of gratification to Canadian manufacturers to know that markets heretofore controlled by Germany can be secured.

A New Alloy.—It is reported that a new alloy has been discovered that is lighter than aluminum. The alloy is being used in the manufacture of airplane piston rods for the Italian army planes by a firm in the Province of Quebec.

ADVERTISING to be successful does not necessarily have to produce a basketful of inquiries every day.

The best advertising is the kind that leaves an indelible, ineffaceable impression of the goods advertised on the minds of the greatest possible number of probable buyers, present and future.

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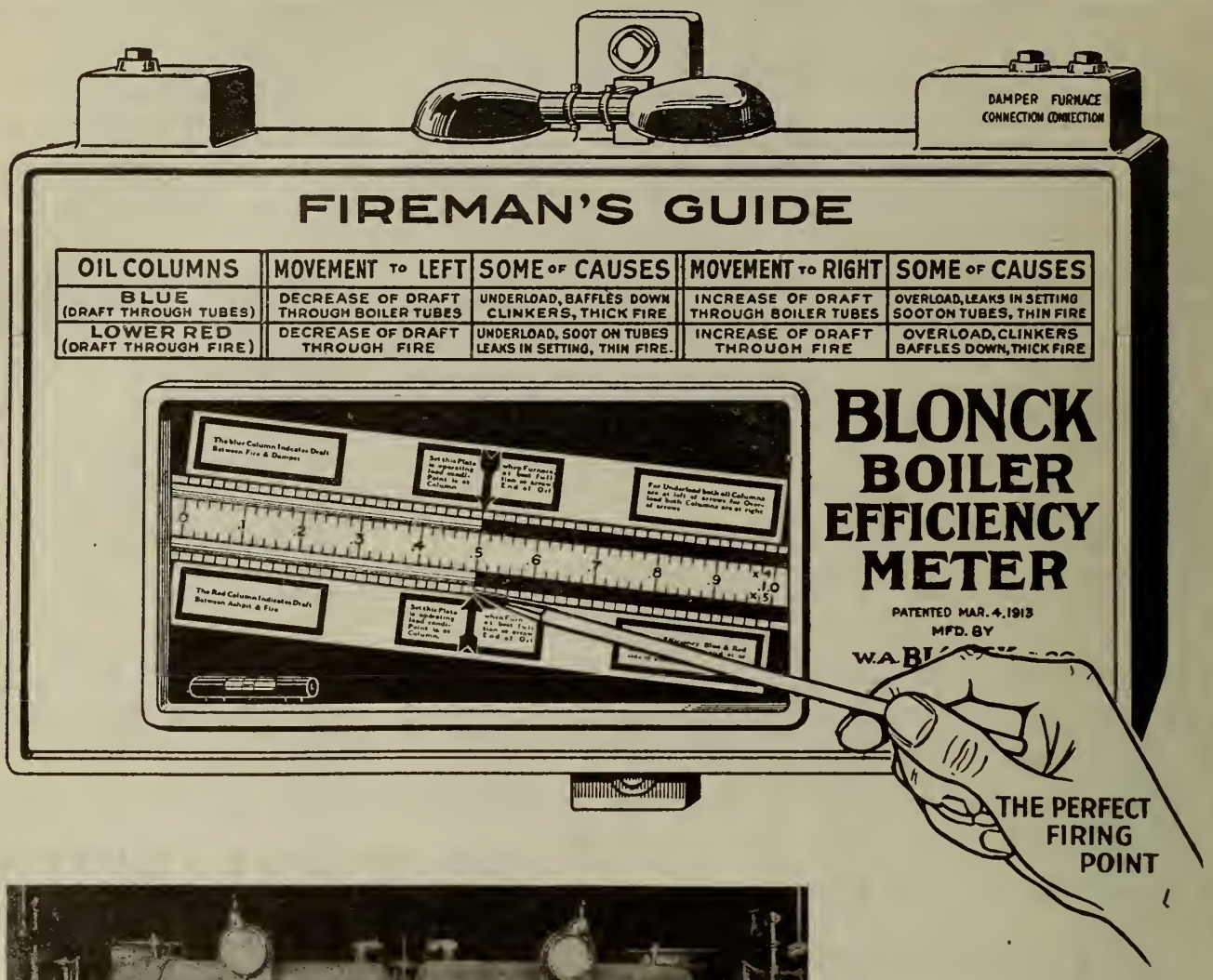
DAMPER FURNACE CONNECTION CONNECTION
FIREMAN'S GUIDE
OIL COLUMNS | MOVEMENT TO LEFT | SOME OF CAUSES | MOVEMENT TO RIGHT | SOME OF CAUSES
BLUE (DRAFT THROUGH TUBES) | DECREASE OF DRAFT THROUGH BOILER TUBES | UNDERLOAD, BAFFLES DOWN CLINKERS, THICK FIRE | INCREASE OF DRAFT THROUGH BOILER TUBES | OVERLOAD, LEAKS IN SETTING SOOT ON TUBES, THIN FIRE
LOWER RED (DRAFT THROUGH FIRE) | DECREASE OF DRAFT THROUGH FIRE | UNDERLOAD, SOOT ON TUBES LEAKS IN SETTING, THIN FIRE. | INCREASE OF DRAFT THROUGH FIRE | OVERLOAD, CLINKERS BAFFLES DOWN, THICK FIRE
BLONCK BOILER EFFICIENCY METER
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The Blonck shows you what you are doing while you are doing it.

Let us demonstrate this meter to you at your plant, or at our office. We have a model boiler and an actual meter, and can demonstrate all conditions that take place in the furnace. Let us show you how the BLONCK will save money, worry and trouble.

Two of the IMPROVED BLONCK BOILER EFFICIENCY METERS at the high level station of the Toronto Water Works

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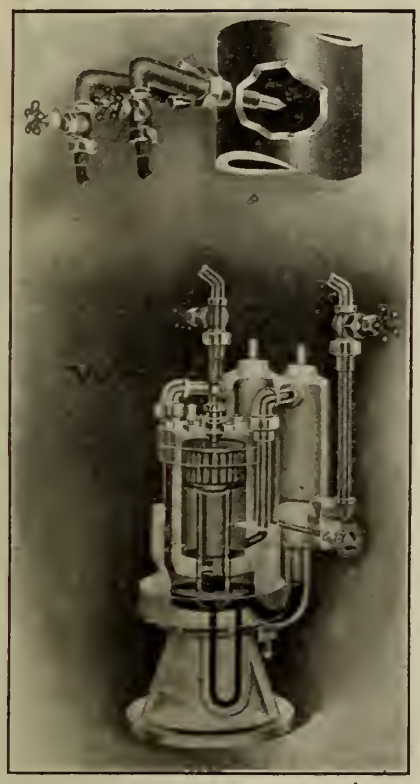

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The engineer must stand upon the record of what he saves—not what he produces. He can turn his job into productive instead of "non-productive" work (as it appears on the payroll) by producing economies that are the same as **profits.**

Primarily the plant and the man running it are gauged by this simple test:

How much steam is produced per pound of coal burned, and how much power is produced by that steam?

One simple, but versatile instrument enables you to determine this and trace all the errors that dwarf boiler output—the

Republic Flow Meter

Connected to individual boilers it shows at which capacity highest efficiency is obtained. It enables you to equalize the load between various units and guards against the extravagant condition of one boiler lagging while others are being crowded to high overrating.

Connected to the steam line it shows which departments are consuming the proper amount of steam and offers a basis for correcting errors and pro-rating power costs.

The Republic Flow Meter is electrically operated, which allows proper flexibility for securing these necessary records and permits centralizing these valuable records at the point where they can be conveniently read and are therefore still more valuable. Request complete details at once.

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For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

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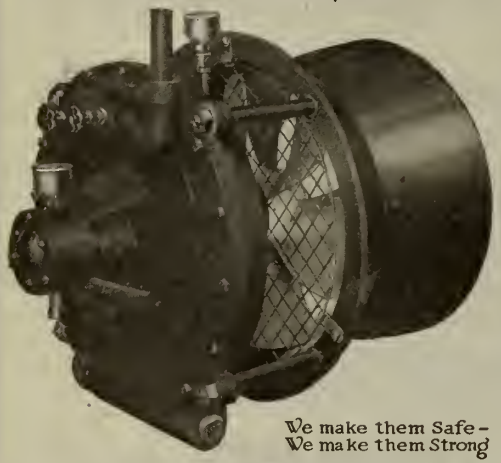

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Dependable regulation under every possible condition.

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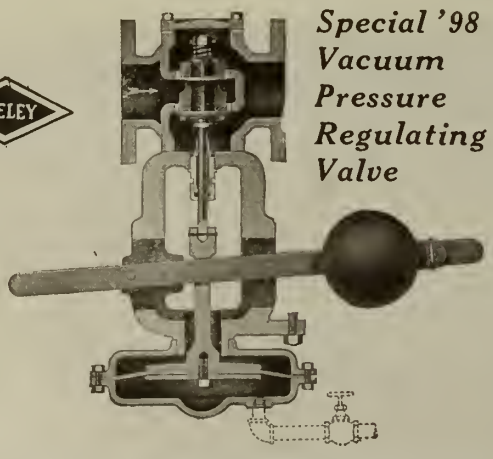
Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

KIELEY

Special '98 Vacuum Pressure Regulating Valve



Responds to Slightest Fluctuation

The independent diaphragm feature of the Kieley Special '98 makes this type of valve especially appropriate for use in connection with vacuum or vapor heating systems, or any other service where close regulation is of importance. Both straight and differential patterns respond to slightest fluctuation. Maintains desired pressure at any point of heating system or supply mains by adjusting weight on lever. This valve is advanced in design. Let us explain it in detail.

THE ARTHUR S. LEITCH CO.
KENT BUILDING, TORONTO

Eight real advantages

in equipping water tube boilers, oil stills and superheaters with Key Boiler Equipment Company's

KEY SAFETY HAND-HOLE CAPS

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

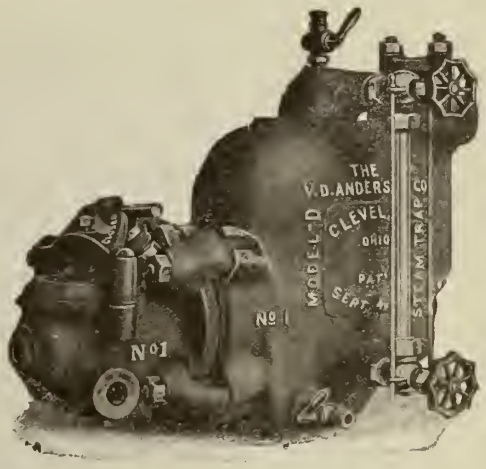
No gaskets required. Over 1,500,000 now in service. Let us send you our descriptive literature.

Power Plant Equipment Co.
Canadian Selling Agents
310 Dominion Bank Bldg., Toronto, Can.

Stays Tight

The ANDERSON Steam Trap will Save You Expense, Time and Trouble

Install it in Your Boiler Room



Maintained steam tightness is what counts. When you install an Anderson Steam Trap you can depend upon it staying tight even under the most severe conditions.

Not only on the first day that you place it in service—but every day thereafter it will continue to be tight with the least attention on your part.

Will not leak steam with just ordinary care.

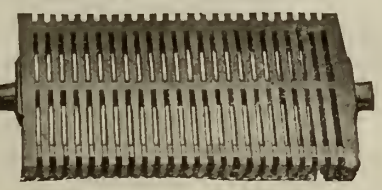
Fitted with a large interchangeable valve and seat, maintained under a 3-inch water seal.

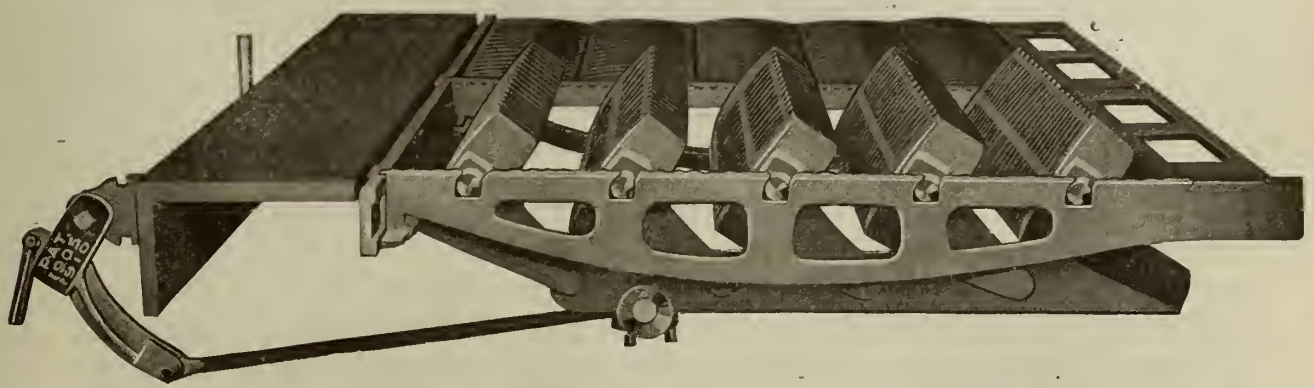
You can tell at a glance whether the trap is working properly or not by means of an outside gauge glass. The practical operating man appreciates the self-contained by-pass and removable strainer and gauge glass—"Anderson" features that show the efficiency of the draining.

Why not investigate it further:

THE V. D. ANDERSON COMPANY

1935 West 96th Street CLEVELAND, Ohio

Cyclone  Grates



With these Grates you get perfect combustion when using lowest priced fuel, such as soft coal and screenings. For these Cyclone Grates provide 60% Air Space and 90% Underdraught—a combination that positively prevents clinker formation and the escape of fuel gas.

The new jarring, shaking movement sifts the worthless ashes through—but not one particle of good fuel.

We would like to see your name added to the long list of pleased users. For the sake of fuel economy, take advantage of our 30 days' free trial offer.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada.

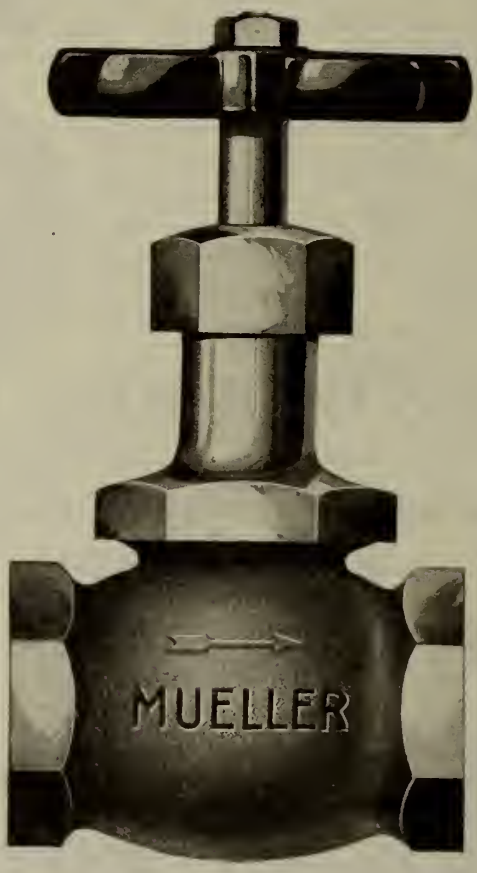
20 McGee Street Phone G.3660 Toronto, Ontario

AGENTS:

ST. JOHN, N.B.: F. W. Blizard, 329 Charlotte St. MONTREAL: Mason Regulator Co., Ltd., St. James St. HAMILTON: Robt. Fitzsimmons, 8 Grove St. WINNIPEG, Vulcan Iron Works. OTTAWA: J. W. Anderson, Room 7, Bank Street Chambers.

Mr. Engineer—
Did You See Our Exhibit At Brantford?—

A STANDARD VALVE COMBINING ALL THE DESIRABLE FEATURES OF HIGH GRADE VALVES



JUST ANOTHER MUELLER SPECIALTY EMBODYING ALL THE NAME MUELLER REPRESENTS

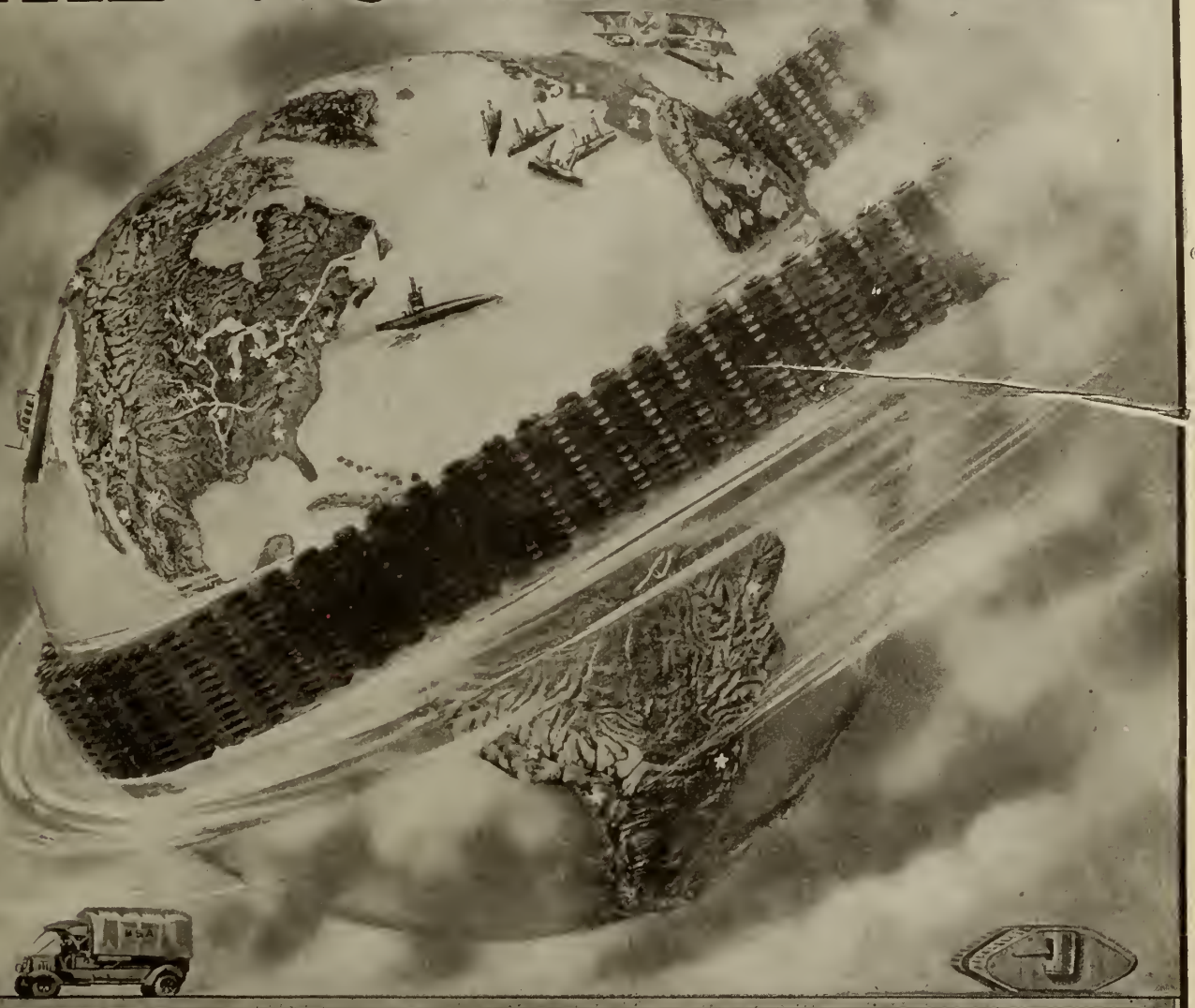
If so, you were undoubtedly interested in our showing of Mueller Globe and Angle Valves. These valves are without question the highest grade standard valves that have ever been offered to the Canadian trade. Each valve is subject to unusual tests for strength and general service. These tests are greatly in excess of the actual service demanded. Provincial authorities have registered for 175 lbs. pressure on this valve.

H. MUELLER MFG. CO., LTD.

Sarnia **Canada**

MORSE DRIVES THE WORLD AROUND

MORSE CHAIN COMPANY ITHACA, NEW YORK



About 2½ MILLION HORSE POWER in WORLD-WIDE SERVICE

MORSE CHAIN CO. Largest Manufacturer of Silent Chains in the World **ITHACA, N. Y.**

MORSE ENGINEERING SERVICE — Address Nearest Office — ASSISTANCE WITHOUT OBLIGATION

BOSTON, MASS.....141 Milk Street
CHICAGO, ILL.....Merchants Loan and Trust Bldg.
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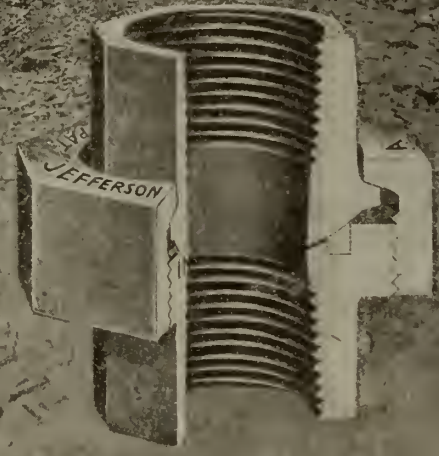
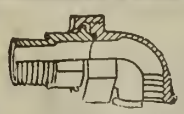
DETROIT, MICH.....1003 Woodward Avenue
GREENSBORO, N. C.....805 Ashboro Street
NEW YORK CITY..50 Church Street, Hudson Terminal Bldg.
PITTSBURGH, PA.....Westinghouse Bldg.
SAN FRANCISCO, CAL.....Mondanook Bldg.

ATLANTA, GA.....Earl F. Scott, M. E., 702 Candler Bldg.
CANADA.....Jones & Glassco, Regis'd
MONTREAL, St. Nicholas Bldg., Toronto, Bank of Hamilton Bldg.
KANSAS CITY, MO..Morse Engineering Co., R. A. Long Bldg.
MINNEAPOLIS, MINN.....413 3rd St., Strong-Scott Mfg. Co.
ST. LOUIS, MO.....Morse Engineering Co., Chemical Bldg.
LICENSEES FOR EUROPE & EASTERN HEMISPHERE
The Westinghouse Brake Co., Ltd., 82 York Road, London, N.

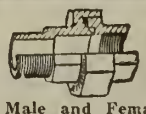
JEFFERSON



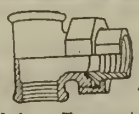
"Look for the name on the nut"



Union Elbow, an economizer of the most pronounced type. Also made all female.



Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.



Union Tee, with union on the outlet. Made also with male end on outlet.

The Guardian of the Pipe Line

Above ground—in breakers and power house—below ground—in shafts and pump rooms—you'll find Jefferson Unions guarding the pipe lines from leaks and breakdowns.

Protect your plant from expensive shutdowns and costly repairs. Insist on genuine JEFFERSONS. It's easy to be sure because the name is clearly stamped on the nut.

A "just-as-good" union costs about as much as a JEFFERSON—you pay as much or more to put it on the line and moreover you have the added cost of taking it out when it fails. Save this time and money—play safe and standardize on JEFFERSON UNIONS.

Write for our Catalog UNIONS.

The Jefferson Union Co.
Lexington, Mass.

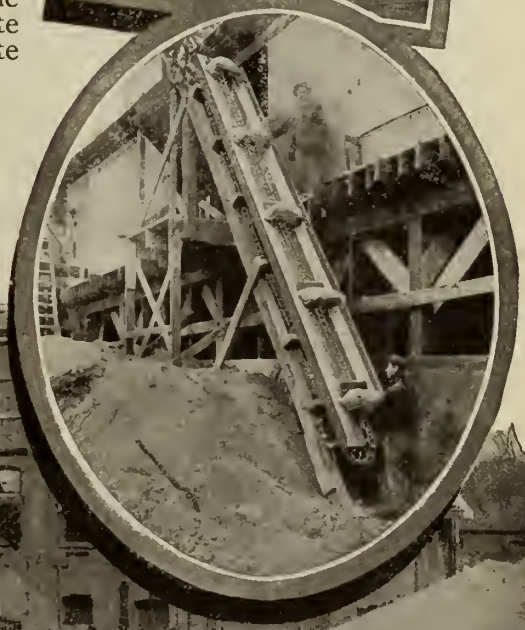
Conveyors for Every Purpose
Small or Large

EVERY industry has its handling problems—problems of handling materials and finished product as well as coal and ashes in the power house.

For nearly half a century Link-Belt engineers have been helping manufacturers to solve these problems—to increase output and reduce production costs by speeding up and reducing handling costs.

These years of experience are at your service. No matter what the nature of your raw materials or finished product may be, we can show you methods of handling which will cut costs to the core. This applies to small as well as large installations. Write us. Get a copy of our General Catalog, showing the complete Link-Belt Line.

CANADIAN LINK-BELT COMPANY
LIMITED
Wellington and Peter Sts., Toronto



LINK-BELT
Elevators and Conveyors

We Also Make

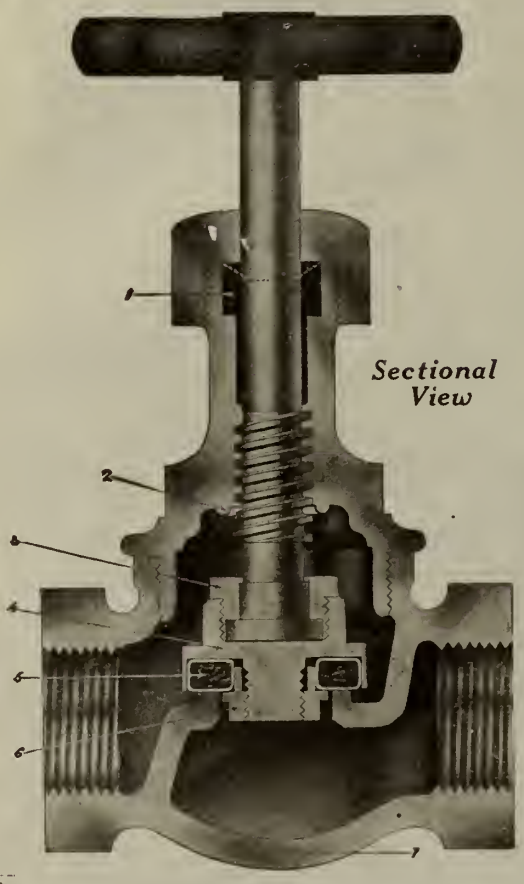
- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Wagon Loaders
- ☐ Coal and Ashes Systems

Write for Catalogs
Place X in Square

"VICTOR"

200 GLOBE VALVES

Hard Metal



Sectional View

Suitable for Working Pressure of 200 lbs. Tested 800 lbs. Hydraulic.

Fitted with special Copper-covered Discs. Guaranteed to have four times the life of the ordinary Composition Disc.

CAN BE USED FOR

High or Low Pressure Steam.
Hot or Cold Water. Gas or air.

T. McAVITY & SONS

LIMITED

St. John, N.B., Canada

TORONTO

Harvard Turnbull & Co., 207 Excelsior Life Bldg.

MONTREAL WINNIPEG EDMONTON CALGARY

BETSON'S TRADE MARK PLASTIC FIRE BRICK

On Your Next Furnace Lining Job

B ECAUSE YOU have had your troubles year after year with the ordinary fire brick or blocks—is one very good reason why you should use something better on your next furnace lining job.

E VERY ONE knows that it's the joints in the brickwork that make the ordinary furnace linings come down. The varying temperature in the furnace causes the mortar to crumble and so the bricks or blocks fall out.

T HESE TROUBLES can be overcome by making the entire lining in one piece so there will be no joints. And the one-piece monolithic furnace lining is practicable. Betson's Plastic Fire Brick has made it so. Betson linings are durable, gas-tight linings.

S O, in those plants where continuous operation is paramount and where the boilers are always on the load, the chief depends on Betson's Plastic Fire Brick. Service counts most, and Betson's has a service record of 20 years. It comes in the yellow-top barrel, ready for use.

O NE MAN CAN DO the job—any handy man around the plant. There is no need paying for special blocks and experts to lay them. So, in your next furnace lining job, use Betson's Plastic Fire Brick. It's good for every other part of the boiler, too.

N O SPECIAL TOOLS are required and no forms are necessary for laying up Plastic Fire Brick. You just place it in chunks, pack it with a mallet, then smooth with a trowel—and the job is done.

S END YOUR ORDER to-day. Five to ten barrels of Betson's Plastic Fire Brick will do your next furnace lining job complete. For repairs, two or three barrels will serve. After that, you will be a Betson booster.

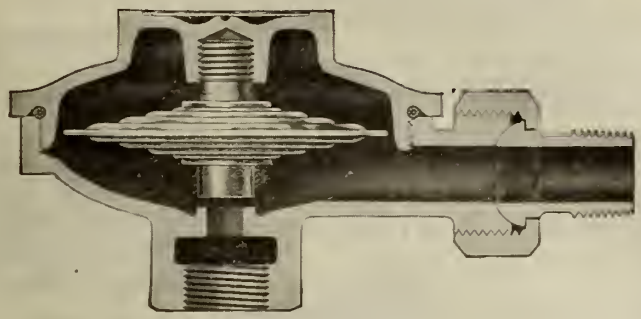
Ask for Practical Booklet—It Will Interest You

There Is Only One Plastic Fire Brick

Canadian Distributor:

International Chemical Company

44-46 Lombard St., Toronto, Canada



Inside Facts About Heating the "Dunham Way"

The Dunham Radiator Trap is distinctive in the simplicity of its construction.

It is this fact that makes a Dunham Heating System so simple, yet so efficient.

The Dunham Radiator Trap is the heart of Dunham Heating. It gets rid of all air and water from the radiator, but holds the steam in until every last bit of heat is given off. It does this automatically—no noise—no air valves on the radiators.

Dunham Heating is standard where efficient and economical operation is desired.

Dunham Heating Service, in advising on heating problems, is given without obligation.

Complete details on request.

The DUNHAM HEATING SERVICE

C. A. Dunham Co., Limited
TORONTO, ONT.

Halifax Winnipeg Calgary
Ottawa Vancouver Montreal

The Plant Behind Norwalk Compressors

NORWALK Compressors are backed by a plant which is equipped throughout in keeping with the most modern engineering and manufacturing requirements. When you contemplate the purchase of a compressor it will interest you to know that the Norwalk Company stands ready to protect your interests with the full resources of a plant which has been developed through forty years of uniform satisfaction to patrons.

New bulletins illustrating and describing Norwalk Compressors for air, oxygen, hydrogen, acetylene gas and carbonic acid gas are now ready. Write for the ones in which you are interested.

THE NORWALK IRON WORKS COMPANY, South Norwalk, Conn.

Plibrico Jointless Fire Brick can be molded to fit any place in the furnace or setting.

Better Than Fire Brick

Jointless Furnace Lining for Industrial Boilers

It can be used for front door arches, side walls, bridge walls, and rear arches and wherever fire brick can be used. Made for hard service and fuel economy.

EASY TO INSTALL

Write for free copy of 36-page book of useful information on furnace building and maintenance

JOINTLESS FIRE BRICK CO.
Kingsbury and Clay Sts., Chicago

CANADIAN DISTRIBUTORS: Beveridge Paper Co., Ltd., 628-630 St. Paul St., West, Montreal.

TRADE MARK

Mark of Proof Is Proof of Quality

There's proved and certified strength in every

WILLIAMS' IMPROVED "VULCAN" CHAIN PIPE WRENCH

Each and every Flat Link Chain is "proof-tested" to two-thirds of its listed catalog strength in a standard tension machine. To each chain so tested is attached the Gray Leaden Seal, illustrated above, and every Flat Link Chain leaving our works *must* bear this seal—the Proof of Quality—as evidence that it has passed our standardized "proof-tests."

Look for this Mark of Proof for it is Proof of Quality—it guarantees uninterrupted, severe service as well as safety to the operator. Williams' "Vulcan" Chain Pipe Wrenches are the *only* Wrenches which offer this certified assurance.

May we send you a copy of our descriptive booklet?

J. H. Williams & Co. *"The Wrench People"*

Western Office and Warehouse: 78 So. Clinton St., Chicago, Ill.

The A. G. Low Co. 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, Alberta and British Columbia

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Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless

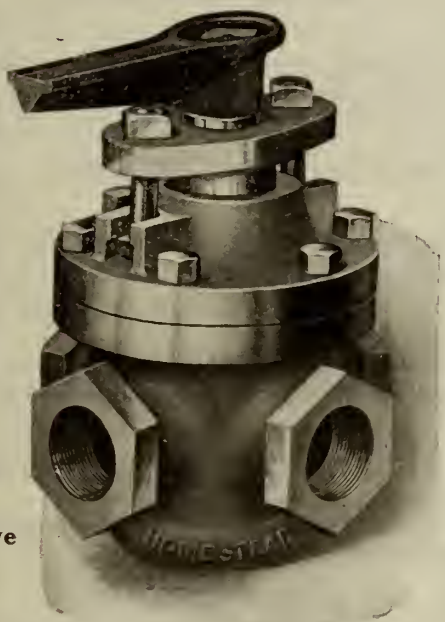
In Cotton Tubes

HOMESTEAD
Quarter-Turn Valves

Why Stand for Leaks In Your Air Lines?

Install HOMESTEAD Quarter-Turn VALVES in your plant and leaks will be a thing of the past. They are tight, and will stay tight under any specified pressure up to 5,000 lbs. Opened and closed by just a quarter-turn of the handle. Always in perfect balance in opening and closing. Fitted with patented floating cam, which forces the plug downward in closing, compensating for wear and holding it securely locked in closed position.

Homestead valves are furnished in straight-way, three-way, four-way and angle pattern. Equally adapted for steam, water, air, gas, heavy, gritty fluids and other power plant service. Send for the Homestead Catalogue.



Homestead Valve Mfg. Company

Pittsburgh, Pa.

[Works:] Homestead, Pa.

"Yes, We Skinned This Tool Steel Mandril in Breaking the Jeffrey Chain Roller"

"The labor scarcity hit us hard several months ago, so we were compelled to substitute mechanical equipment wherever possible. We could not afford to pay war-time wages for handling coal and ashes after we learned the economy of Pivoted Bucket Carriers on this work. But before we selected our Carriers we made a number of thorough tests—and the Jeffrey Carrier showed up fine on every one.

"The Jeffrey People told us that the Chain Rollers were so hard and tough that the bores have to be turned out on a grinder instead of in the usual way on an engine lathe.

"However, we split one of the Rollers with a tool steel mandril and were convinced. The case-hardened mandril was actually skinned by the tough metal of the Roller."

Catalog No. 210-4 will tell you about other tests that proved rugged, dependable construction, and shows in addition many interesting illustrations of the Jeffrey Carrier."

THE

Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL
CANADA

Since 1880

Starrett Tools

Carry with them the assurance of accuracy. For almost 40 years the name Starrett has meant unvarying accuracy to the men who use precision tools.

Catalog No 21CD, showing 2.100 kinds and sizes of fine precision tools, sent free upon request.

The L. S. Starrett Co., Athol, Mass.

The World's Greatest Toolmakers 42-935

Mnufacturers of Hack Saws Unexcelled

Have The Maritimes Had Fair Play?

THE Maritime Provinces did not enter Confederation very willingly and it may surprise people in other parts of the Dominion to learn that at the present time the people of New Brunswick and Nova Scotia are not altogether pleased with the results of the bargain. There is a distinct feeling among them that the advantages of Confederation have gone to the other Provinces. In the course of an article in the July issue of MACLEAN'S MAGAZINE, Thomas M. Fraser explains why this feeling has grown and the basis for it.

This article was written for the purpose of letting the other provinces know that the feeling exists but it will be of intense interest to people in the Maritimes. Be sure to read it—"The Spirit of the Maritimes."

"The Land of National Leaders"

An article on the political aspect of the Eastern Provinces and the achievements of their leading statesmen.

"Guarding Our Coast Line"

An extremely interesting description of the measures that were taken to patrol and guard the Atlantic seaboard during the war.

Bonar Law, the man from the Maritimes, who has been the able lieutenant of Lloyd George at all crises in Great Britain, appears on the cover in a handsome three-color reproduction.

Other Big Features of the Number

"With the Snowball Brigade"

By Captain Louis Keene

Just back from Siberia—Captain Keene tells some sensational and intensely gripping things about conditions in that country which the Canadian forces are helping to stabilize. It is a record of international complications, strange atrocities and almost unbelievable living conditions.

"The Three Tommies"

By Robert W. Service

A war poem of unusual strength.

"Solving the Problem of the Arctic"

By Vilhjalmur Stefansson

The fourth instalment of his remarkable story of the five years he spent in the north for the Canadian Government, appearing exclusively in MACLEAN'S.

Three Magnificent Stories

The best fiction obtainable is found in this issue: "Owners Up," a race horse story by W. A. Fraser; "His Majesty's Well Beloved," by Baroness Orczy; "Bunkered," by Allen C. Shore.

The Review of Reviews

Here are a few of the articles in this splendid department chosen as the best published during the past month in all magazines:

Finding Husbands For Three Million Women.
Will England Become an Agricultural Country?
Germany Can be Prosperous Under the Peace Terms.
The Woman Who Wrecked the World.
The Great Lama Rides in Motor Car.
Strange Personalities at Paris.
Making All Men Equal.
Winning the Secrets of the Desert.

Over 70,000 Canadian Families Buy

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

JULY ISSUE *Now On Sale At All News Dealers* ***20c.***

If there are no newsdealers in your town, or if your newsdealers cannot supply you, send 20 cents for a sample copy or $2.00 for a whole year's subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto, Canada.

"There's no Trouble *Now*"

"I've found the right packing at last—one packing that serves everywhere in the plant. I am all through with leaky flange joints and I don't have half a dozen different kinds of packing cluttering up my supply room. I use the same packing for every purpose—

VULCABESTON

Red Fibre Sheet Packing

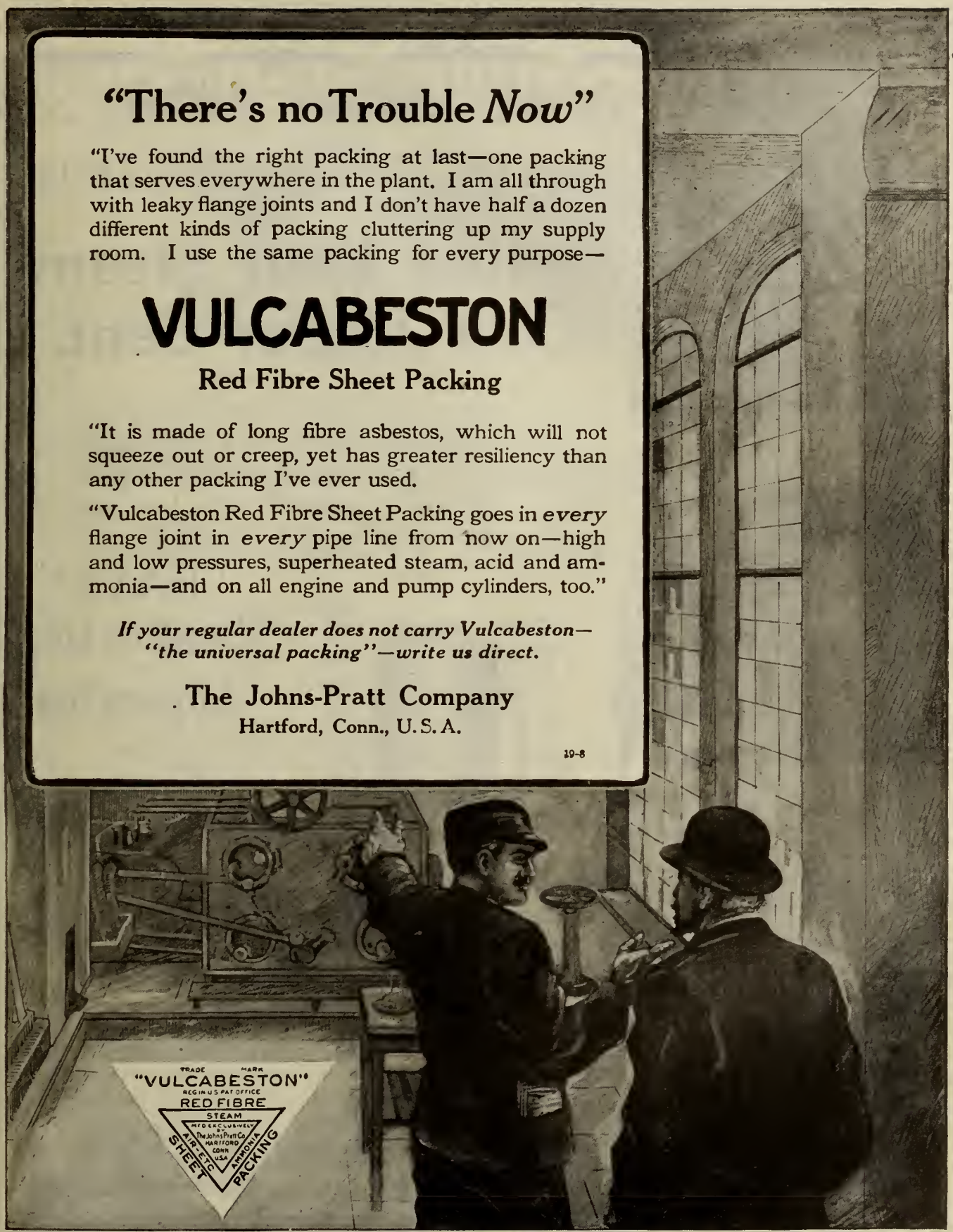
"It is made of long fibre asbestos, which will not squeeze out or creep, yet has greater resiliency than any other packing I've ever used.

"Vulcabeston Red Fibre Sheet Packing goes in *every* flange joint in *every* pipe line from now on—high and low pressures, superheated steam, acid and ammonia—and on all engine and pump cylinders, too."

If your regular dealer does not carry Vulcabeston—"the universal packing"—write us direct.

The Johns-Pratt Company
Hartford, Conn., U.S.A.

19-8



VULCABESTON

1/4

of the coal mined is wasted in burning

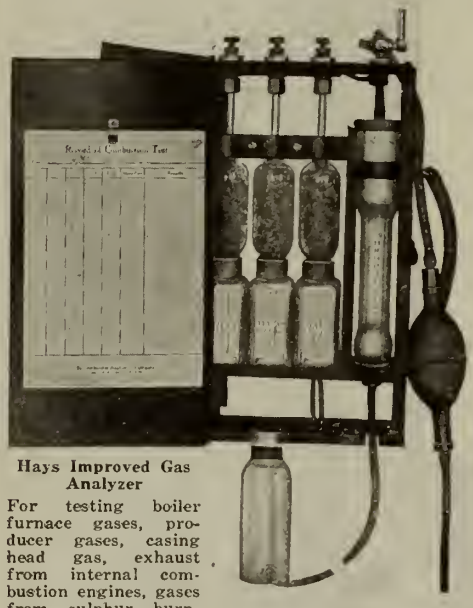
Save ONE Carload in Every FOUR

Reduce Your Steam-Cost 25 Per Cent.

Improper draft, holes in fire, leaky settings, improperly timed firing periods and other common *causes of fuel waste* can be easily detected when you have the records of

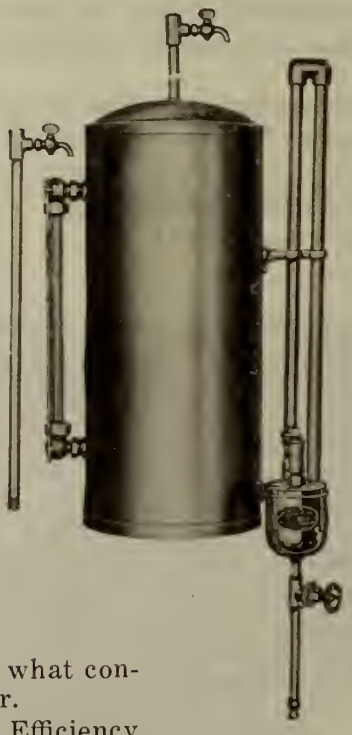
"HAYS" Combustion Apparatus

before you. And knowing is the first necessity of taking corrective measures.



Hays Improved Gas Analyzer

For testing boiler furnace gases, producer gases, casing head gas, exhaust from internal combustion engines, gases from sulphur burners, nitric acid gases, chlorine gas, etc., etc.



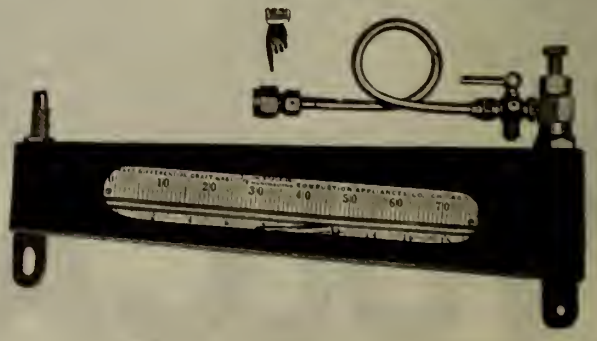
Gas Collector with water-flow regulator.

Hays Automatic CO_2 and Draft Recorders, Automatic Gas Collectors, Draft Gages and other Hays Equipments installed on your boilers keep you posted as to just what conditions your boilers are operating under.

In hundreds of plants, Hays Combustion Efficiency Appliances are leading the way to increased efficiency in boiler firing, a most effective way in **offsetting high coal prices.**

May we send you our Book "HOW TO BUILD UP FURNACE EFFICIENCY." It tells how fuel is wasted, how to stop that waste and keep it stopped.

The Hays Differential Draft Gage indicates the draft over the fire or the drop in draft through the boiler.

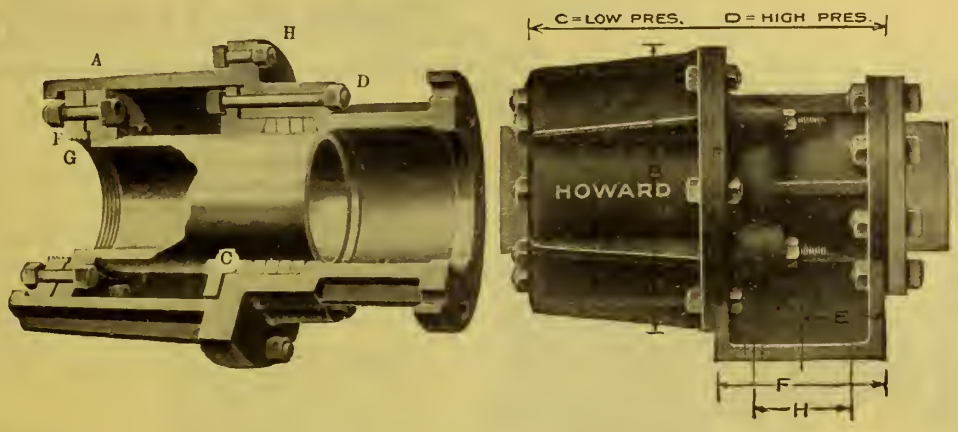


The J. W. Hays Corporation

Michigan City, Indiana, U.S.A.

Stephen H. Payne, 30 Church St., New York, Canadian Representative

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



Howard Guided Expansion Joints

Howard Guided Expansion Joints put the "How" in all expansion problems. The high pressure and superheat of modern engineering practice have added tremendously to pipe line dangers and the engineer's troubles.

"How" to take up the greatly increased expansions and contractions while at the same time keeping joints tight under the greater pressures?

That is the question to which HOWARD Guided Expansion Joints are the exclusive and satisfactory answer.

MAXIMUM OF TRAVERSE is the first essential of an expansion joint. Here the HOWARD excels with its full 4 inches of play between the "cold" position (see cut above), and the "hot" position. Assuming the outside temperature is 32 degrees, this 4 inch play amply takes care of the linear expansion in more than 100 feet of wrought iron pipe at any pressure from 30 to 300 pounds. Very often one HOWARD, by its greater capacity, takes the place of two or more other expansion joints.

Inquire about this to-day.

The Canadian Fairbanks-Morse Co., Limited

Halifax St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Saskatoon Calgary
Vancouver Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Scale in Your Boilers

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

METLSKIN CO., Inc.

Rochester, N. Y.

Canadian Representatives:

Canadian Fairbanks-Morse Co., Limited

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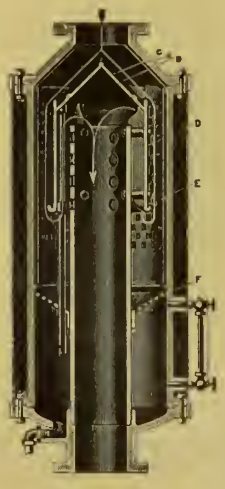
III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents:

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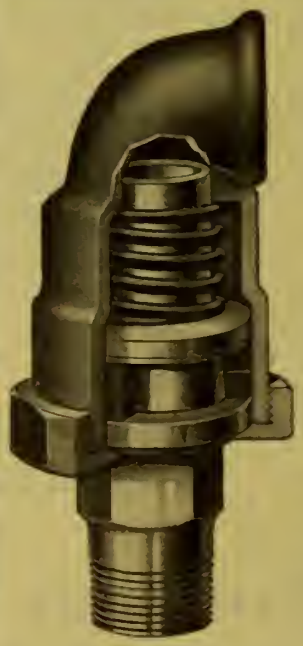


Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

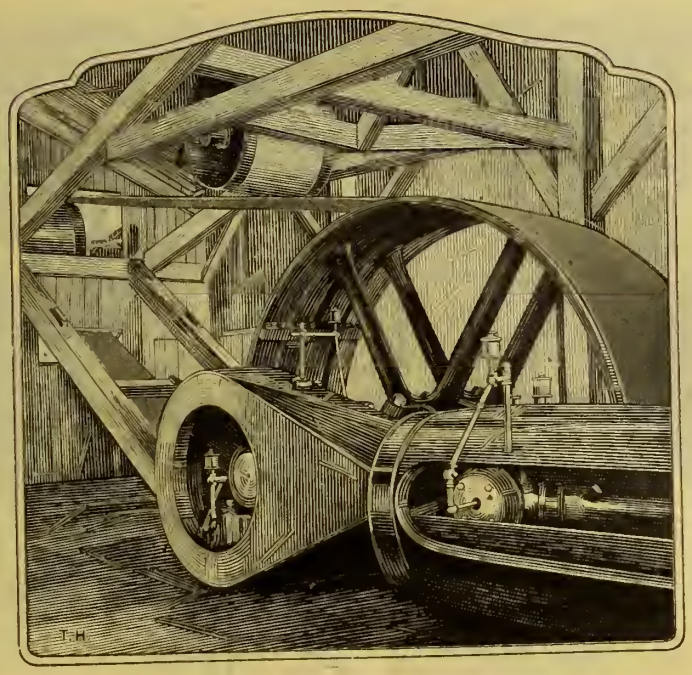
FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Through the scientific investigation of our Engineering Department, all the factors which enter into the design of a belt have been standardized. According to best modern practice, belts are designed with an overload capacity of about 60%. Such ratings are found to give the lowest cost per horse-power transmitted per year.



48" Heart 3-ply Belt, 86 feet long, installed in 1911 in the mill of the C. A. Smith Lumber Company, Baypoint, Cal. Driving Pulley, 14 feet, 101 R.P.M. Driven Pulley, 4 feet. Belt Speed, 4400 F. P. M. Theoretical horse-power, 600. Actual horse-power transmitted, 850 to 900. Cost of Belt, 1-5 of 1c per horse-power per week.

"Where Little Things Are Big"

Think what this belt must do. Travelling at 4,400 feet per minute, it makes its circuit fifty times every sixty seconds. For every one of these revolutions, each part of the belt must slacken and tighten itself, practically once a second.

To be efficient, it must do this without loosening its grip on the pulleys, without jumping or slipping,. That this 48" Heart Belt does transmit power efficiently is evidenced by the fact that it is delivering 250 more horse-power, or over 40% in excess of that for which it had been designed. It has been doing this for over 8 years.

The test of such conditions seems impossibly severe, and yet this belt succeeds because it is made from the right material—leather—which has retained so many of the wonderful properties that fit it to be the skin of a powerful, active, living animal.

In order that our leathers may meet these almost impossibly severe requirements of elasticity and pulley grip, we tan them ourselves specifically for belting use, handling 1,000 hides a day.

That we may offer always the right belt for the required work, we make our Standardized Series of Leather Belting—a Belt for each class of power transmission. Standardized in manufacture, and standardized in application to the work to be done.

Many of the best belted plants ask us to specify the belting for every *pulley* drive. Try the plan yourself. Then, when buying, call for "Graton & Knight—Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for "Standardized Leather Belting" Book

THE GRATON & KNIGHT MFG. COMPANY, Worcester, Mass., U.S.A.

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Leather Belting
Tanned by us for belting use

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STRENGTH—GOODNESS—QUALITY
GASOLINE

Gaskets used on the cylinder heads of gasoline engines and pumps are subjected to extreme temperatures and pressures. Many hundred thousand joints in this service made tight by DURABLA gaskets have proved to others that DURABLA is a standard for all gasoline work.

Use DURABLA on the next gasoline joints you make and it will prove its worth to you. It is guaranteed to make a tight joint at all temperatures and pressures.

DURABLA Gasket Material is also guaranteed for air, water, oil, steam, ammonia and acids.

One Standard Material for All Gasket Work. Sold on a "Service" Basis.

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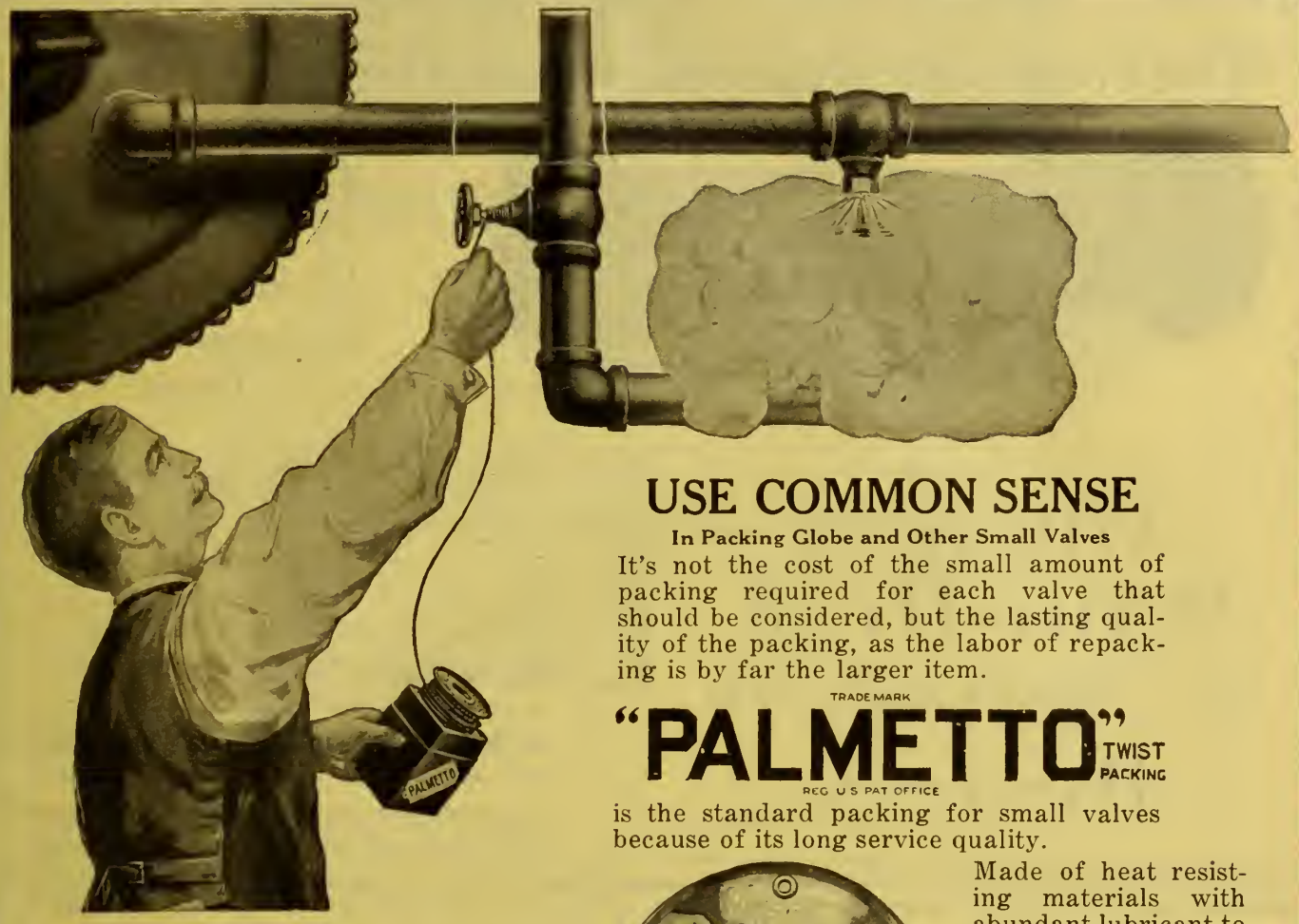

USE COMMON SENSE

In Packing Globe and Other Small Valves

It's not the cost of the small amount of packing required for each valve that should be considered, but the lasting quality of the packing, as the labor of repacking is by far the larger item.

TRADE MARK
"PALMETTO" TWIST PACKING
REG U S PAT OFFICE

is the standard packing for small valves because of its long service quality.

Made of heat resisting materials with abundant lubricant to keep it soft and pliable.

ANY SIZE VALVE CAN BE REPACKED FROM ONE SPOOL OF "PALMETTO" TWIST.

TRY THIS SAMPLE SPOOL ON A LEAKY VALVE
Ft. Robert Greene
Fort Wayne
Ind.
ANY SIZE VALVE PACKED FROM ONE SPOOL OF "PALMETTO" TWIST BY UNSTRANDING
TEST THIS SAMPLE ON A LEAKY VALVE

On one pound tin spools in dust-proof boxes.

A TROUBLE-SAVER wherever small valves are used.

May we send you this **WORKING SAMPLE** which you can test and know why you should use "PALMETTO" twist in all your valves?

Greene, Tweed & Co.
Sole Manufacturers
109 Duane St., New York

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Heater Without the Usual Heater Troubles

No corrosion
No split tubes
No leaky heads
No expansion strains

Alberger Multi-Head Water Heaters

AND IT WORKS FAST, TOO, HEATING WATER AS FAST AS IT IS DRAWN. IN FACT IT TRANSMITS 50% MORE HEAT THAN ANY STRAIGHT TUBE HEATER.

The small, corrugated, pure copper tubes in this Alberger Heater expand into a floating head independent of the cast iron shell, which means that there cannot be trouble from expansion or contraction strain.

These corrugated tubes will remain scale-free longer than a heater with plain tubes, because the corrugations promote a scouring effect on the tubes.

May we send catalogue describing both Horizontal and Vertical Types? No obligation whatever.

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BUFFALO N.Y. U.S.A.

General Sales Agents: Canadian Fairbanks-Morse Company Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria.

Voorhees Rub-Steel Valves

"The Valve with a backbone"

Are without an Equal for

Deane of Holyoke Condensers

or Suctions on Paper Machines

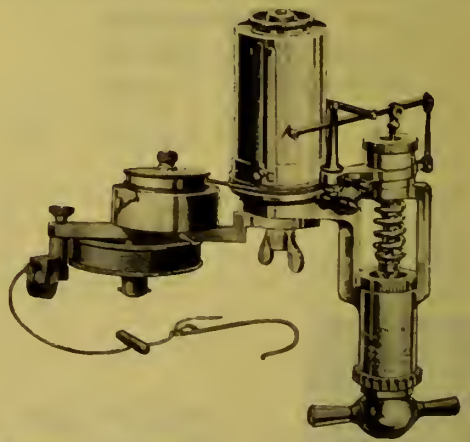
Softest high-grade rubber as seating, supported by an inseparable **steel core.** Spring guides and brass bushed stud-holes as above, if desired, or plain faces.

Not a cheap valve, but positively smoothest in action and longest lasting.

This construction in Four Grades for **every** known pumping service.

The Canadian Fairbanks-Morse Co., Ltd.
Sole Distributors for Canada

THE AMERICAN



THOMPSON IMPROVED INDICATOR with New Detent Motion and American Ideal Reducing Wheel.

Ask any user whether our claims of Indicator Superiority have been borne out by his experience.

Then write our nearest office for new booklet.

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A further Demonstration of the Excellence of
MAGNOLIA METAL

PERKINS MACHINE & FOUNDRY CO. INC.,
Founders and Machinists.
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Magnolia Metal Co.,
New York City.

May 13, 1919.

Gentlemen,—The writer has been using MAGNOLIA METAL for 18 years with excellent results.

Have used MAGNOLIA on Dynamo and Engine Bearings (Connecting Rods more particularly) and claim it to be the most excellent metal for hardest service obtainable. Am glad, indeed, to be able to rcommend it.

Beg to advise you that I am a mechanical man of many years' experience, having handled all kinds of Babbitts, and MAGNOLIA METAL is my preference.

Yours truly,
PERKINS MACHINE & FOUNDRY CO.,
Augustus H. Morrison,
Engineer and Manager.

PRACTICAL ENGINEER POCKET BOOK
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A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.

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285 BEAVER HALL HILL, MONTREAL

Alternating Current Generators

3 Phase, 60 Cycles:

No. For Sale	K.W.	Volt.	Speed	MAKE AND TYPE
1	7½	240	1800	General Electric—ATB.
1 KVA.	50	2300	300	Fairbanks-Morse—D.
1	50	2300	1200	General Electric—revolving field.
1	75	2300	900	General Electric—ATB.
1	150	220	600	General Electric—ATB. revol. field
1	200	2300	600	General Electric—ATB. revol. field
1 KVA	250	2300	720	Electric Machinery revolving field
1	450	2400	360	General Electric—
1	500	2300	400	General Electric—ATB. revol. field
1	540	2300	360	General Electric ATB. revol. field

3 Phase, 25/30 Cycles:

1	125	220	257	General Electric—ATB. revol. field
1	160	440	750	General Electric—ATB.
1	300	6600	375/450	Westinghouse—Synchronous
1	425	2300	500	Westinghouse—revolving field

2 Phase, 60 Cycles:

No. for Sale	K.W.	Volt.	Speed	MAKE AND TYPE
1	50	2300	1200	General Electric—IQB. revolving field
1 KVA.	75	2300	900	Crocker Wheeler—revolving field
1	120	440	720	Westinghouse—
1	180	440	514	Westinghouse—
1	200	1150	720	General Electric—AQB.
1 KVA.	450	2400	360	General Electric—
1 KVA.	533	200		Bullock—revolving field
1 KVA.	600	440	360	Crocker Wheeler—revolving field

MACGOVERN & COMPANY Incorporated
Head Office: 285 BEAVER HALL HILL, MONTREAL
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DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

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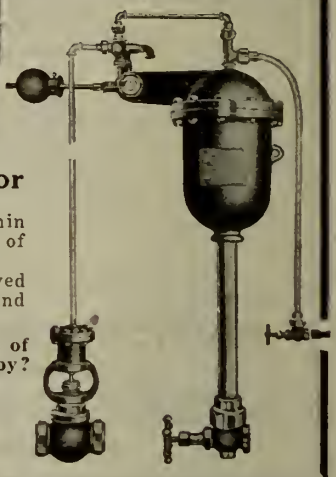
VIGILANT



Automatic Feed Water Regulator

The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.
Years of service test has proved it the utmost in reliability and efficiency.

Catalogue presents many points of interest. May we send you a copy?

The CHAPLIN-FULTON MFG., CO.

28 Penn Ave., Pittsburgh, Penn.

The Simplest and Best Cleaner on the market is

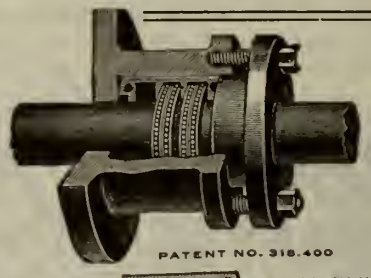
PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.

For sale by leading Canadian jobbers.

Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo
Eastern Office: 71 Fulton St., New York.



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	905,103
" "	775,194	" "	934,629
" "	791,300	" "	979,206
" "	805,669	" "	1000,76

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
incorporated 1897

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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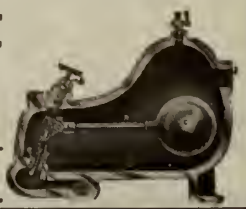

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Water Turbines, Hydraulic Governors, Centrifugal Pumps

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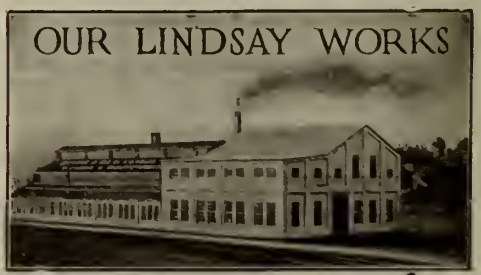

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Lindsay, Ontario

DARLING BROTHERS, LIMITED

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Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.

W. C. McGHIE, Chairman of Board.

W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

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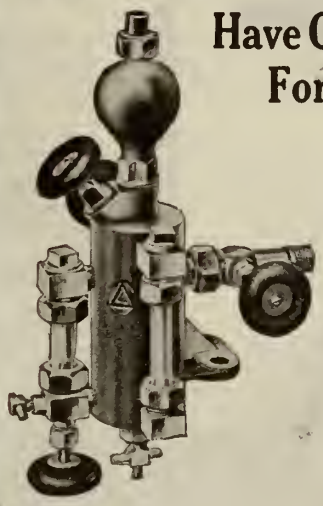
Power House Subscription Price is still only $1.00 per year. Tell the other fellow.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.

WALKERVILLE, ONT.

When Buying Thermometers

There's Just Three Things to Remember—

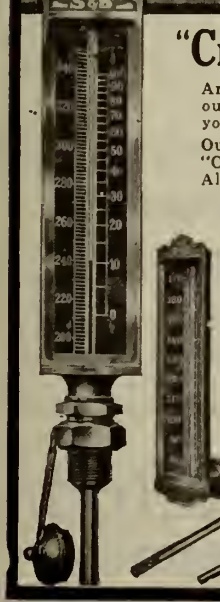
First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers



And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H.-200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

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Pittsburg
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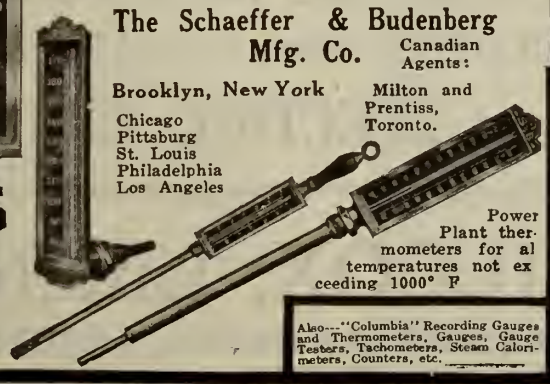
Philadelphia
Los Angeles

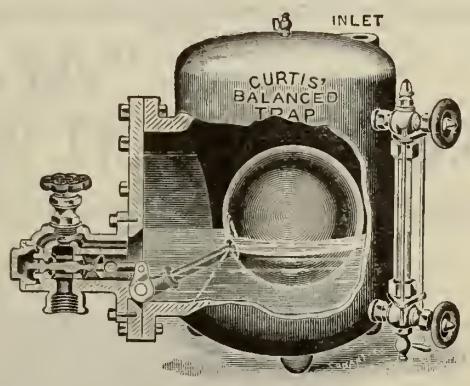
Canadian Agents:

Milton and Prentiss, Toronto.



Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.



Five Superior Features of the Curtis

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lb.

Write for catalog of Curtis Engineering Specialties.

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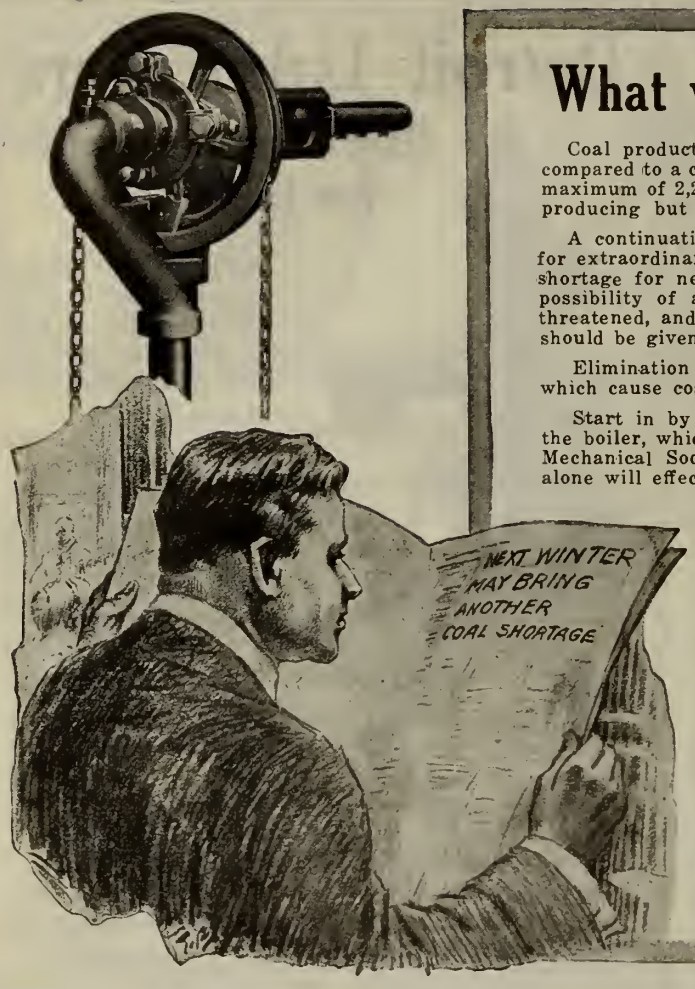


What will you do next winter?

Coal production is at the lowest possible point in three years. As compared to a combined 1917 production of 1,800,000 tons daily, and a 1918 maximum of 2,200,000 tons daily, Canada and the United States are to-day producing but 1,167,000 tons.

A continuation of this condition beyond the present month will call for extraordinary production during the remainder of the year if a fuel shortage for next winter is to be avoided. Combine this fact with the possibility of a coal miners' strike in the early fall, which has been threatened, and there is very good reason why the boiler room problem should be given serious consideration NOW!

Elimination of methods and practices of the boiler room operation which cause coal waste is an intelligent step in the right direction.

Start in by discarding the hand hose and lance system of cleaning the boiler, which is only 50% effective, and replace it with the Diamond Mechanical Soot Blower System, which is 95% effective. This change alone will effect the following economies:

1. FUEL: a saving of 4 to 8 per cent.
2. BOILER EFFICIENCY: an increase of 4 per cent.
3. LABOR: a saving of many hours per day.
4. LONGEVITY: an increase in the length of service of the boiler tubes through the prevention of corrosion.
5. STEAM: a saving of 25 to 75 per cent. of steam used for cleaning.

Diamond Soot Blowers are in use in hundreds of plants in Canada.

For lists of these users and full information write for Bulletin 170.

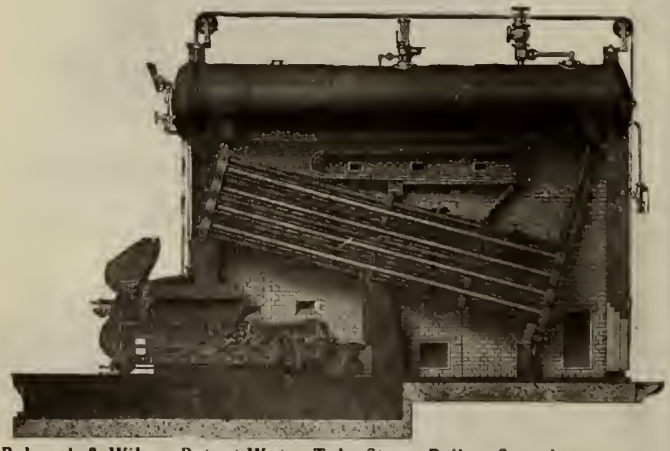
DIAMOND SPECIALTY COMPANY
Windsor, Ontario

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
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Piping, Feed Water Heaters
Water Softeners and Purifiers
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Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR VALVES
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

AMMETERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.

AMMONIA VALVES AND FITTINGS
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa

AMMONIA TANKS
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
Canadian Fairbanks-Morse Co., Ltd. Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd. Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co. Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto, Ont.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
Waterous Engine Works Co., Brantford, Ont.
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

BELTING, LEATHER
Bond Engineering Works, Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. Consol. Rubber Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng. Co. Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Metlskin Mfg. Co., Rochester, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

BOILER SKIMMERS
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mfg. Co., Woodstock.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Coppus Eng. & Equipment Co., Worcester, Mass.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Engineering Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Montreal.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
MacGovern & Co., Inc., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd. Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity, T., & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BUCKETS, ELEVATOR
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CAR LOADERS AND UNLOADERS
Portable Machinery Co., Inc., Passaic, N.J.

CAST IRON FITTINGS
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Waterous Engine Works Co., Brantford, Ont.

CELLAR DRAINERS
Morrison Brass Mfg. Co., James, Toronto, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDNER & WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates, John W., St. James St., Montreal.
Green's Economiser, Ltd., Toronto.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford, Ont.

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Morse Chain Co., Ithica, N.Y.

CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.

CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.

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Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithaca, N.Y.

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Jeffrey Mfg. Co., Montreal, Canada.

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Jeffrey Mfg. Co., Montreal, Canada.

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Morse Chain Co., Ithica, N.Y.

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Morse Chain Co., Ithica, N.Y

CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.

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Darling Brothers, Ltd., Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLOCKS
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CLOSETS
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Mueller Mfg. Co., H., Sarnia, Ont.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford, Ont.

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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

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Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

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Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal
MacGovern & Co., Inc., Montreal, Que.
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Taylor Instrument Co., Rochester, N.Y.

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American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto, Ont.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
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Beveridge Paper Co., Montreal, Que.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Beveridge Paper Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLING, FRICTION
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Smart-Turner Machine Co., Ltd., Hamilton.

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Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
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Can. Link-Belt Co., Toronto, Ont.

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Babcock & Wilcox, Ltd., Montreal.
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Can. Link-Belt Co., Toronto, Ont.
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Babcock & Wilcox, Ltd., Montreal.

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
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Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

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Defender Automatic Regulator Co., St. Louis, Mo.

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Morse Chain Co., Ithica, N.Y.

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Penberthy Injector Co., Windsor, Ont.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

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Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
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Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.

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Empire Mfg. Co., Ltd., London, Ont.

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Penberthy Injector Co., Windsor, Ont.
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Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
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Waterous Engine Works Co., Brantford.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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MacGovern & Co., Inc., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
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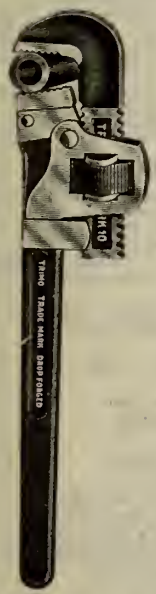
The Wrench of 25% Greater Efficiency

TRIMO PIPE WRENCH



Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

The inserted jaw in the handle can be readily replaced when worn, thus adding to the life of the tool.

Nut with Nut-Guards

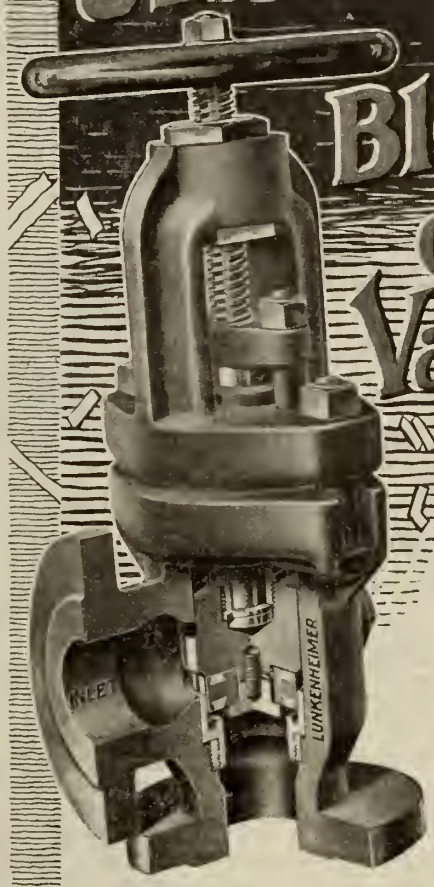
Inquiries from Importers and Dealers Solicited. Send for Catalogue No. 55.

TRIMONT MANUFACTURING CO.

Cable Address: Triwrench
Code: Western Union

Roxbury (Boston) Mass., U.S.A.

The ULTIMATE in Blow-off Valves



The "Duro" has demonstrated its peculiar adaptability as a blow-off by many years of satisfactory service, with a minimum cost for upkeep.

The self-cleansing seat feature prevents an accumulation of sediment on the seating faces during the blow-off, thereby reducing wear to a minimum and preventing leakage while the boiler is in operation.

To further enhance the durability of the valve, the disc is reversible; the disc face can easily be replaced with new material in case of wear, and all the parts, including the seat ring and reversible disc are renewable.

The materials and workmanship are of characteristic Lunkenheimer "Quality."

Specify **Lunkenheimer "Duro"** and insist on their installation.

Write for descriptive booklet No. 515DC.

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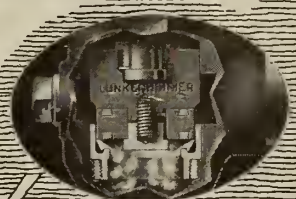

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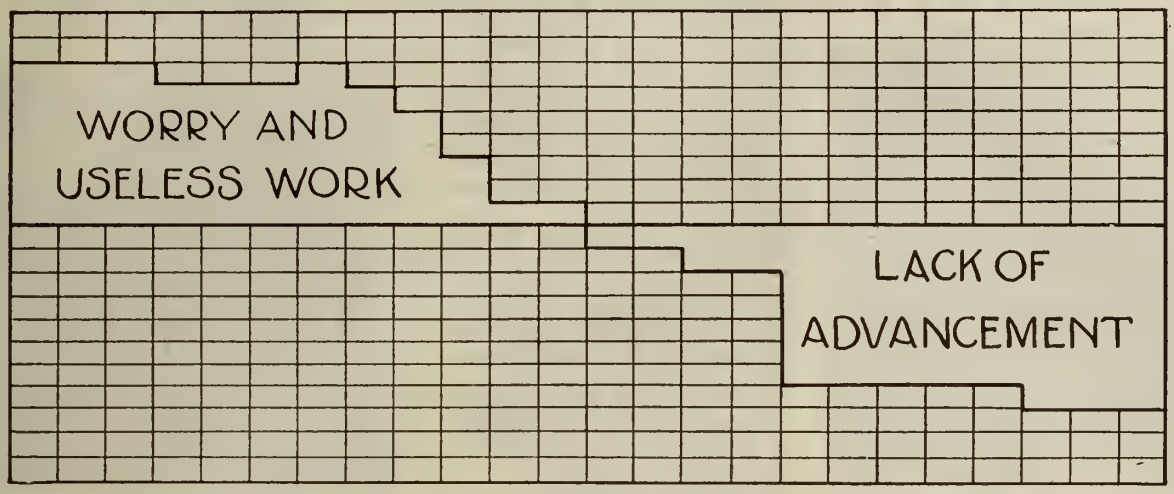

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Jas. Morrison Brass Mfg. Co., Toronto.

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Garlock Packing Co., Hamilton, Ont.
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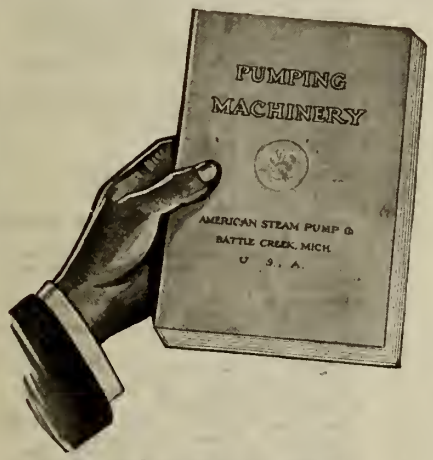

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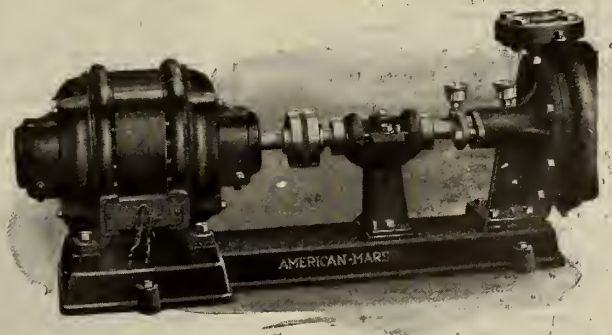

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Economiser Practice in Great Britain

From

"Engineering"

Nov. 1, 1918

EXACT DATA ON THE RUNNING OF STEAM BOILER PLANTS No. 1

By D. BROWNLIE, B.Sc.Hons.(Lond.), F.C.S.
J. COMPSTON, and H. W. ROYSE.

(Extracts from above article)

The economizer is, of course, an absolutely essential part of any up-to-date boiler plant, and the saving obtained should be 17½ per cent. to 20 per cent. under average conditions. In this connection to be saving 15 per cent. or over, given in Table II, the figures of each of the separate 24 plants found will be of interest, showing what is actually being done on many boiler plants.

The other advantages of the economizer are the reduction of the strain on the boilers by the provision of a high-temperature feed water preventing unequal expansion and contraction, and also that there is always a large reserve of hot water at hand for any sudden demand for steam. Further, the evaporative capacity of the boilers is greatly increased.

TABLE II.—DETAILED RESULTS OF WORKING OF ECONOMIZERS IN 24 PLANTS SAVING OVER 15 PER CENT.

No. of Plant	Average Temperature of Feed Water		Average Temperature of Flue Gases.		Draught in Inches		Steam Pressure Gauge.	Total Evaporation on Plant per Hour.	Number of Tubes in Economiser on Plant.	Per Cent. Saving due to Economisers.
	Before Economisers.	After Economisers.	Before Economisers.	After Economisers.	W.G. Chimney Base	Side Flues or Downtake Boilers.				
	deg. F.	deg. F.	deg. F.	deg. F.			lb. per sq. in.	lb.		per cent.
1	100	321	612	344	1.40	0.50	180.0	18843.0	480	19.6
2	59	282	548	328	1.52	0.98	81.0	41166.0	560	19.3
3	95	311	680	375	3.10	0.80	161.0	37785.0	488	19.2
4	65	281	605	475	1.50	0.80	76.0	18174.0	288	18.8
5	88	289	662	372	0.67	0.28	97.0	12882.0	394	17.8
6	60	266	625	420	0.45	0.85	79.0	16395.0	216	17.8
7	112	309	565	393	0.45	0.75	98.0	5310.0	120	17.8
8	90	301	609	366	1.70	0.82	139.0	72516.0	960	17.6
9	115	303	585	324	1.00	0.60	119.0	14394.0	192	17.4
10	110	308	689	448	1.20	0.86	104.0	11578.0	320	17.4
11	104	296	616	377	0.60	0.40	74.0	6032.0	144	17.3
12	92	289	612	336	1.70	0.66	189.0	16118.0	288	17.3
13	151	333	463	370	0.61	0.42	160.0	11830.0	320	16.9
14	91	275	609	377	1.00	0.59	95.0	7968.0	192	16.3
15	105	287	759	525	1.20	0.60	103.0	29484.0	640	16.3
16	133	307	715	353	1.75	0.45	120.0	41435.0	640	16.0
17	79	259	609	450	0.92	0.55	111.0	12908.0	320	15.8
18	129	302	487	325	1.68	0.52	154.0	6396.0	160	15.7
19	114	286	603	387	1.50	0.60	112.0	24808.0	384	15.6
20	109	280	749	550	1.50	0.70	103.0	8734.0	96	15.4
21	107	276	597	328	1.15	0.30	81.0	25264.0	400	15.3
22	115	281	539	463	0.90	0.30	72.0	7676.0	168	15.2
23	117	284	588	394	1.15	0.55	88.0	18219.0	280	15.2
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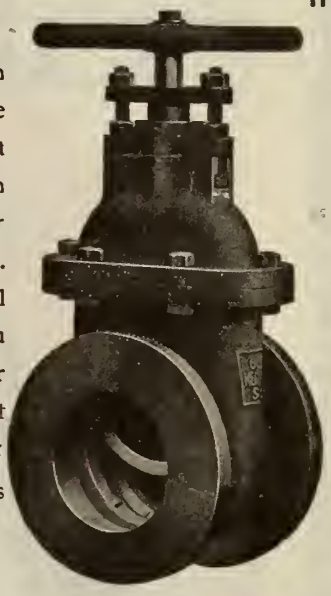

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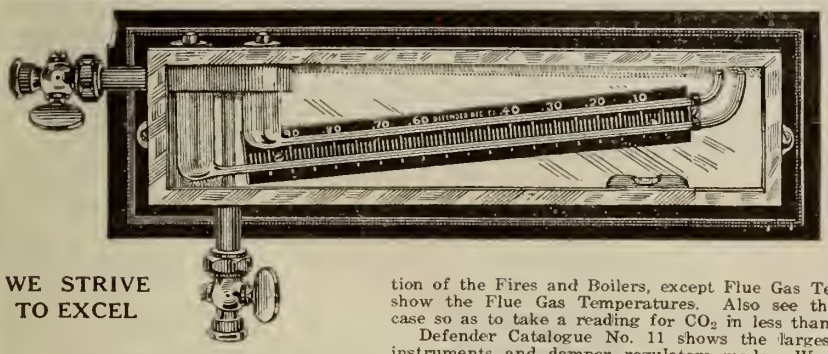

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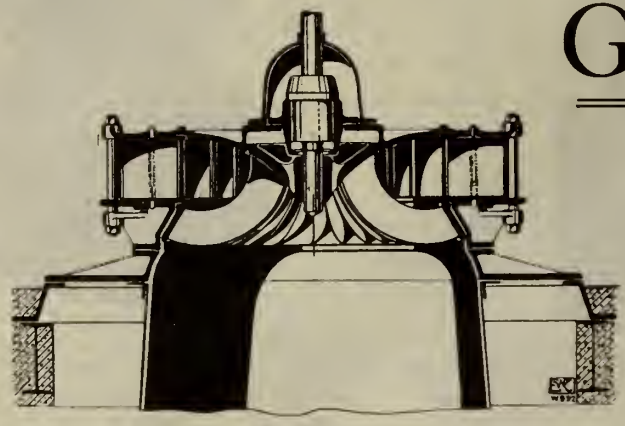

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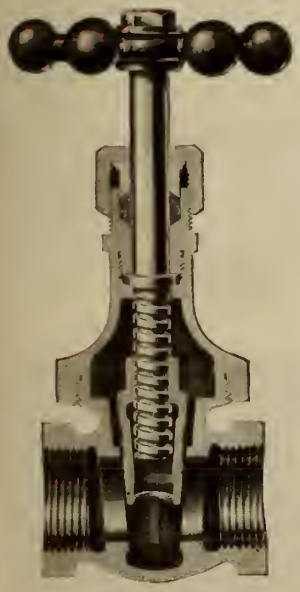

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Look for our name on the Valve you buy. It's your guarantee of valve comfort and economy.

COMPODISK Discs are interchangeable with other standard makes on the market. They will stand high steam pressure and severe conditions without cracking or flaking and have a record for long and efficient service.

HAVE YOU A COPY OF OUR POCKET CATALOG? SENT FREE TO YOU ON REQUEST.

PENBERTHY INJECTOR CO., Limited

WINDSOR, ONTARIO

When Production Costs Are Mounting

COMPETITION knows no favorites. The very life of your industry depends on keeping down production costs. When these soar high, one good place to look for a solution is in your power plant. Study the conditions under which your machinery works.

Rigid mechanical efficiency is only maintained by careful, systematic, **correct** lubrication. Select your lubricants with the same scrupulous care with which you choose your machinery; be sure they are the **proper** lubricants as well as the best; remember that poor lubricants are expensive at any price.

Imperial Lubricants are a full line, scientifically formulated for all types and parts of machines. Among them is a correct lubricant for each requirement. They are made in Canada, of uniform high quality, thoroughly dependable, always available and recommended by experts everywhere.

Imperial Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS
- Imperial Shield Cylinder Oil
- Imperial Ebony Cylinder Oil
- Imperial Capitol Cylinder Oil
- Imperial Beaver Cylinder Oil
- Imperial Cylinder Oil
- Imperial Acme Cylinder Oil
- Imperial Disc Cylinder Oil
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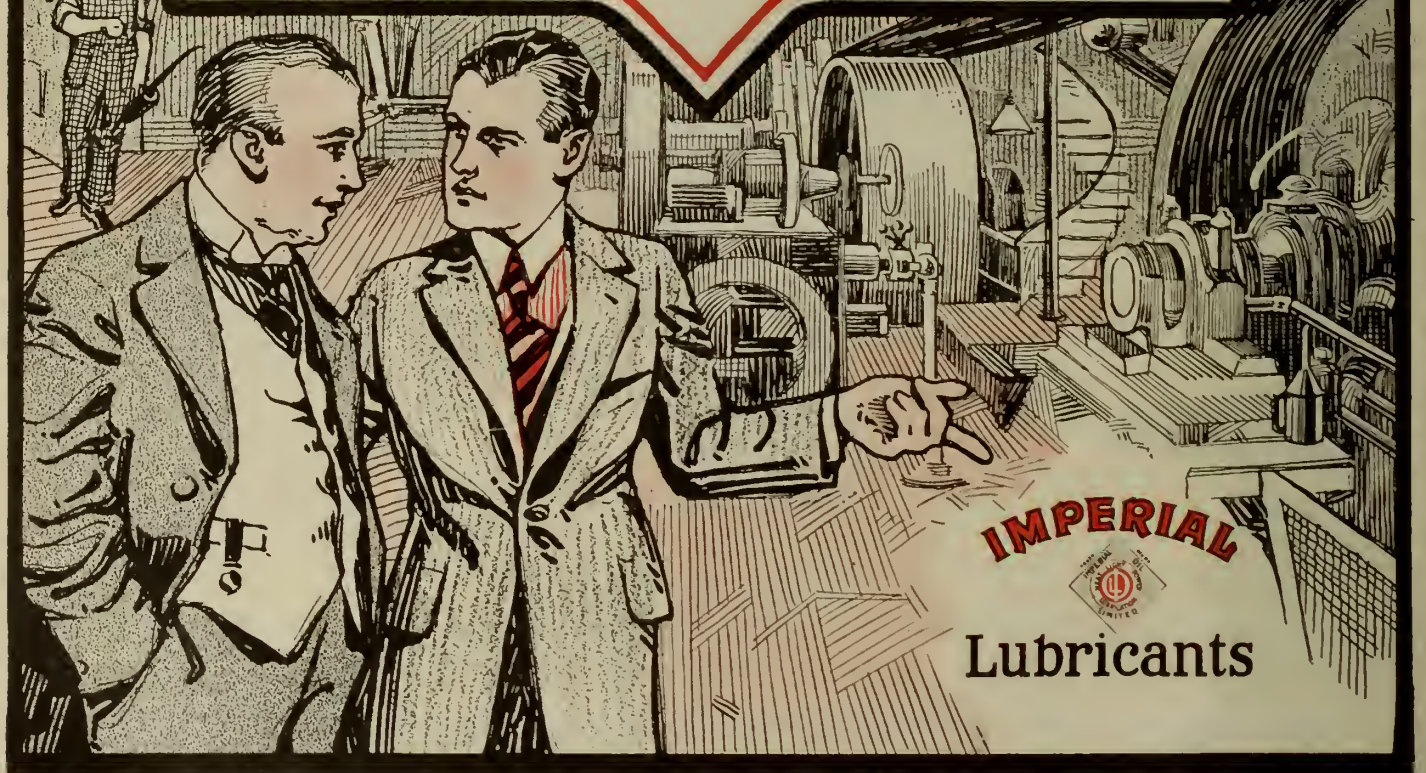
ENGINE OILS
- Imperial Atlantic Red Engine Oil
- Imperial Bayonne Engine Oil
- Imperial Kearsarge Engine Oil
- Imperial Renown Engine and Dynamo Oil
- Imperial Solar Red Engine Oil
- Imperial Standard Gas Engine Oil
- Imperial Junior Red Engine Oil
- Imperial Eldorado Engine Oil

Imperial Lubrication Engineers are glad to give you, without charge, the benefit of their knowledge and experience. They will be pleased to co-operate with your own mechanical engineer in making investigations and recommendations for the correct lubrication of your plant.

You should do everything possible to keep your mechanical operation costs down to the lowest figure. Do not hesitate to call Imperial Lubrication Engineers for consultation. Write us at our home office, 56 Church Street, Toronto.



IMPERIAL

Lubricants

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

D. K. McLAREN, LIMITED · MONTREAL · TRADE MARK

Many of Canada's Largest and Most Efficient Power Plants

SHOW A PREFERENCE FOR

D. K. McLaren's Genuine British Oak Tanned Leather Belting

THERE'S A REASON: **The test of time has proved that the length of service is the only true way to judge the quality and value of belting.**

Many of Canada's largest power plants have put D. K. McLaren's Belting to the quality test and have found it satisfactory in every way as is proven by the fact that the biggest percentage of our business comes in the form of repeat orders.

The great success of D. K. McLaren's Belting is due to the fact that only the flawless backs of the hides of choicest steers are used and these are tanned by the genuine British Oak process, the best known for preparing belts for hard service. Every bit of the hide's natural strength is preserved. Minimum stretch, minimum slippage and fewer breaks are the results you can expect.

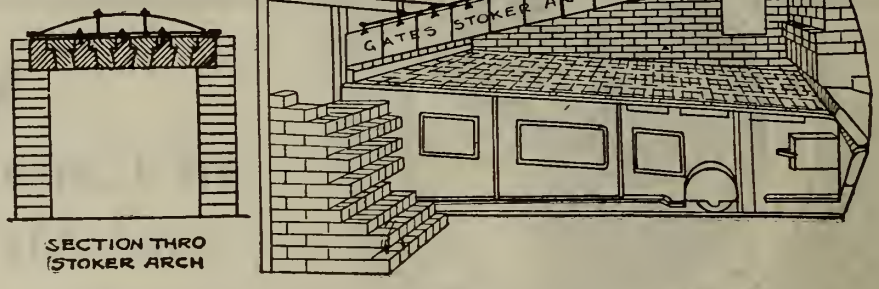
May we put you in touch with users so that you can profit by their experience.

D·K·McLAREN LIMITED

Head Office and Factory: 351 St. James St., Montreal, P.Q.

Toronto, Ont., 194 King St. W.; St. John, N.B., 90 Germain St.; Vancouver, B.C., 849 Beatty Street

GATES STOKER ARCH



BUILT on the unit principle, any section of the arch can be placed without disturbing the rest of the brick work. Saves both time and money in making repairs—and frequently saves expensive shutdowns.

The Gates Stoker Arch minimizes stoker arch maintenance cost.

Our new type of arch block is adapted to Dutch oven type of boiler setting, or H.R.T. boiler back arches, large fire door arches, reverberatory and smelting furnaces as well as stoker arches.

If your setting is not standard we will design a block to suit your requirements.

We specialize in all kinds of POWER PLANT BRICK WORK.

Call on our engineers at any time for information you may require. Their services are offered to you without obligation.

GATES REFRACTORIES, LIMITED

382 St. James Street **MONTREAL**

Hoyt's Babbitt Metals

Hoyt's Nickel Genuine

This alloy is exceedingly tough and durable. Specially designed for gas engines, gasoline engines, marine and automobile engines.

Hoyt's Dynamo Genuine

An extremely high copper alloy. Purely bronze as babbitt can be made. Especially compounded for Dynamo use where the service is severe.

HOYT'S FROST KING BABBITT is widely known as the premier of all babbitts for general use.

For saw mills, planing mills, threshing engines, traction engines, rolling mills, pulp machinery and all classes of stationary engines, it is without equal.

HOYT METAL CO., TORONTO

NEW YORK, N.Y. **LONDON, ENG.** **ST. LOUIS, MO.**

POWER HOUSE, July 20, 1919, Vol. XII., No. 11. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1.00; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

TRADE MARK

DART

Dart

Service means Permanence

Once Dart Unions are Connected All Cost is Ended--

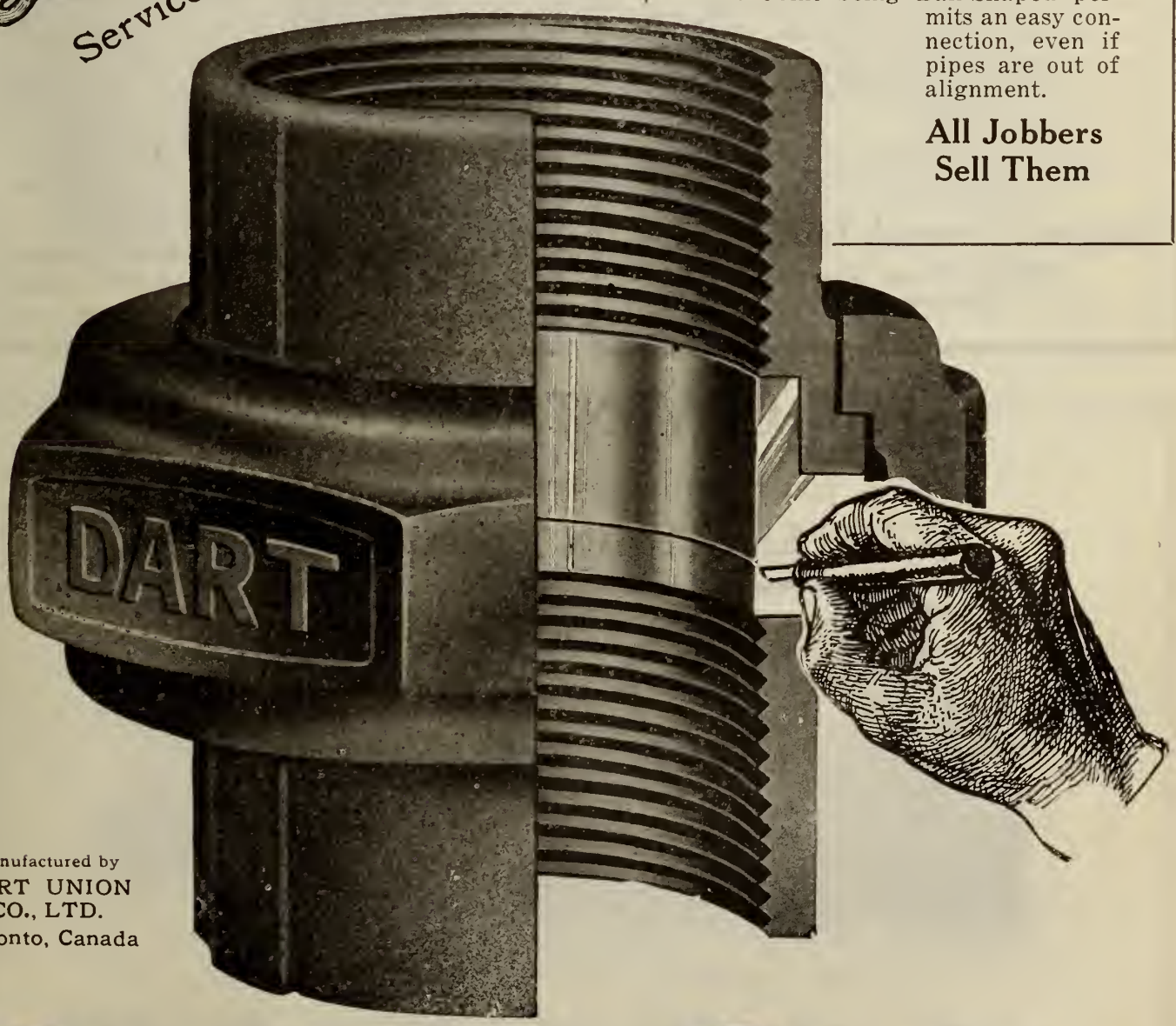
They never haue to be replaced and are trouble-proof

Bronze will not rust or corrode—will not deteriorate.

The Face and Seat of Dart Unions are made of Bronze—they never loosen up and leak.

The Joint being Ball-Shaped permits an easy connection, even if pipes are out of alignment.

All Jobbers Sell Them



Manufactured by
DART UNION
CO., LTD.
Toronto, Canada

Bronze to Bronze

(AT THE JOINT)

TALBOT
Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)

Reduce power cost because they burn low grade fuel oil. There is no waste of fuel and no induced draft necessary.

Water enters the "Talbot" near the stack and leaves as steam nears the burners.

One man can look after a dozen "Talbots."

The "Talbot" saves space as it covers only one seventh as much floor as an ordinary boiler of equal H.P.

Built in all sizes from 50 to 4000 H.P.

Canadian Manufacturers and Sales Office:

Montreal General Tool Co., Ltd.

675 Notre Dame, Misonneauve
MONTREAL, P.Q.

"BOND" HANGERS

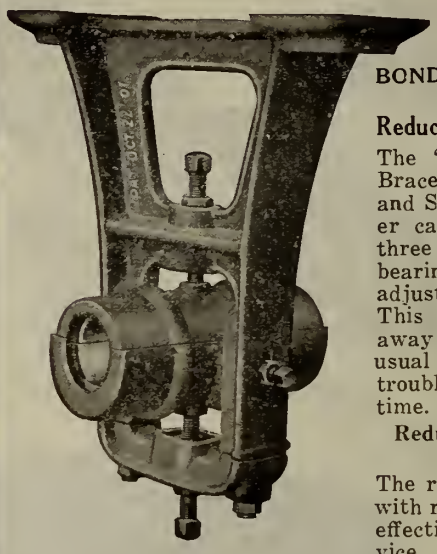


FIG. 1

B
D-S

BOND DOUBLE-SURE QUALITY

Reduced Installation Cost

The "Bond" Double Braced Universal Ball and Socket Drop Hanger can be adjusted in three directions and the bearing proper can be adjusted in the hanger. This flexibility does away with much of the usual installation trouble thus saving time.

Reduce Maintenance Cost

The ring oiling feature with reservoir is a most effective lubricating device as the reservoir needs refilling only once every six months under ordinary circumstances.

Write for our Catalogue 38 P.H. It is an educational booklet on power transmission machinery.

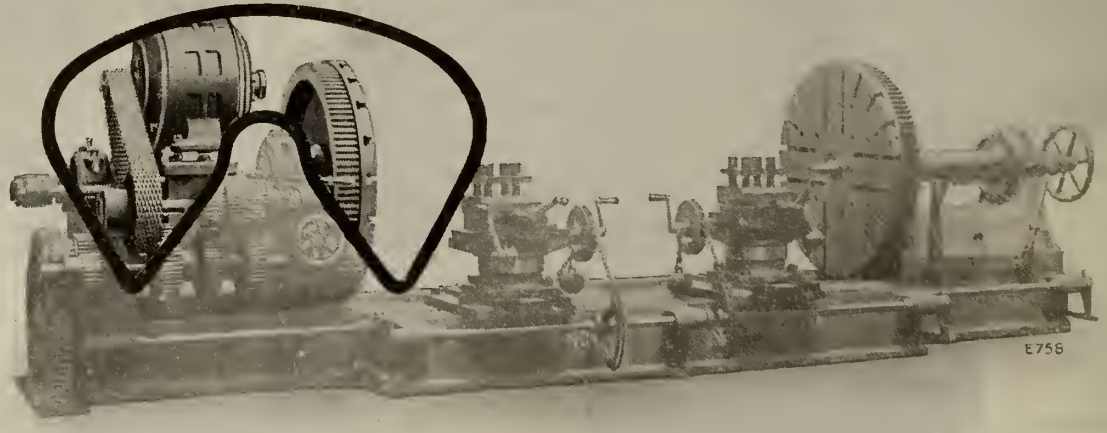
Bond Engineering Works, Limited

Harbour Industrial District TORONTO, CANADA

Sole Makers Bond Double-Sure Transmission Machinery

"THE COVENTRY" CHAINS

Have you Considered the Advantages of
NOISELESS CHAIN TRANSMISSION?



"The Coventry" Noiseless Chain transmitting Power on a Tangye Lathe built for heavy work.
Note the compact arrangement of the drive.

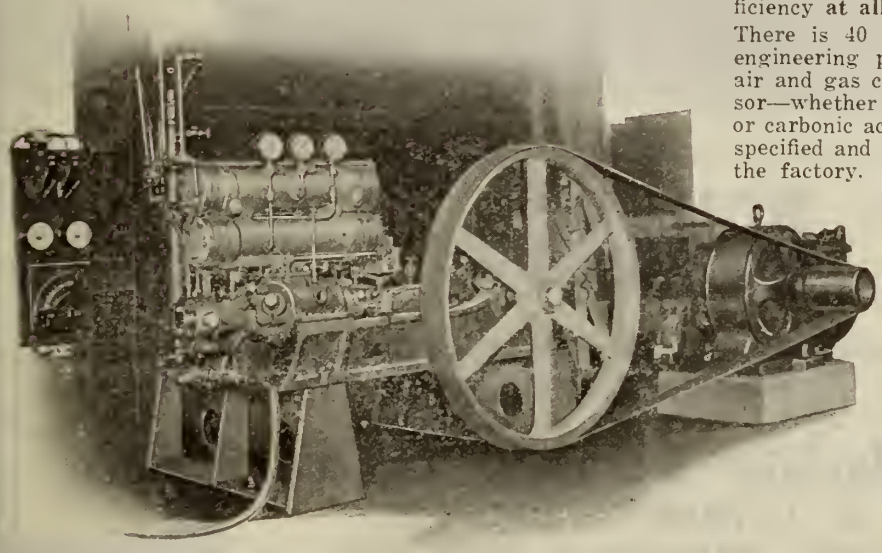
"THE COVENTRY" CHAIN CO., LTD., COVENTRY, ENGLAND

CANADIAN AGENTS—TAYLOR & ARNOLD, LTD., BANK OF TORONTO BUILDING, MONTREAL

NORWALK AIR & GAS COMPRESSORS

Forty Years of High Quality Compressor Building

A Norwalk Compressor on Testing Stand



Every engineer knows that it is a simple matter to obtain one desirable result by sacrificing another. But only strict adherence to the highest ideals of designing and manufacturing can give uniform efficiency **at all points** in a mechanical product.

There is 40 years of such adherence to the best engineering principle behind the Norwalk line of air and gas compressors. Every Norwalk compressor—whether for air, oxygen, hydrogen, acetylene, or carbonic acid gas—is guaranteed for the capacity specified and is painstakingly tested before it leaves the factory.

Write for Bulletin on Norwalk compressors for air, oxygen, hydrogen, acetylene and carbonic acid gas.

The
Norwalk Iron Works
Company
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY CAPACITY ANY PRESSURE

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

ACIDS

The action of any acid is severe on gasket material. The service which DURABLA material has given on sulphuric acid lines, which is particularly severe, has proved to others that DURABLA is a standard for all acid work.

Use DURABLA on the next acid joint you make and it will prove its worth to you. It is guaranteed to make a tight joint at all temperatures and pressures.

DURABLA Gasket Material is also guaranteed for air, water, oil, steam, ammonia and gasoline.

One Standard Material for All Gasket Work. Sold on a Service Basis.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada:
The Canadian Fairbanks-Morse Company, Limited

DURABLA

STANDARD RETURN TUBULAR BOILER

Horizontal Tubular
Vertical Tubular
Locomotive Types

BOILERS

We have registered designs to conform with various provincial codes.

Our BOILERS Are Installed in the Largest Industrial Plants.

Write Us for Boiler Information and Prices.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Office: Hall Machinery Co., Sherbrooke, Que.

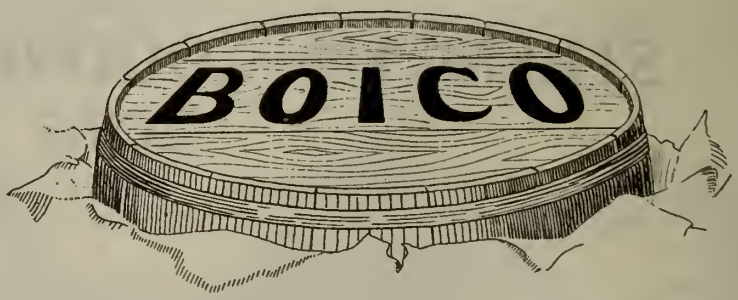
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

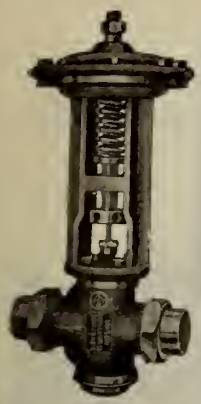
Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Ltd. 376 Dufferin Street Toronto

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec



Mason No. 55 Pump Pressure Regulator

Mason Standard Bronze Reducing Valve

The Age of Efficiency

You can't afford to take chances on your power house equipment. Nothing but the best should satisfy you. This is the age of efficiency and to meet competition you must be adequately equipped.

MASON

For Efficiency and Service

We are able to supply you with leading designs in Power House Specialties. We couple with this unequalled service a staff of competent engineers who help you to choose the equipment best suited to your purpose. They solve problems such as yours every day and their services are FREE.

Our salesmen, also, are practical engineers. They know the practical application of the lines they sell—they sell from knowledge, not from catalogue.

The Ashton Improved Single Spring Bourdon Steam and Pressure Guages

Full Details of MASON Equipment on request

The MASON Line

"Mason" Reducing Valves (genuine)
"Mason" Pump Governors.
"Mason" Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Coppus Turbine-driven Boiler Feed Pumps.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Feed Water Filters.

The Ashton Improved Lock-up Pop Safety Valve

Use Mason Service

The Mason Regulator & Engineering Co., Limited

Successor to H. L. PEILER & COMPANY

Toronto Representative:
The Arthur S. Leitch Co.
506 Kent Building

Montreal Office and Factory
135-153 Dagenais Street

Most Efficient Boiler Feeder

LUNKENHEIMER AUTOMATIC INJECTOR

Will deliver more water per pound of steam and the capacity is diminished in a lesser degree by long lifts and hot feed water than any other Injector made.

This is due to the scientific design of the tubes, which are proportioned for maximum delivery, and it maintains its maximum delivery in service, because the tubes are made of a special **hard bronze** which is peculiarly resistive to the inevitable and severe erosive action of the saturated flow at high velocity. Besides, the Lukenheimer design of "spill" eliminates the rapid wear of the combining tube.

The wide range of operation of the Lukenheimer Injector; its instantaneous restarting after a temporary interruption of either the steam or water supply; its durability and the interchangeability of parts, are details which merit the consideration of every user.

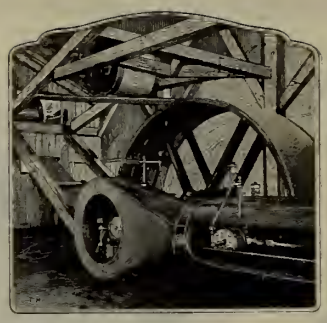
Write for descriptive Booklet No. 504DC—which contains valuable information on the care and operation of injectors.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World.

New York Chicago CINCINNATI Boston London

19-12-43



48" Heart 3-ply Belt, 86 feet long, installed in 1911 in the mill of the C. A. Smith Lumber Company, Baypoint, Cal. Driving Pulley, 14 feet. 101 R.P.M. Driven Pulley, 4 feet. Belt Speed, 4400 F.P.M. Theoretical horsepower, 600. Actual horsepower transmitted, 850 to 900. Cost of Belt, 1-5 of 1c per horsepower per week.

"WHERE LITTLE THINGS ARE BIG"

Think what this belt must do. Traveling at 4400 feet per minute, it makes its circuit fifty times every sixty seconds. For every one of these revolutions, each part of the belt must slacken and tighten itself, practically once a second. To be efficient, it must do this without loosening its grip on the pulleys, without jumping or slipping.
This 48" Heart Brand Belt is one of the Standardized Series—made according to the work to be done. It has been running over 8 years.

Write for "Standardized Leather Belting" Book.

THE GRATON & KNIGHT MFG. CO.
Worcester, Mass.
Oak Leather Tanners and Belt Makers.

Branches and Distributors in all principal cities.

Canadian Graton & Knight Ltd., 84 St. Antoine St. Montreal, P.Q., Canada

Graton & Knight
Standardized Series
Leather Belting
Tanned by us for belting use

Eight real advantages

in equipping water tube boilers, oil stills and superheaters with Key Boiler Equipment Company's

KEY SAFETY HAND-HOLE CAPS

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

No gaskets required. Over 1,500,000 now in service. Let us send you our descriptive literature.

Power Plant Equipment Co.
Canadian Selling Agents
310 Dominion Bank Bldg., Toronto, Can

Starrett Tools

Carry with them the assurance of accuracy. For almost 40 years the name Starrett has meant unvarying accuracy to the men who use precision tools.

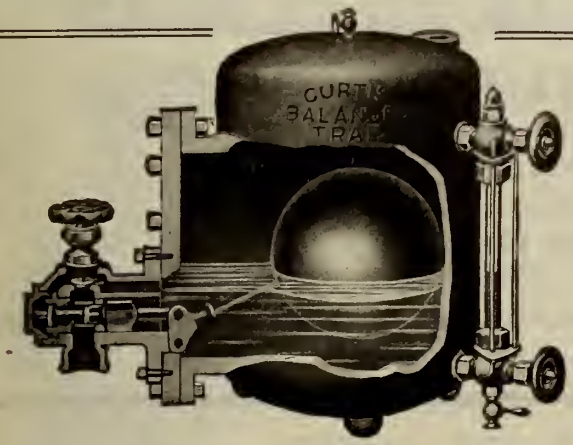
Catalog No 21CD, showing 2,100 kinds and sizes of fine precision tools, sent free upon request.

The L. S. Starrett Co., Athol, Mass.

The World's Greatest Toolmakers 42-935

Mnufacturers of Hack Saws Unexcelled

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

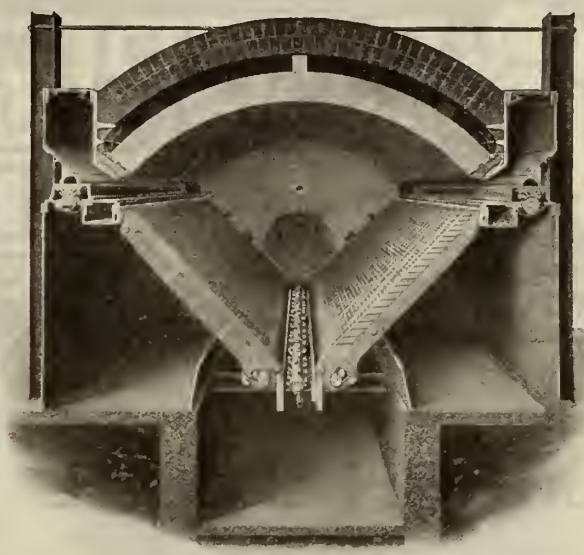
1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.



Cross Section Showing Furnace Construction

Burn Any Fuel

Coals that nobody wants are welcomed by the MURPHY FURNACE.

During past coal famines many a plant kept its equipment operating by burning such fuels as slack, lignite, sawdust or even refuse in

MURPHY AUTOMATIC FURNACES

While, of course, bituminous coal produces the most economical results, the MURPHY FURNACE, however, will burn such fuels efficiently enough to keep a plant operating during emergency.

The Murphy construction is such that it feeds the fire from two sides (not one) giving double the coking area. The coal is fed —the fires cleaned — the ash removed — continuously and automatically.

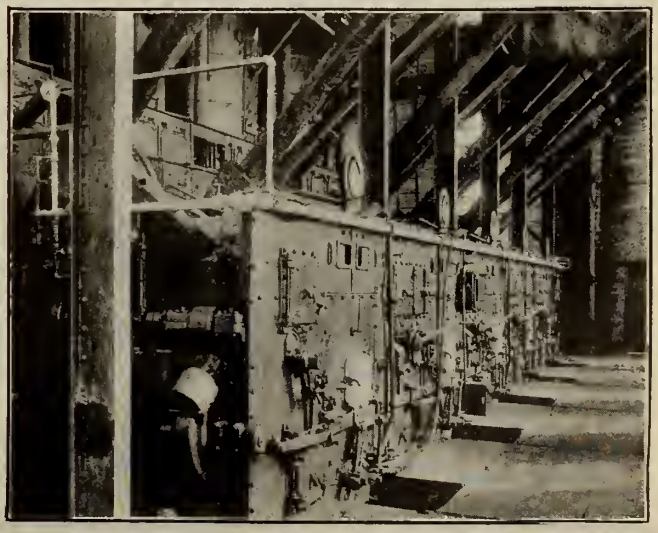
Couple Murphy ability to burn any kind of fuel with natural draft and you have a simple explanation of Murphy economy in hundreds—yes, thou ands—of plants.

You will be surprised to know how easy the MURPHY FURNACE can be installed under any type of boiler—50-H.P. and up.

Large Murphy Ca.alog HM-7 sent on request.

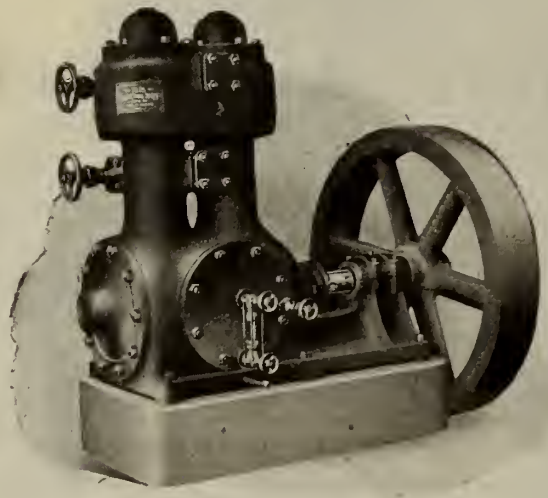
For information on RILEY UNDERFEED STOKERS for large boilers, see July 5 advertisement or send for Riley Stoker Catalog HR-7.

Murphy Iron Works, Detroit, Mich.



MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS



"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively

YORK, PA., U.S.A.

Canadian Representatives

Canadian Ice Machine Company

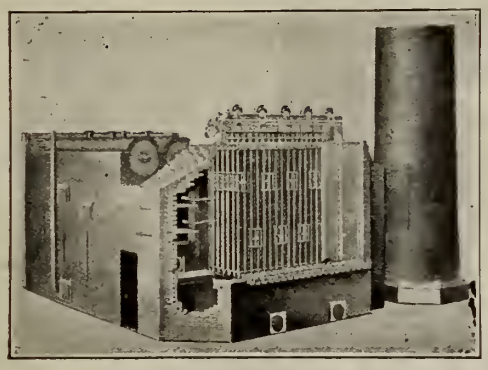
WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 324 Craig St. West | CALGARY 605 Second St

Efficiency

In Power Plant Equipment and Service—that's our Policy.

Study POWER HOUSE advertising and editorial pages—brimful of latest technical and new equipment information. Keep thoroughly up-to-date and you'll profit.

SPECIAL Send in **your** subscription to-day for any number of years at the remarkable rate of **$1.00 Per Year.**



Green's Fuel Economizer in Operation

GREEN'S ECONOMISERS

1. Utilize waste heat, thereby saving 10-25% of fuel.
2. Increase steaming capacity of boilers.
3. Provide large quantities of hot water at all times for all purposes.
4. Prolong life of boilers.

Does economy mean anything to you? If so, write

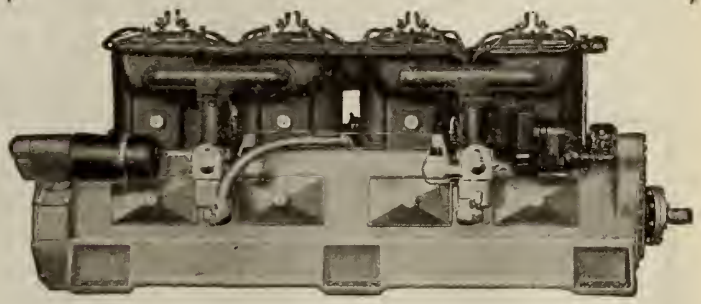
GREEN'S ECONOMISER, LIMITED.
TORONTO

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Pump Dealers!

Construction Engineers!

Sterling gasoline engines for emergency pump and generator drives, should be employed as standby plants for fire protection, etc., in every village, municipality or manufacturing plant. Send for catalog, become familiar with Sterling power and its possibilities, and add another source of profit to your business. The demand is just opening and Sterlings are the quality engine.



Model FC 8-cylinder, 200 H.P., at 1400 R.P.M. Sterling Commercial Engine.

Sterling Engine Company

Department C-4 - Buffalo, N.Y.

Complete line 10 to 300 H.P., 2, 4, 6 and 8 cylinder.

HEATING BY HOT WATER & HOT WATER SUPPLIES

HIGHEST EFFICIENCY GUARANTEED

Instantaneous Heater, with connections for Fresh and Salt Water and Steam

ROW'S PATENT CALORIFIERS are strongly recommended for heating water in bulk for supplying a number of Baths and Lavatories. Also for HEATING CIRCULATIONS for PUBLIC INSTITUTIONS, HOTELS, etc.

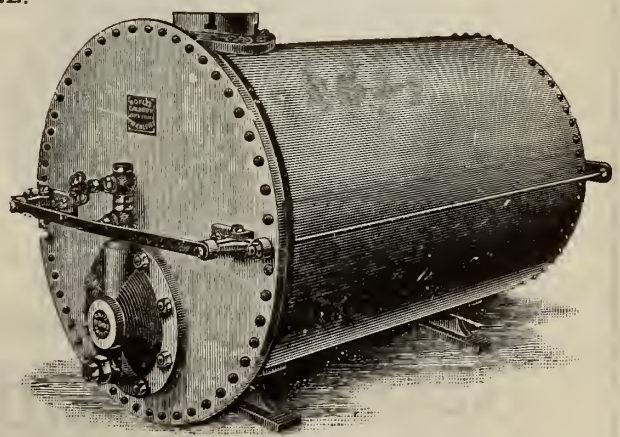
ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

ROW'S PATENT

CALORIFIERS
FEED WATER HEATERS
RADIATORS

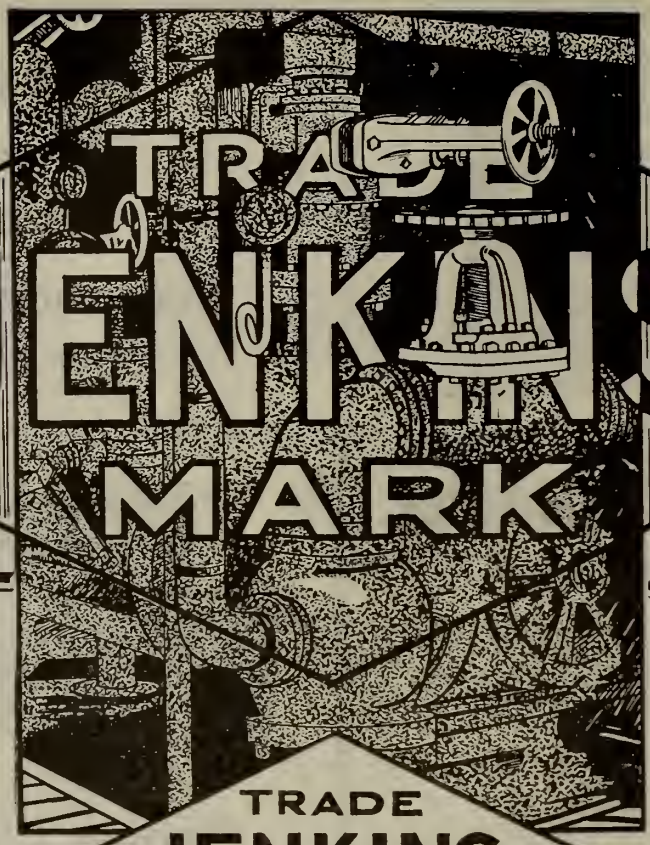
Suitable for Hot Water or High Pressure Steam

STEAM and GAS KETTLES
EVAPORATORS
CONDENSERS



ROW'S PATENT CALORIFIER. STORAGE PATTERN.

ROYLES LIMITED, ENGINEERS AND SPECIALISTS IRLAM, MANCHESTER ENGLAND



TRADE
JENKINS
MARK

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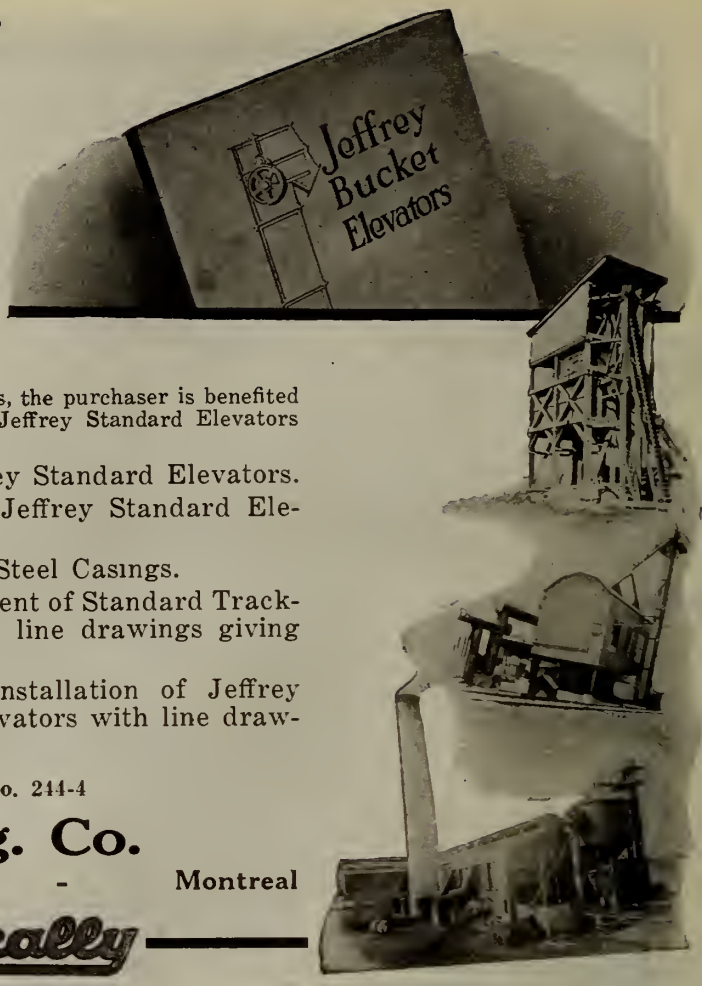

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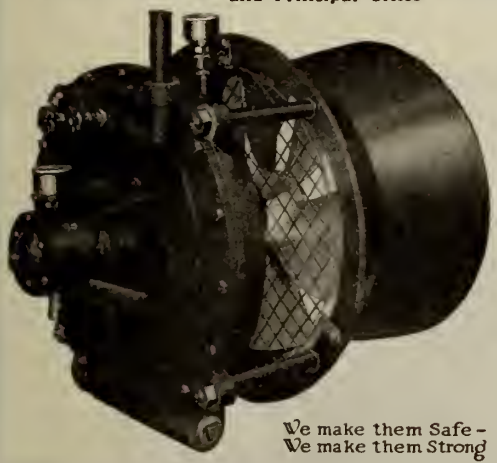

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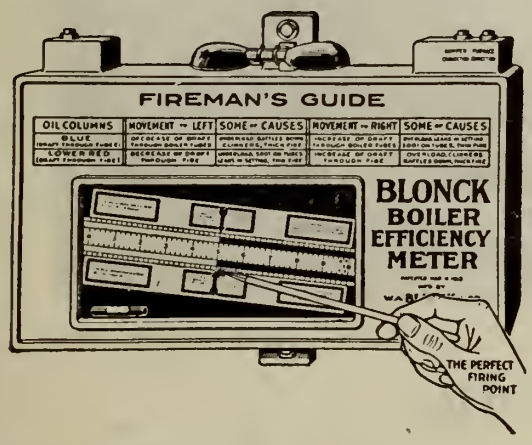

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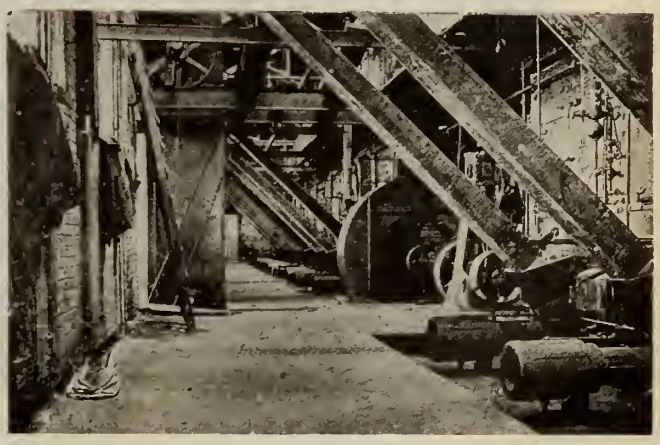

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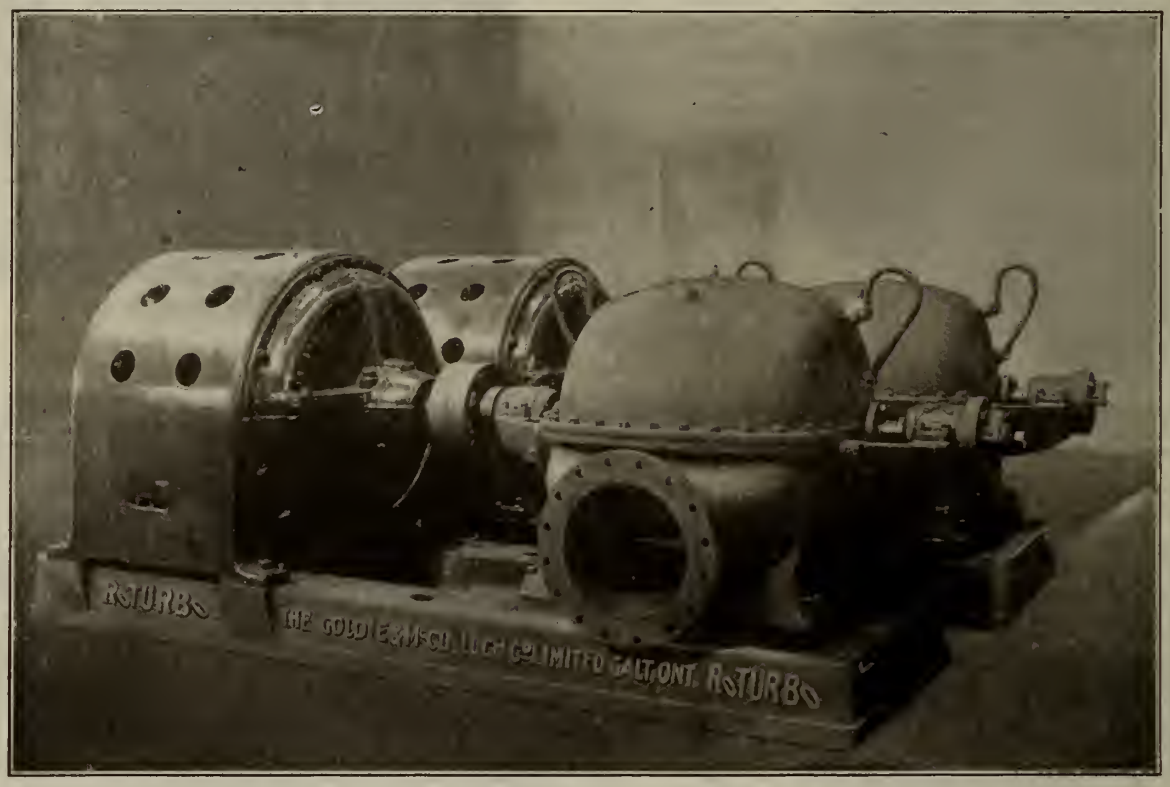

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Niagara Falls from an Historical Standpoint

It is Often of Interest to Look Back Over the History of Natural Wonders Useful to Man, and Niagara Falls is a Case in Point for Its Origin Dates Back to Comparatively Recent Times

By J. F. HEFFRON

TO engineers, many of whom have written of the great cataract, Niagara is generally regarded as a gigantic piece of machinery, the greater part of whose energy is accomplishing nothing but the pounding out of its own life on the rocks which form its bed.

Since the Horseshoe Falls, half a mile long and 155 feet high, together with the American Fall, 1,400 feet long and 162 feet high, discharge 222,000 cubic feet of water per second at mean water level, equal to about four million horsepower, of which less than 500,000 horsepower has been actually developed, engineers have not exaggerated the wastage which occurs. There are others though, among men who have been moved to view the great cataract from another angle, and it is with this view we propose first to deal.

BIRD'S-EYE VIEW OF NIAGARA FALLS AND VICINITY.

Perhaps the most interesting part of the study of Niagara's geological and physical history is the record of the attempts that have been made to determine its age. To the scientist, geologic time presents one of the most difficult problems with which he has to deal. When the various periods into which he divides the history of our globe are numbered by hundreds of thousands, and millions of years, the human mind is appalled at the prospect, and when the calculations of different geologists regarding the age of the cataract vary by thousands of years, the lay mind cannot help becoming somewhat credulous, and at times be tempted to discard the whole mass of scientific data relating to the subject.

Man, however, actuated no doubt by his inveterate egotism, is prone to measure all things in relation to, and by comparison with himself and with his short span of existence. Because of this fault he looks naturally upon the great wonders of the world as destined to last as long as the earth itself. He fails to realize, for instance, that our hills and mountains are slowly crumbling before our eyes, or that our rivers are slowly but surely carrying the matter forming these prominences on the earth's surface toward the sea, filling the lakes and lower portions of the land along their courses. These slow, almost imperceptible, but ceaseless forces are ever at work reducing the earth's surface to that of a level plain, and at the same time depriving the land of its lakes by filling their depressions with silt. The winds and the waters, together with the wearing power effected by frost, constitute the forces struggling with this gigantic task.

Let us observe also, that the calculation of the life of Niagara is interesting in itself even if we overlook any other great questions that can be settled by the solution of the problem of its age, such as the probable number of years that the river shall exist in its present form, the many centuries that have elapsed since the ice retreated from this region, and certain facts concerning the antiquity of man on this part of the earth's surface. In order to make a proper study of the problem regarding Niagara's probable age, we must review carefully the conditions that existed at the time a great ice sheet covered this district, and also the changes which were undoubtedly effected in the contour of the earth's surface in this district during the northern retreat of the great glacier that one time covered it.

The Niagara River

It was undoubtedly during that period in the history of our planet known as the last glacial epoch that the greater part of the present Niagara River was formed, but the conditions of the glacier epoch were so abnormal that they have long made it difficult for the geologist to substantiate a vast number of inferences drawn from present conditions concerning this prehistoric time.

The Niagara River, nevertheless, forms perhaps the best means in the world for determining the lapse of time since the last "ice age." The best material in existence is found here for this study and has led to exhaustive scientific analysis of every clue presented by the cataract and the massive gorge it has cut through the limestone and Niagara shale forming it bed.

If we observe a relief map of the Niagara district it shows at once that the formative forces which gave to it its present characteristics were at the highest stage of their development when the lands to the south had almost reached their present stage, and that the Niagara district is therefore a comparatively new region. The wonderful work of the great cataract itself is going on before our very eyes, and the history of this great river is now working itself out at the height of its glory, in our age, when all can behold. It is especially interesting since it is the only example of the kind known.

Time was, before the excavation of the present gorge had begun, when the water flowed along the top of the plateau extending from Lake Erie to Lewiston, where the Falls were then situated at the latter point.

In remote times the waters of Lake Erie did not find an outlet through Niagara River, so there was no channel ready made for the river when it began its present course. Even after the birth of the river the upper lakes, Superior, Michigan, and Huron, did not discharge their waters through Niagara, and as it is only in comparatively recent times that the waters from Lake Erie discharge through this channel, but a small fraction of the present volume could have been at work on the Fall for some time. The most prominent features of the present river are therefore modern, and hence have been very little affected

by those agencies which are continually remoulding the contours of all land surfaces. The inclination of the river's bed has undoubtedly varied greatly with the ages. This has been due to a gradual uplifting or depressing of the earth's crust, and there seems to be abundant evidence that great changes of land level occurred in the northern hemisphere, first in its depression during the glacial period and again in its re-elevation after its close. Dr. G. Frederick Wright, F.G.S.A., assures us that this post-glacial depression amounted to six hundred feet at Montreal and over a thousand feet in the more northern latitudes of North America, this condition applying also in corresponding latitudes in Northern Europe. There is, also, he tells us, distinct evidence of a depression in Central Asia amounting to seven hundred feet, and considerable evidence of its extension to two thousand feet. The floods connected with the final melting of the ice were enormous in amount and incalculable in their destructive effects on the animal life of that time.

During that period of glacial floods it is estimated that the Missouri River was compelled to handle, during the summer months, twenty-five times its present volume of water, resulting in floods over two hundred feet in height, while the Mississippi River was compelled, at the same time, to dispose of some sixty times its present volume; consequently the current of the Niagara River has varied greatly in velocity with these changes of elevation and depression of the land surface. A calculation therefore, of the work done by the river during each epoch of its history is surrounded by many difficulties. Continued investigation has been made along this line which now seems to have resulted in a rather satisfactory measure of success.

The Niagara River, as we will observe by looking at a map of the region, has its origin in the eastern end of Lake Erie, at a point which is about three hundred feet higher than the surface of Lake Ontario. From Erie to Ontario the descent is not gradual, although after leaving Lake Erie the river's waters meet no obstructions until the head of Goat Island is reached. The river has no valley and the country is so nearly level that its waters present more the appearance of an arm of the lake extending over this region than they do a flowing river. The earth's surface in this district presents a gently rolling plain with almost no slope for nineteen miles until the shore of Lake Ontario is nearly reached. At this point, just above the towns of Lewiston and Queenston, we find ourselves looking over a high precipice affording a magnificent view of the lower lake (Ontario). This cliff is known to geologists as the Niagara escarpment. By the descent of the rapids above the Falls and the Falls itself, the waters take a drop of two hundred feet, and thence rush through the deep gorge at a rapid rate, continually descending lower through the whirlpool and on to Queenston, seven miles distant, at which point the current becomes more moderate as the level of Lake Ontario is reached.

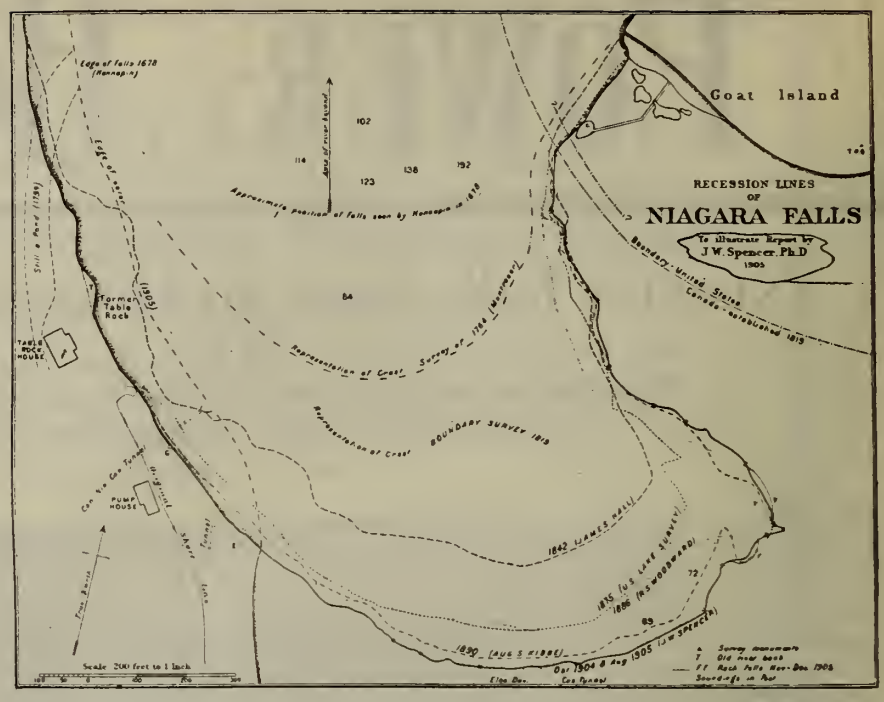


FIG. 1—CHART SHOWING THE RECESSION OF NIAGARA FALLS AT THE END OF DIFFERENT PERIODS OF TIME.

The deep, narrow gorge extending from the Falls to Lewiston is of special interest to the geologist. This canyon is scarcely a quarter of a mile wide and varies little in distance from cliff to cliff throughout the greater part of its course. The walls are so precipitous that they offer few opportunities for foothold, and in height from the bottom of the river vary from two hundred to five hundred feet. If we observe both sides of the gorge we find the same order in the layers of rock and shale on comparatively the same level, with the same thickness of each corresponding stratum. Observing these features we cannot help but conclude that this immense cleft has been worn out by the force of the water from a structure whose features were one time continuous, as is made manifest by the similarity of the exposed strata on both sides of the stream.

To be convinced of the fact that the Falls themselves are gradually receding, it is only necessary that we refer to the various surveys which have been made at different times (see Fig. 2), or we can by observing them closely, witness with our own eyes masses of rock which have broken away and lie in huge broken masses at the foot of the Falls.

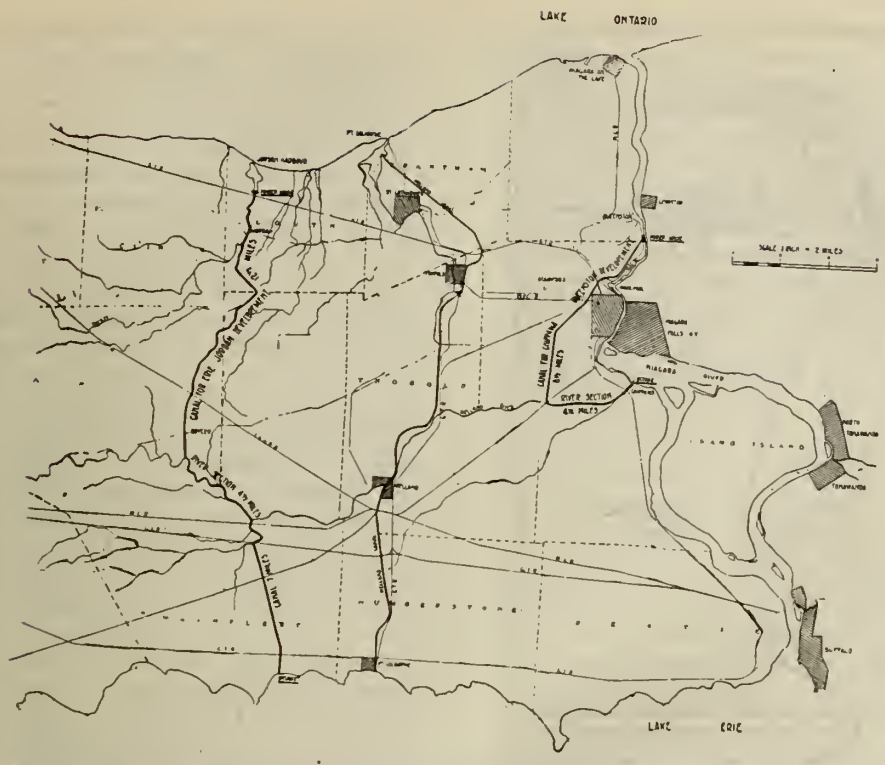
Rate of Recession

Between 1890 and 1905, the Canadian or Horseshoe Falls, according to exhaustive investigations made on this subject by J. W. Spencer for the Canadian Government, have indicated that a mean annual recession of 2.2 feet has occurred during this period, while the recession of the American Falls has been found to be less than 0.60th of a foot per annum.

If we observe closely the violent whirling of the water as it strikes the rocks below the falls and recoils most powerfully against the shale forming the greater part of the surface of the cliff, we see how the soft shale beneath the harder stratum of limestone rock is worn away until the harder surface rock forming an overhanging ledge is broken off by the weight of the water and falling, is in its turn crumbled by the constant action of the falling water and shale until it also is carried away down the river. This is illustrated by Fig. 3.

All this establishes the fact that the gorge is growing longer from its northern end through the agency of the waterfall. We see, therefore, that the river has a big task before it and that its work is only partly accomplished. Two thoughts spring into our minds instantly: When this work is completed, what will be the result, and what did it do before its present work had begun? It is apparent at once that waters of Lake Erie could never have flowed to Lake Ontario without wearing the Gorge as we now see it. The birth of the river and the wearing away of the canyon must, therefore, have been simultaneous

Upon observing a map of the continent of North America, it is noticed that a great difference exists in the appearance of the land surface of the northern and southern sections. From the region of the Great Lakes northward, the district is one continuation of irregular indentations filled with water, forming many lakes and swampy regions. The northern rivers are also filled with many rapids and waterfalls containing undreamed-of potentialities for the generation of hydro-electric power, while south of the Ohio river there are but few lakes and the rivers flow through almost unbroken courses. To the geologist this difference of the earth's surface in-



MAP SHOWING VARIOUS CANALS PROPOSED FOR THE NIAGARA PENINSULA. THAT TO THE LEFT IS THE PROPOSED JORDAN DEVELOPMENT ABANDONED IN FAVOR OF THE CHIPPEWA SCHEME SEEN ON THE RIGHT. THE MIDDLE CANAL IS THE NEW WELLAND NOW UNDER CONSTRUCTION.

dicates that the southern region is much older than that to the north; its waters have had greater periods of time in which to mould down elevations and fill up depressions. This difference in the characteristics of the streams of the north and those of the south is explained by the great ice age.

The Glacial Epoch

There probably was little difference in relief forms between the two sections of the continent before the incroachment of the ice, but during the glacial epoch the whole northern part of the continent was covered with a massive sheet of ice. The ice sheet was continually renewed at the north, and as continually drifted in a southerly direction. As this enormous ice cap passed over the earth's surface it acted somewhat like a river in its erosive power, only working for greater changes in much less time, the whole configuration of the country being thus recast.

Many old valleys were obliterated, while a number of new ones were carved out. A change of climate, which astronomers explain by a gradual change in the earth's inclination to the sun, but which we have not the space at our disposal to describe, occurred, causing the ice to retreat northward as its southern edge melted, and so the new depressions were filled with water, which formed new lakes and rivers, and with the ending of the ice age the history of the Niagara River began.

If we look closely at the map again, we see that a low range of hills form a water-shed between the Great Lakes and the streams flowing to the south.

When the southern terminal of the ice had retreated to the north of this divide but still blocked all outlet to the north or east, there probably were a number of lakes here discharging their waters across the present low watershed to the south . Some of these ancient valleys can still be traced for long distances of their course. These lakes passed through varying changes as have those of the present day, and their waters have left indelible carvings on land surfaces which then formed their shores.

The ice continued its retreat, and we next notice the greatest change in elevation of the surface of the water. The ice finally passed to the north of the present Mohawk River, thus permitting the waters to escape by that outlet, which resulted in a lowering of the surface of the lakes over five hundred feet. Then the Niagara began to flow and its falls commenced their gigantic task.

The ice barrier waters of the lower lakes (Ontario) were as yet discharged near Rome, New York, but finally the encroaching warmth of the south removed the ice barrier which blocked the regions north of the Adirondack Mountains, and the water began flowing by the St. Lawrence course. These variations had a great effect on the work of the Niagara River. When the Niagara River commenced to flow, its terminal, instead of being seven miles from the escarpment, was only about two miles away, and the surface of the lake was about seventy-five feet higher than at present. While the Rome outlet remained the same, the eastern end of the lake was continually rising, thus causing the waters at the western end to rise over one hundred feet. The shore of Lake Ontario was thus placed almost at the foot of the cliff at Queenston. It occupied this position for a considerable period, but finally the waters again fell over two hundred feet, carving another shore line now submerged beneath the waters of Ontario. After this, various changes in the level of the land and shifting of the ice barrier caused numerous old shore lines to be faintly carved. Changes of this nature continued until the present outlet was established and the waters began their flow along the present course of the St. Lawrence.

Let us turn once more to the gorge of the river itself. The similarity of the structure of its two sides has been noted. This similarity is continuous throughout its length except at a point about half-way between Lewiston and the Falls, where the river makes a turn in its course of almost ninety degrees. This point is known as the Whirlpool. On the outside of this angle appears the only place in the entire course where the material of the cliff changes. We find here a break in the solid rock of the bank, filled with loose rock and gravel. This rift is of pre-glacial origin, for it is filled with the same material, the glacial drift covering the whole region. A few miles west of Queenston on the Ontario shore we find a broad gap in the otherwise unbroken wall. This gap is also filled with glacial drift. This buried St. David's Valley has, by sinking well along its course, been traced back to the Whirlpool, and undoubtedly formed the course of some pre-glacial stream.

Later this interpretation was destined to furnish further explanations, for the question at once arose, how far and where did the upper course of this ancient valley extend? If it had cut across the course of the modern river there would have been a break in the continuity of the cliff somewhere on the opposite side of the Gorge; this break, however, was nowhere to be found. The conclusion was therefore reached that the upper course of this ancient channel must have coincided with that of the present channel.

Therefore, when the Falls had receded from Queenston by its present course to the side of the present Whirlpool it reached a point where the greater part of its work had been performed. From here, to whatever distance the upper course of the ancient river extended, the only work it had to do was to remove the loose gravel and boulders with which the glacier had filled its ancient channel. Of course this was effected far more rapidly than the wearing away of the hard limestone bed.

As to just what was the depth and the extent of this old deserted valley, it is of course almost impossible to estimate.

Estimates of Age of Niagara

Thus, the calculations of the age of the Niagara River, made by Andrew Ellicott in 1790 as 55,000 years, by Bakewell as 12,000 years, and by Sir Charles Lyell as 36,000 years, which estimates of the age of the Falls were arrived at by dividing the length of the Gorge by

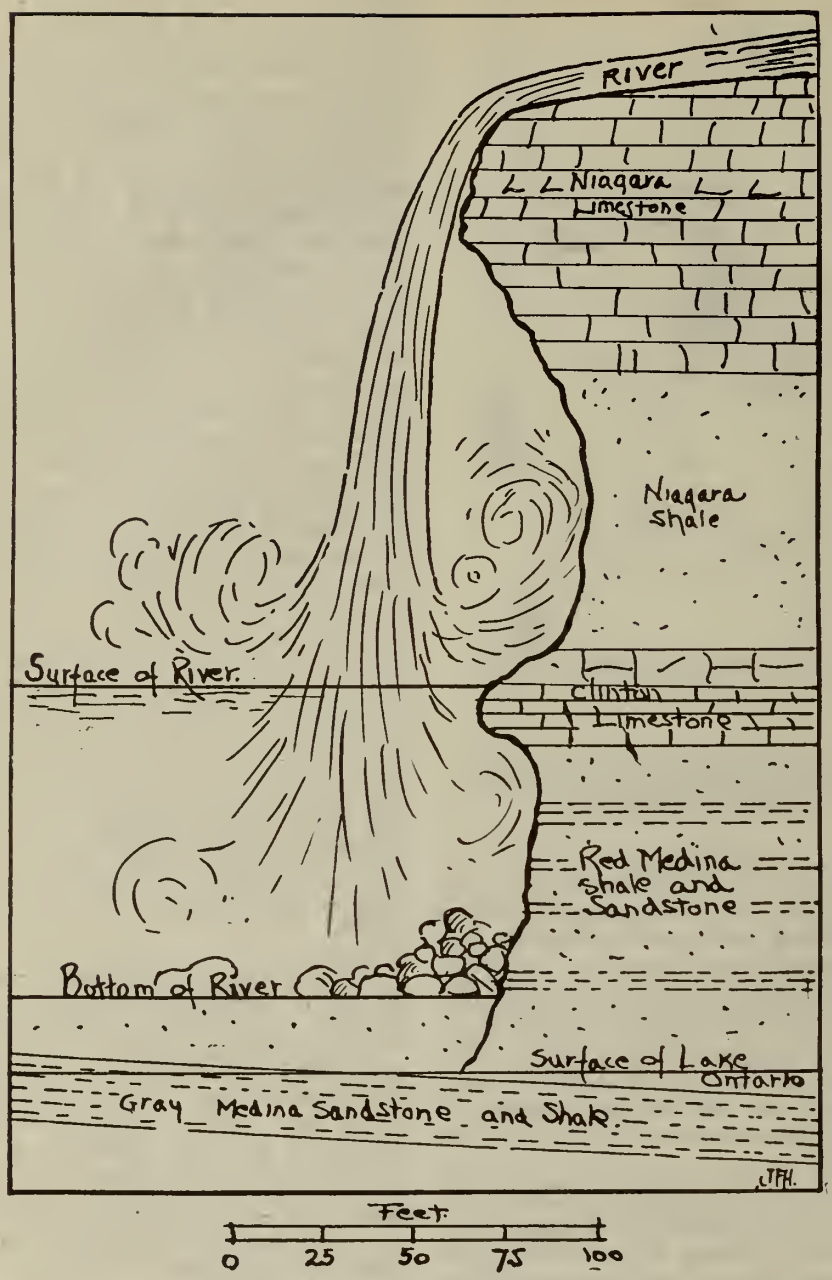


FIG. 3—CROSS-SECTION THROUGH FALLS.

the supposed rate of recession per annum involved certain errors in the rate of movement of the Falls, besides making no allowance for the variations introduced by the discovery of the buried St. David's Channel.

In 1842 Professor James Hall made a survey of the Horseshoe Falls under the authority of the New York Geological Survey. This survey plotted the position of the crest of the Falls and established monuments at the points at which the angles were taken, thus leaving lasting marks of reference to which any future survey might refer. J. W. Spencer, before mentioned, after making a thorough study of the history of the river, revealed in its markings, and also of the lakes, after making allowance for all known variable factors, calculated the duration of each epoch separately and found the age of the river to be about 32,000 years.

Dr. Frederick Wright later on hit upon an entirely different means of calculation, one which seems to be much more free from unknown factors and based upon the rate of enlargement of the mouth of the river at the Niagara escarpment where the Falls first began their existence (Dr. Wright's observations may be read in detail in Archer Butler Hulbert's fine work, "Niagara River"). The cliffs at the mouth of the Gorge, as is the case with the newer portions of the river and characteristic of all canyons when first formed, were undoubtedly almost perpendicular when they were first cut by Niagara's rushing waters. The mouth of the Gorge at Lewiston is of course the oldest part of the modern river, and were it possible to measure the age of this part this would surely give the date of the birth of Niagara.

Just as soon as the Falls commenced their work at Lewiston the waters began the cutting of the Gorge; at the same time as the formation of a gorge began there was set to work upon it walls the disintegrating agencies of the atmosphere, free from indeterminate variables tending to pull down the cliffs up each side of the stream. This work has continued year after year and century after century without being affected by the volume of the river's waters or the shifting in the elevation of the land. This work of the atmospheric agencies in enlarging the mouth of the Gorge has had the effect of changing its shape from that of a rectangle, with perpendicular sides of 340 feet, to a figure with a level base formed by the river, whose sides slope off at the same angle on each side. Were it possible to measure the rate at which this enlargement is taking place the problem of determining the age of the river would be a far more simple one.

Dr. Wright's calculations were taken along the line of the railroad which has been constructed along the eastern cliff. For a distance of about two miles the course of the road runs diagonally down the face of the cliff, descending in that distance some two hundred feet and laying bare in its descent the layers of shale upon which the observations must be made. Along the course of the road at this point, watchmen are continually employed to remove obstructions which have fallen and to give warning of danger when any large masses fall. The disintegration goes on much more rapidly in wet thawing weather than at other times of the year.

Dr. Wright estimates that at the rate of one-fourth of an inch a year of waste along this cliff, taking into consideration its area, there ought to fall slightly over six hundred cubic yards of earth and stone annually for each mile where the wall is 150 feet high. At this rate of enlargement, which is a very conservative one, Dr. Wright estimates that such enlargement would take place in somewhat less than ten thousand years.

The estimate of the annual fall was made from the railroad records showing the cost of removal of the falling matter, together with the observations of the watchmen, one of whom had been watchman at this point for twelve years, and also by measuring the distance to which the cliff has receded since the construction of the road.

Several variables, however, still enter into these calculations, one of them being that when the railroad was built, a fresh section of the shale was presented for the atmospheric agencies to work upon, yet making all due allowances the rate of disintegration at the mouth of the Gorge could not have been much less than that assumed above. From observations made, if the calculations be true, this new line of evidence places the birth of the Niagara and the beginning of the cutting of the George at Lewiston about ten thousand years ago, in fact, the glacial epoch, affirms Dr. Wright, continued down to historical times. The evidence, he believes, is such as should convince anyone who candidly considers all the facts, that glacial ice did not retreat from southern Sweden until seven thousand years ago. Nor did it retreat

from central New York and northern Minnesota at a much earlier date. Even at late as the present day it is still retreating at a rapid rate in Alaska, the Muir Glacier having retired on the average of seven miles and half in the last twenty-five years, and nearly all the other glaciers have retreated proportionately. It would therefore appear that when the civilization of Egypt, Babylonia and Central Asia was at its height, the most populous and progressive present centres of civilization were hidden beneath a tremendous glacial covering.

In concluding our geological observations, let us consider the proximate future of Niagara. The measurements obtained by various authorities concerning the recession of Niagara Falls indicate that there has been some reduction in the rate of recession during the last twenty years. The discharge of the river has been reduced to some extent artificially. The diversion of water for power purposes shows that a pronounced lowering of the upper rapids has taken place and a reduction of flow has been caused to a small extent by meteorological conditions. If the diversion of water for power purposes goes on, as it undoubtedly will, even though this diversion is at present limited by international treaty, generations hence may know of the grandeur of the Falls as a matter of history only. This result, however, may be overcome by the suggestion that the water be turned on for a brief period daily and run through turbines the rest of the time.

It has now been estimated that over 3,000,000 horsepower of energy is flowing to waste at Niagara, a writer in "Engineering and Contracting" (Chicago), whom we cannot help concluding is possessed of a somewhat Shavian humor, estimates that Niagara Falls power is worth to society $50 per horsepower per annum. As about 1,000,000 people view this great "natural moving picture" annually, it follows that each observer is indebted to society for $150 every time he visits the Falls. This writer suggests, therefore, that this great waste be avoided by arranging that for one hour each day the entire volume of water be allowed to flow over the great brink, and for the remaining twenty-three hours the water be run through shafts and tunnels upon turbines. This, he points out, would lower the cost of a look at the Falls down to about $7—the price of three theatre tickets, instead of the price of six suits of clothes.

A further suggestion regarding the recession of the Falls has been made by an eminent engineer who, presuming that the present rate of recession may continue indefinitely, has pointed out that as the Gorge recedes it will drain, as it has hitherto done, the banks to the right and left of it. This will, of course, eventually drain entirely the American branch of the river, the present channel of which will in time become cultivable land, while the American Falls will be transformed into a dry precipice that will then form but a simple continuation of the cliff boundary of Niagara Gorge. The draining of the present banks of the river, coupled with the recession of the Falls will, of course, seriously affect the present power companies' intakes located at various points along the river. The engineer referred to, therefore, suggests that, in order to prevent this taking place, an excavation be made beneath the river's bottom from either bank at a point some distance back from the present brink of the Falls. If this excavation, made to a depth equal to the bottom of the lower river and nearly to the surface of the upper river, be filled with concrete, it will form an effective artificial barrier against any further recession of the Falls when the recession now going on reaches it.

The Latest Niagara Projects

Canada, with her characteristic energy, is starting upon a great enterprise in order that she may, in addition to the power already developed, produce 300,000 additional hydro-electric horsepower from the Niagara River. In order to secure this vast amount of energy she proposes to secure an entirely new effective head of 305 feet (instead of about one-half of this amount as in the cast of the power plants located at the Falls), by constructing this new power plant at Queenston on practically a level with Lake Ontario.

In addition to this project a still larger proposal has been made by the United States. This covers the construction of a combined ship, sanitation, and power canal from Lake Erie to Lake Ontario. Its length would be roughly 40 miles, its depth 30 feet, with a fall of 327 feet. It would be capable of transporting the largest vessels and barges from lake to lake, and it would also divert the sewage of Lackawanna, Buffalo. Tonawanda, and other cities from Lake Erie and the Niagara River, and after purifying it would discharge the waters into Lake Ontario. These waters would also be used to develop 800,000 hydro-electric horsepower. If this splendid project be carried out, it may be expected that the Niagara district, in possession of the cheap power that will be thus made available, will become perhaps the greatest manufacturing centre on the face of the globe. The tremendously beneficial results that will accrue to Canada as a result of this achievement of modern engineering, are scarcely realizable, but doubtless the comparatively near future will find them an accomplished fact.

Those of us, therefore, who have stood in awestruck silence before Niagara's majestic moving flood formed by an accumulation of waters drawn from almost half a continent, may soon recall only in memory the effect of permanence that this mighty fall of water, reborn as it dies, brings to us as we thrill with admiration and delight upon its towering brink.

The passing of Niagara will perhaps also recall to the minds of those who know it best the gradual disappearance also of an inscription to be seen engraven on a rock, but now almost obliterated by the action of the elements, on Luna Island:

"All is change
Eternal progress
No death!"

The author of the sentiment is unknown, but no one has ever more truly voiced the spirit of the great cataract.

FURNACE COLLAPSE DUE TO EXCESSIVE DENSITY OF WATER

Recently an inspector was sent for to report on a severely collapsed furnace. He found no signs of shortness of water, nor of grease, nor a scale, in the boiler. Within a day or two the same firm telephoned that the furnaces of the other boiler had collapsed. We thereupon asked them to draw off some of the water before emptying the boiler, and our chemist visited the works in the hope that he might find the reason for these mishaps. He too could detect no apparent cause for the collapse, but when he asked for the bucket of boiler water of which he wished to bring back a sample, it was found to be almost a solid mass of crystals which, on being analyzed, proved to be sulphate of soda (Glauber salts). It thus appears that the boiler had been working not with water but with melted Glauber salts. This is the well-known salt with which the beautiful experiment on supersaturation is generally carried out.

Comparing this collapse with collapses due to common salt in solution it is quite evident that boiler water may without danger be allowed to contain a much larger percentage of sulphate of soda than of common salt, for, judging by a well-authenticated case of a new boiler of 200 lbs. pressure, collapse took place when the percentage of salt in the boiler water reached 8 per cent. In the present case the percentage of the anhydrous sulphate of soda must have been about 30. No reliable information was obtainable as to whether the steam produced from the melted sulphate of soda was superheated as it ought to have been. The only available information is that the piston rods were frequently covered with salt. —C. E. Stromeyer in Report for Manchester Steam Users' Association.

Belts form a very important part of the equipment of factories—a part of equipment that is habitually used, however, in most inefficient and wasteful manner. There are exceptions, notably in connection with the more modern machinery. But many belts are running at an average speed of nearer 1,000 than 4,000 or 4,500 feet a minute. As a result six-inch belts are used where one-and-a-half or two-inch belts would be not only much cheaper in first cost but also much better. Bearing pressures are materially lessened, while friction and the accompanying wear and power consumption are reduced. This tends to conserve leather, fuel and oil, and lower repair expense.

Water Softening and Purifying Processes

It is Much Better to Keep Scale Forming Materials Out of the Boiler Than to Use It as a Medium for Carrying on Chemical Reactions. The Following Article Deals With Some of the Purifying Processes Used

By C. E. STROMEYER

THE Permutit process is based on a selective action possessed to a small degree by all chemical compounds, and which is very strongly marked in a few. In them chemical changes are affected by the relative solubilities of these chemicals. A few natural minerals of this class are known as zeolites, and are similar to the artificial permutit, which has the following composition: 2 SiO_2 (Silicic acid), Al_3O_6 (ammonia), a loosely-held base and 6 molecules of water. Let it be assumed that the loose base is soda, sodium oxide, then, if a solution of a calcium salt, for instance bi-carbonate of lime, be passed through the permutit, the sodium oxide is exchanged for the calcium oxide, the former combining with the carbonic acid to form bi-carbonate of soda. If now we pass a solution of common salt (chlorine of sodium, NaCl) through the changed permutit it parts with its calcium, and again takes up sodium. But this second reaction takes place the more readily the greater the relative strength of the dissolved sodium salt to the dissolved calcium salt. This means, that whereas sodium permutit will extract all the calcium out of a solution with which it is brought in contact, calcium permutit will not act in the reverse sense and extract all soda from its solution, unless the solution is practically free from calcium salts. This means that the salt solution with which the permutit is regenerated ought to be as pure as possible. Thus, for instance, the output of a permutit softener is nearly doubled by using pure salt instead of rock salt, or natural brine.

The softening procedure therefore consist in passing the hard (lime) water through the permutit whereby all the hardness is readily removed, and then indulging in a regenerating process by passing an excess of a solution of common salt through the permutit. It is, therefore, evident that more salt must be used than the equivalent of the lime contained in the untreated water. It also follows that the treated water will contain an equivalent amount of sodium bi-carbonate or sulphate, as the case may be, for the amount of lime removed. This process, therefore, although it removes all the lime, can therefore produce a water which is perfectly soft and suitable for almost any washing and dyeing process, yet it adds soluble salts, which, if the untreated water was very impure, would soon accumulate in the boiler and necessitate blowing down at certain intervals.

A very serious objection to the adoption of this process is the expense of working it, for every ton of lime to be removed requires two tons of common salt. The process is therefore sometimes modified in practice by firstly reducing the hardness of the natural water to a few degress by the ordinary lime and carbonate of soda process, and then treating it with permutit. About 5 per cent. of permutit is lost per annum, due to the purifying and regenerating operations. The speed with which the feed water is passed through permutit should not exceed 12 ft. to 15 ft. per hour. This speed fixes the diameters of the permutit tanks.

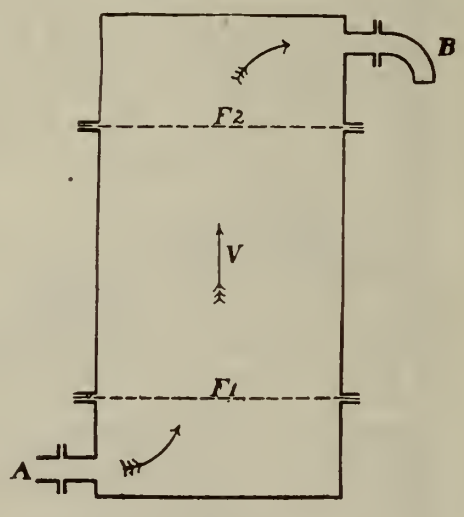


FIG. 1.

The Chemical Process of Water Softening

Before discussing the principles of sedimentation and filtration it will be well to deal with the incompleteness of chemical reactions, more particularly as this subject is related to the chemical action of permutit.

It is well known that if a carbonate of soda solution be brought into contact with sulphate of lime, an exchange of acids takes place, the carbonic acid of the soda passing to the lime salt and its sulphuric acid passing to the soda. But the process is not a perfect one, a trace of sulphate of lime remaining in solution even when there is an excess of carbonate of soda. This and many similar incompletenesses of chemical reactions are well known to chemists, and their laws have been formulated, but there is great uncertainty as to the relative affinities.

In order, however, to obtain some information as to the limits to which water softening processes can be carried, the two following experiments were made:

First experiment.—Assume that a softening reaction has been carried out, that sulphate of lime (permanent hardness) has been converted into carbonate of lime (temporary hardness), and that all the carbonate of soda used in this imaginary softening reaction has been converted into sulphate of soda. Chemically pure carbonate of lime emulsion and sulphate of soda solution were now tested for alkalinity and mixed together, when it was found that the alkalinity of the mixture had increased by an amount which corresponded to a reversal of the imaginary softening process to the extent of 2.43° of hardness. This then seems to be approximately the limit to which the softening of permanent hardness can be carried, though it will be materially affected by any other salts which may be present in the treated waters.

In the second experiment carbonate of lime and sulphate of magnesia solutions were mixed, and again a slight reversal of the chemical reaction took place corresponding to 3.26° of hardness.

In addition there is the slight solubility of carbonate of lime which at ordinary temperatures is equal to about 2.4° of hardness, but this is easily exceeded if carbonic acid has access to the water.

Thus these experiments seem to indicate that the ordinary softening processes cannot reduce the real hardness below 2.4°. These laboratory experiments are in agreement with practical experiences, it being found impossible to remove all hardness by the ordinary softening reactions. "Hardness" here means actual contents of lime and magnesia salts.

The time factor also plays an important part in water purification. Thus assuming that the impure water and the chemicals are merely turned into a channel which conducts them into a tank, it is quite conceivable that the desired intimate mixing does not take place, and if the reaction tank be small, some portions of the two fluids will not have met at all, a certain amount of hardness will remain in the water, and the process will only be completed in the boiler, where long-continued intimate mixing takes place, instead of in the water purifier. Possibly the reaction tanks might become more effective if the two fluids were to be thoroughly mixed the moment they are brought together. Very effective mixing is effected in some

chemical processes by passing the two fluids through a channel shaped like Row's tube, i.e., a tube flattened at successive points, intermediate flats being at right angles to the two adjoining ones.

However, even when perfect mixing has been effected between two fluids, chemical reaction requires a certain amount of time before it is completed, and much research work is now being devoted to the subject, though numerical results are scarce as yet.

One of the best illustrations of the slowness of chemical reaction is afforded by the developing process of photographic plates, which extends according to circumstances over one to 10 minutes. The chemical process of water softening is much slower than this one, but, like it, it can be accelerated both by heat and by agitation.

The Archbutt-Deeley process takes these factors into account, for the water and chemicals are both heated and agitated while the chemical process lasts. This process also takes account of the fact that the conditions which are favorable to the chemical reaction, especially agitation, are unfavorable to the settlement of the sediments, and in this process the chemical reaction and the settlement are separated by a time interval. In nearly all other processes the desire to save space had led to merging the chemical and the settlement conditions, and although the results are in many cases favorable, the margin between success and failure seems to be far too narrow, and it is more than likely that even better results than those obtained up to the present might be achieved by separating the two processes more completely.

In order to be able to judge of the merits of the several types of water softeners, it is desirable to bear in mind not only the limitations of the chemical processes, the necessity for intimate mixing, and the slowness of the reaction, but also the leading principles of filtration and sedimentation. They may at the very start be summarized by saying that it is desirable to make the particles of sediment as large as possible, for if the water is to be filtered it is evidently a very great advantage to have coarse particles. If the desired coarseness cannot be attained, the filtering fabric must have finer meshes than can be produced in practice, but the apertures can also be reduced by partially choking them with coarse sediment particles. This means that if all the particles cannot be made so large that they will not pass the filter, they should be associated with larger particles which choke the fabric sufficiently to prevent finer ones from passing. The same object is attained by using sand filters in which the finer particles take the place of coarse sediment particles. Mattress filters act by offering a very large rough surface for the adherence of passing particles.

Now the slower the chemical process, the higher the temperature at which it is carried out, and the more violent the agitation of the water under treatment, the larger will be the sediment particles. All these conditions are aimed at in the Archbutt-Deeley process, with this addition, that old sediment, which is naturally of a coarse nature, is mixed with the new sediment and helps to increase the size of the particles. In continuous processes this object cannot easily be attained, more particularly if, as is generally the case, the attempt is made to save space by merging the chemical into the precipitation or filtration process. For instance, if the tank in which the chemical reaction is mainly carried out should be barely large enough for its purpose, the final chemical reaction, which naturally produces the very finest particles, takes place either in the filter or in the sedimentation tank, and these very fine particles have a very good chance of escaping with the treated water into the boiler.

There are two principles on which particles can be removed from fluids. Both are based on the fact that particles which are heavier than water will sink in it with a definite velocity, depending firstly on the excess density over that of water, and secondly on the sizes of the particles.

The velocity with which similarly-shaped bodies of equal density sink through water is roughly proportional to the square root of the dimensions. Thus a flake of sediment of 1-100 in. largest dimension would sink twice as fast as a particle of 1-400 in. length, although it would be 64 times as heavy.

Conversely a very slight change of speed will very materially affect the sizes of the retained particles, and therefore also the perfection of the purification process. This explains why eddying currents in settling tanks should be avoided as much as possible.

The ideal conditions for this process are sketched in Fig. 1. The chemical process is supposed to have been completed, and the treated water enters at and passes through a filtering fabric F_1 in order that the upward velocity V may be uniformly distributed over the section of the tank. The fabric F^2 prevents the discharge at B from creating local eddies. As long as the velocity V is constant, particles of a certain size will tend to remain stationary, neither rising nor falling, but gradually they will draw together to form larger particles and sink But, as this is of importance, all those particles whose downward velocity is less than V, the average upward velocity of the water, will be carried over with it. In this clarifying process it is, therefore, very essential to complete the chemical process before entering this tank and to adopt every possible means for producing the coarsest possible particle.

No attempt has been made either in this or the next diagrammatic sketch to show how the sediment might be removed.

In Fig. 2 the treated water passes from the trough T^1 through a filtering fabric, which gives it a uniform velocity, before it passes across the tank through another filtering fabric to the discharge trough T^2. Now no matter how small the suspended particles may be, if only they are heavier than water, they must of necessity sink if the water has no upward movement, and by making the section of the tank large and the velocity V of the water small, we can ensure that all the water above the slanting line T'a is absolutely free from particles, the coarser ones falling down at b, c, d, etc. The reason why filtering fabrics are shown is because if there were merely weir overflows at T^1 and T^2 a considerable addition would have to be made to the length of the tank in order to get out of the region of local eddies.

Indications are noticeable in many water purifiers that the above two principles have forced themselves on inventors, but apparently the desire to save space has in most cases led to a merging of the chemical and the filtering processes.

There are, however, a few processes, those known as the Boby and as the Lawrence purifiers, in which purification is mainly effected by the application of heat, and the problem of removing the sediment is then very different from the above.

Approximately 400 water softeners have been installed in works of our members, and on the whole we have received few complaints. A few of these were due to wrong instructions, but as a rule inattention was the chief cause of trouble. It was, therefore, decided that our chemist should make a careful examination of a number of water softeners which had been in use for some time.

There are at present 20 different patterns of water softeners, of which half-a-dozen or more are in use amongst our members, and about 25 other patterns of which less than half-a-dozen have been installed by our members. The first lot includes the following, arranged alphabetically: Archbutt-Deeley, Bell, Boby, Criton, Crossfield, Desrumaux,

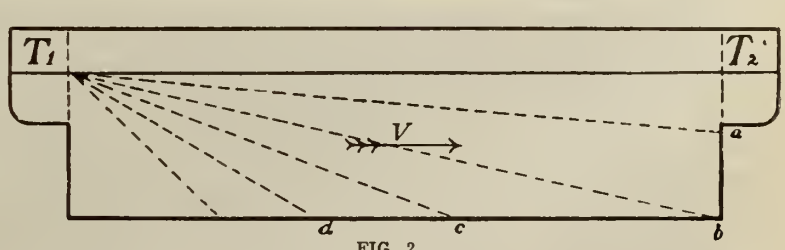


FIG. 2.

Doulton, Guttmann, Harris-Anderson, Kennicott, Lassen & Hjort, Lawrence, Maigneu, Paterson, Permutit, Porter-Clark, Reisert, Stanhope, Tyache, Wollaston.

With the exception of the Archbutt-Deeley softener, in which the chemical reaction and settling operation are separated by a time interval, the other softeners are all continuous, and in most cases, too, the chemical reaction continues as far as the settling tanks and sometimes even as far as the feed pipes and the boilers, as is proved by the deposition of scale in these parts. In the Boby and in the Lawrence softeners the chemical reaction is supplemented by, and sometimes entirely replaced by, heat reaction, and sometimes these so-called detartarisers are added to other softeners. The only softener in which the principle illustrated in Fig. 2 is made use of is the Desrumaux softener, the horizontal tank being replaced by a helix. All the other softeners use the principle illustrated in Fig. 1, the differences between them being confined to the appliances for adding the chemicals. These, however, are of comparatively little importance if the flow of the water through the apparatus is too rapid and the times allowed for reaction, settling, and filtering are kept too short. Thus in some softeners which were inspected by our chemist the upward velocity was as high at 20 ft. per hour, in others as low as 2 ft., which means that in the first-mentioned case the weights of the particles carried over with the treated water would be about one million times greater than those carried over in the second case. No wonder, therefore, that in the first set of cases there would be complaint about the feed pipes choking and floury deposits forming in the boilers and being carried into the steam pipes and even into the turbines.

The information gained by these inspections was of great value, but it cannot be detailed here as it would consist to a large extent of criticisms of details for which the makers are responsible, including instructions about the chemical reagents, which are not always quite correct. But most of the troubles met with were due to inattention on the part of the attendants.

There is, however, one point to which attention should be specially drawn—the tendency in some cases for softened water to cause corrosion, usually of a local character. In these cases the water contains salt, and, as is now well known, the combination of salt and soda along with dissolved air tends to cause pitting of boiler plates. The reason for this behaviour is as yet not fully understood, but it is known that whereas soda solutions will rapidly polarize iron surfaces, salt solutions will depolarize them, and it is possible that when the two salts act together they cover the iron surface with alternating patches of polarized and depolarized iron which, when in company, of course act as powerful galvanic batteries and cause local corrosion of the depolarized area. Good preventatives are a slight excess of soda or the addition of tannin solutions. The latter must, however, be added to the feed after, and not before or during the softening process, otherwise the tannin is precipitated and removed in the filters before it can do any good.

In view of the injurious effect of salt and soda combined, all those boilers which are supplied with feed water which has been treated with permutit were reviewed, because here, the regenerating fluid being brine, and carbonate of soda being in solution in the softened water conditions for pitting seemed to be favorable, but in none of these cases did our inspectors detect either pitting or local corrosion. Possibly, therefore, the pitting process is not such a simple one as that suggested above.

The Lawrence water softener is still called a sterilizer, because it was at first used only for sterilizing purposes. It is based on the counter-current principle, and may be illustrated by the movements in a Field tube. The untreated water passes along the inner tube and flows out through the annular space between the inner and outer tube. The extreme end of the tube is heated to any desired temperature, and as the heated water passes along the annular space it parts with its heat to the incoming water in the inner tube and leaves the apparatus at a temperature which is only slightly in excess of that of the supply. This difference can be reduced to 20° Fah. or even 5° Fah., if the heat-exchanging surface be made large enough, so that although the water may be raised to 212° Fah., or even converted into steam and recondensed, which process represents a heat exchange of about 1,000 B. T.U., the actual loss of heat need only be 5 to 20 B.T.U. Such an arrangement is, of course, a very economical one if the water has to be cooled down to ordinary temperatures after sterilizing, but there is no need to adopt this refinement when it is desired to supply warm water to the boilers Consequently in the Lawrence feed-water softeners the counter-current arrangement is of secondary importance and special attention is devoted to suitable arrangements for dealing with the sediment which is formed when the water is heated.

If the principles on which this sterilizer is based were carried to extremes an apparatus would result which seems to have been invented several times and forgotten again. The oldest record is a Viennese invention, then followed a French and a Belgian one. Instead of merely heating the water, it is actually evaporated and recondensed before it passes along the heat-exchanging surface. The apparatus might be conceived as being of the same design as an ordinary evaporator, i.e., a vertical cylindrical vessel with a lower and an upper chamber connected by a number of heat-exchanging tubes. The cold water enters the lower chamber and slowly rises in the tubes to a suitable height, its temperature being gradually raised by the condensed water around the tubes, which travels downward with an equally slow motion and is drawn off at the bottom. A pipe leads from the upper chamber to the middle cylindrical space around the tubes. Into this connecting pipe there must be fitted a compression pump, or fan, or an ejector, which will produce a partial vacuum over the incoming water and a slight pressure in the cylindrical vessel around the tubes. The power used for driving the compressor or ejector is converted into heat, and is finally carried away with the distilled water and as radiation. Assuming that these devices create a difference of pressure of say 6 lbs., the steam and water around the tubes will be 18° Fah. hotter than the water in the tubes, which will. therefore, be evaporated, pass through the compressor or ejector, and be condensed in the cylindrical vessel and cooled as the condensed water sinks lower and lower, the differbe 18° Fah. being maintained to the end. Under these circumstances the heat required for distilling and recondensing 1,000 gallons of water would be 180,000 B.T.U., or about as much as could be got out of 20 lbs. of coal in an ordinary boiler, which is a ridiculously small quantity compared with the total exchange of heat. As the heat transmission through a metal plate is about ½ B.T.U. per second per square foot for a difference of 18° Fah., and as the total heat transmission for the evaporation and condensation of 1,000 gallons is about ten gallons, it follows that if we should wish to produce 1,000 gallons of distilled water per hour the heat exchanging surface would have to be nearly 5,000 sq., ft. If we double the difference of temperature from 18° to 36° Fah., the surface could be reduced to 2,500 sq. ft. A very simple calculation could, therefore, be made to show which temperature difference should be adopted in order that the interest and depreciation of the apparatus, plus the cost of fuel, would be a minimum. The trouble with these distillers seems to have been the removal of the scale and sediment.

The subject of water purification would be incomplete without a brief reference to barium aluminate, which, like caustic lime, removes temporary hardness without adding more soluble salts to the water, but it differs from lime in that it leaves no residual hardness of 3 or 4 degrees, and is, therefore, almost as effective as distillation. It is however, associated with the drawbacks that barium salts are poisonous and not easily procurable at present.

Railway Converter Substations—Part I.

The Author Gives Some Useful Information Concerning theClass of Equipment to be Used and Its Arrangement in the Substation Buildings

By C. F. LLOYD, Manager Sub station Section, Westinghouse Electric and Mfg. Co., Pittsburgh

DIRECT current railway substations are essentially very similar, since they all perform the same general functions, that is, supply power to propel cars and at the same time provide for safety, convenience of operation and economy. Necessarily, various substations differ widely in arrangement in details to best meet various local conditions.

The rotary converter is generally applicable and preferable to other classes of converting apparatus for railway service, requiring 600 and 1200 volts D.C. This statement is made unreservedly, since the converter has proven its reliability from an operating standpoint while its efficiency, including transformers, is from five to eight per cent. better than that of a similar motor generator without transformers. In cases where a motor generator requires transformers, a greater efficiency advantage is obtained from the converter outfit. The railway substation, at least for interurban work, operates at comparatively poor load factor and in consequence, a further advantage is gained with the converter outfit, since a greater saving in efficiency maintains at the lighter loads. Practically the only conditions which may preclude the use of the converter are two in number, as follows:—

First—Where alternating current feeder line conditions are very poor, having, for instance, excessive ohmic drop, severe surges, wide frequency fluctuations, etc., on which synchronous apparatus would probably prove unstable, the induction motor generator is the proper application. To-day, this application is rarely met, since a system to be consistently efficient must afford alternating current lines with comparatively little loss and be comparatively free from frequency variations, surges, etc. The choice in converting apparatus, therefore, usually narrows down to synchronous motor generators, or rotary converters.

Second—Where the line power factor is very poor it may be desirable to raise it with the converting apparatus, operating partially as a condenser. As the rotary converter is purely a unity power factor machine, a separate condenser is required to produce the same results as a synchronous motor generator, having its motor designed to operate partially as a condenser. Where the first cost and efficiency of the converter, with separate condenser, are equal to or better than the first cost and efficiency of the motor generator, the former is preferable.

Transformers

The type of transformers selected depends almost entirely upon local requirements. The oil-insulated, self-cooled transformer is most universally used, especially in the smaller sizes on account of its simplicity, due to its not requiring any additional apparatus for cooling purposes. If water is to be had in sufficient quantity at little or no expense, it may become desirable to use the oil-insulated, water-cooled transformer, except in the smaller sizes where this type of transformer is more expensive than the self-cooled. In some localities, fire insurance rates are considerably reduced where transformers do not require oil. In cases of this kind, assuming moderate voltages, not to exceed 33,000 volts, the air blast transformer is used. This type of transformer may also be applicable and desirable in large sizes, from a cost standpoint, even though there is nothing to be gained by lower insurance rates. It is, however, a safe rule to

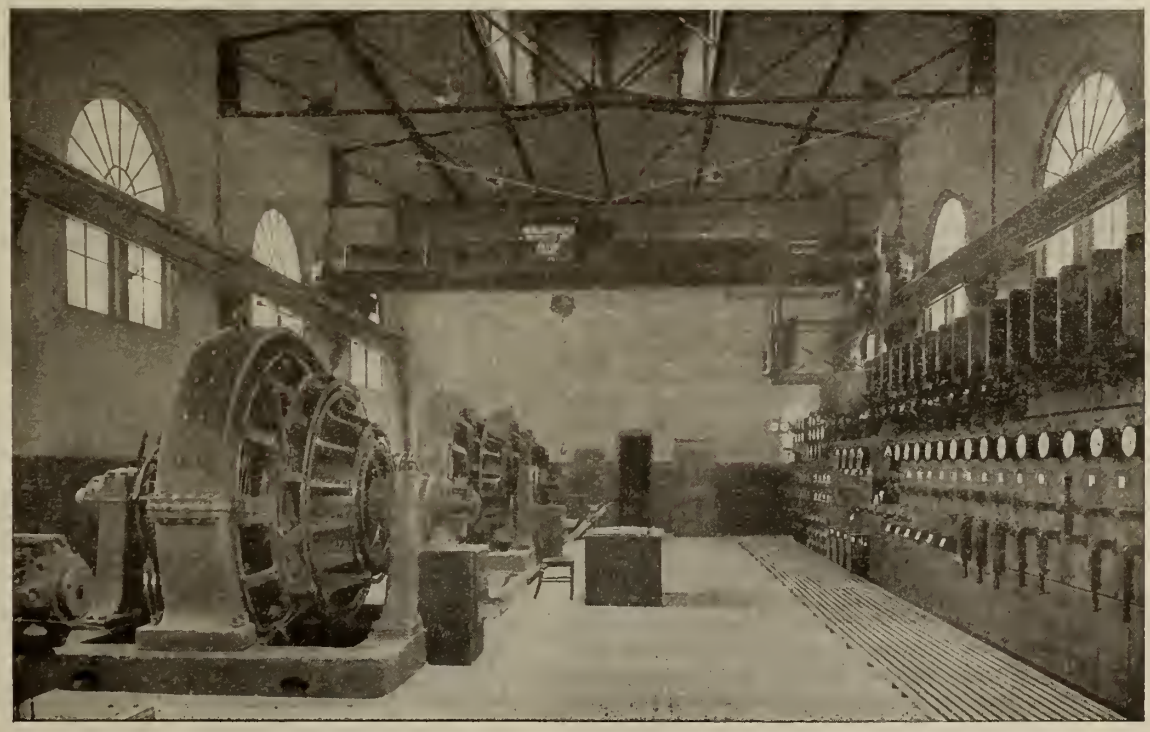


FIG. 1.—FOUR 1,000-K.W. 600-VOLT, 60-CYCLE WESTINGHOUSE RAILWAY CONVERTERS INSTALLED IN PITTSBURGH.

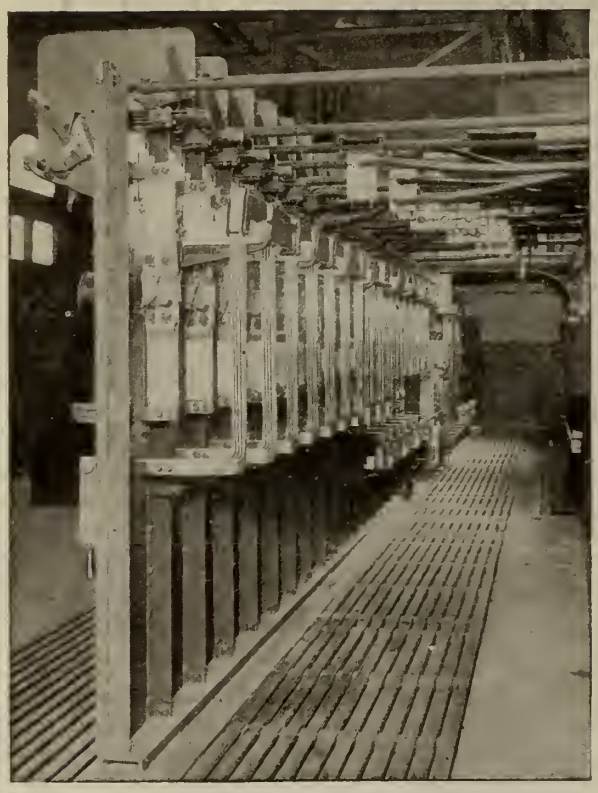


FIG. 2—D.C. SUB-STATION SWITCHBOARD, REAR VIEW.

use oil-insulated, self-cooled transformers, unless some marked advantage is to be gained, such as lower first cost or reduced insurance rates, by the use of one of the other types.

The place selected may be dicated by local conditions. However, since the stationary transformer is possibly even more reliable than the rotary converter there is little to be gained by the use of single-phase in preference to three-phase transformers, unless the first cost is equal or less. Roughly, in the self-cooled type, there will be a saving in the three-phase transformer in voltages below 33,000 for converters up to 1,000 k.w. capacity. Above this size, single-phase are practically no more expensive than three-phase transformers and are, therefore, recommended. In the oil-insulated, water-cooled and air blast, the three-phase transformer is always less expensive.

Reactance, either inherent or external, to their transformers is required by compound railway converters for compounding purposes. Transformers with inherent reactance are recommended in preference to those with normal reactance and external reactance coils primarily due to lower initial cost.

Switching

Upon the selection of switching equipment very often depends the success or partial failure of a substation. The switching equipment must be selected with a due regard for maximum simplicity, convenience and reliability. While essentially standard switching equipment is applicable in practically every case, there are very often local conditions which warrant and require additional protective apparatus for the best results. There is no universal rule to follow in the selection of switching equipment. It can only be selected by competent engineers after careful study of individual local conditions.

A. C. circuit breakers must be selected not only of sufficient ampere capacity, but must be capable of rupturing the maximum capacity available under short circuit conditions. The possibility of short circuit trouble between the high tension breaker and the low tension side of the converter is very remote; in fact, so remote that protection for such an occurrence is not recommended. Consequently the impedence in the converter transformer should be taken into consideration in figuring the current under short circuit conditions. Assuming, therefore, the standard converter transformer having 15 per cent. inherent reactance, the maximum line current that can be taken by a converter operating from this transformer under short circuit conditions will be approximately seven times normal. Therefore, a breaker capable of rupturing seven times normal three-phase line current is recommended for the standard transformer and rotary converter outfit.

D.C. circuit breakers and switches are rated on the basis of the maximum current they will carry for one hour or more, not to exceed temperatures approved by the underwriters. Since standard converters are rated on the basis of 150 per cent. load for two hours, the rating of the circuit breakers and switches should correspond to this value. The calibration range of the D.C. breakers should be considered, as it is good practice to set the machine breaker, where automatic, comparatively high with the feeder breakers set as low as practicable.

A.C. and D.C. meters should be carefully selected to meet the particular application requirements. A D.C. ammeter scale equal to the momentary swing capacity of the converter is recommended. It may, however, be desirable to shorten this scale in some cases in order to obtain better readings on average loads.

Protective Devices

Protective devices as follows are recommended for all installations, if the best results are to be obtained:—

1—A.C. machine breaker with low voltage release and pallet switch attachment.
2—D.C. machine breaker with low voltage attachment.
3—Reverse current relay.
4—Reactive factor meter.
5—D.C. feeder breakers.
6—D.C. feeder resistance.

Adjustment of protective devices is recommended as follows:—

1 (a) The alternating current machine breaker should be automatic. At least in sizes of 1,000 k.w. and below, this breaker should entirely protect the converter from excessive swing loads, and in consequence, should be equipped with an instantaneous trip. In general this will require a high setting, it being satisfactory to work

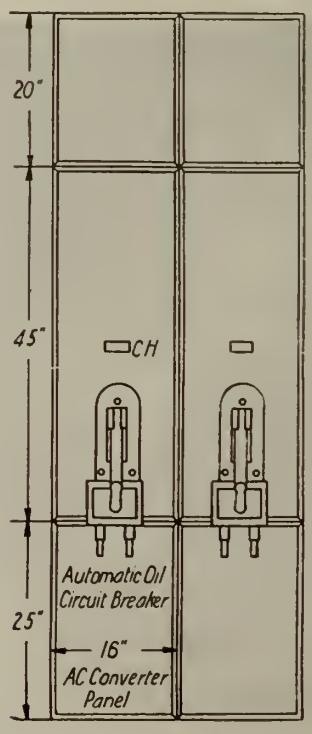


FIG. 3—STANDARD A.C. ROTARY CONVERTER PANELS.

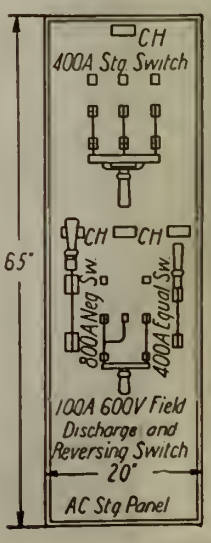


FIG. 5—A.C. STARTING PANEL.

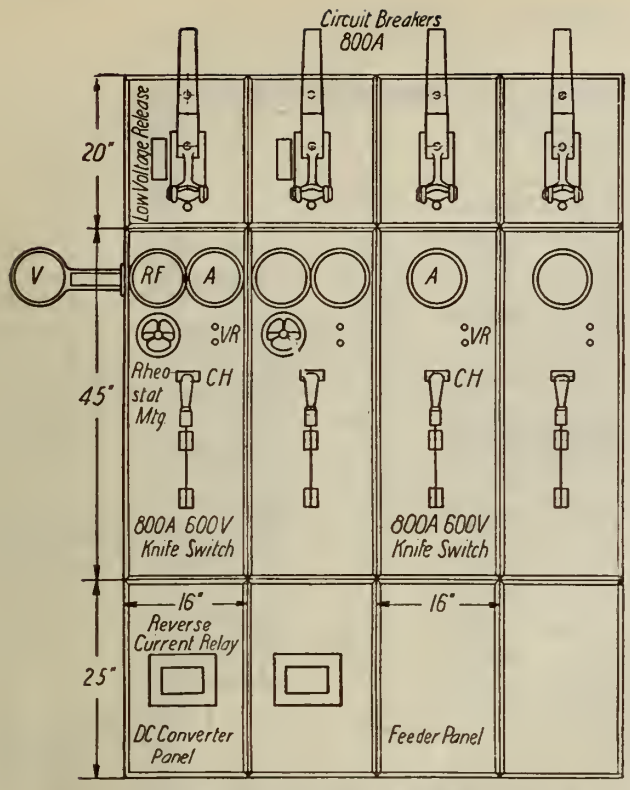


FIG. 4—STANDARD D.C. MACHINE AND FEEDER PANELS.

at any value within the guaranteed swing capacity of the machine. In sizes larger than mentioned above applications may require definite time or inverse time limit trip, which may be entirely satisfactory.

(b) The pallet switch should connect the alternating current and direct current breakers electrically in a manner to cause the direct current breaker to open upon opening the alternating current breaker. The speed limit switch is connected in series with the pallet switch, which also opens the direct current breaker upon operating.

(c) The low voltage release should be adjusted to operate at as high a voltage as is practicable for the application. It is essential, especially for commutating pole converters, to disconnect them from the line when the alternating current voltage drops an appreciable amount, since the restoration of the normal voltage presents conditions similar to switching the converter from the starting to the running position in starting with its trouble, and the nearer the converter and the alternating current capacities agree, the less serious will be the damage resulting from trouble.

2. Capacity of converting apparatus—The larger the converting apparatus, the less sensitive it is to D.C. line troubles, since for instance, feeder short circuits are a smaller proportion of its capacity, and therefore, the machines are less subject to flash-overs from this cause, at least.

3. Voltage of system—The lower the voltage of a given system, the nearer the taps may be placed to the machines. In general, on a given system, tap distance for 1,200-volt service, should be at least twice those of 600-volt service.

4. Size of feeders—The larger the feeders, the greater the tap distances should be from the machines.

5. Disposition of feeders—When possible, the distribution of feeders should be such, that each will carry a reasonable proportion of the station output: that is, where several feeders originate in one station, no excessive proportion of the station output should be handled over any single feeder. Any trouble on such a feeder reacts on the entire substation and is frequently responsible for flash-overs.

6. Size of rails—The heavier the rails, obviously, the greater should be the tap distances.

7. Bonding—Broken bonds and poor ground connections have been known to result in flash-overs. Such cases, however, are not frequent. Obviously, the bonding has a direct bearing on proper tap distances.

8. Sizes of cars—It is evident that with a given substation unit, the heavier the car equipment and the larger the motor rating, the greater will be the "drag" on the substation equipment and the more destructive the effects in case of motor troubles. The rating of the car equipment had, therefore, a bearing on the proper tap distances, especially when the substation units are relatively small, as compared to the motor ratings.

From the foregoing, it will be seen that to evolve a formula to cover such a diversity of conditions would prove itself a problem, and the results, until proven, could not be accepted as much more reliable than a guess. In general, experience has shown that on 600-volt systems, the first tap should not be nearer the machine than 2,500 feet, and on 1,200-volt systems, 5,000 feet. Should flashing persist, these distances should be increased until the flashing stops. The line losses due to these tap distances are of little consequence when compared to the loss on account of flash-overs, including the time and expense involved in cleaning up the damaged apparatus. Furthermore, the car equipment is benefited by being worked at a more uniform voltage.

Rotary Converters Standards

All standard ratings consist of single units, except the 1,200 and 1,500-volt 60 cycle ratings which consist of two machines, each wound for 600 or 750 volts, mounted separately or on a common bedplate, insulated and arranged for series operation. The following table shows the ratings that have been standardized:

Table of Standard Ratings

60 cycle				25 cycle		
Kw.	Volts	Volts	Volts	Volts	Volts	Volts
300	600			600	1,200	1,500
500	600	1,200	1,500	600	1,200	1,500
750	600					
1,000	600	1,200	1,500	600		
1,500	600			600		
2,000	600			600		
3,000	600			600		
4,000				600		

Ventilation

Railway converters are usually designed after careful study of the ventilation problem. It is particularly important on machines for this class of service, since they are often from necessity called upon to deliver very heavy sustained peak loads, which is possible only on well ventilated machines that quickly and efficiently radiate the increased heat generated if they are not to become dangerously hot. Further, the very open construction with thin copper cross sections, especially in field winding, necessary to obtain maximum ventilation, makes it possible to observe accurate temperatures and to know how hard the machine can be worked in emergency.

Starting

Rotary converters are suitable for either alternating or direct current self starting. The alternating current self starting method is recommended on account of its simplicity, due primarily to the elimination of synchronizing. The objection on account of excessive starting Kva required is practically eliminated, due to larger capacities behind the machines and because the self starting machine as now built requires very low starting Kva. The Westinghouse Co. accomplished this by the use of a very effective cage winding located in the pole faces. The efficient manner in which the copper of this winding is distributed over the pole faces renders it, if possible, a more efficient damping winding, which is the heart of stable operation, incidentally meaning successful and reliable operation. The shunt field is controlled by a two-pole, double-throw field switch, with discharge clip and resistance, by which the polarity is reversed when necessary, usually mounted

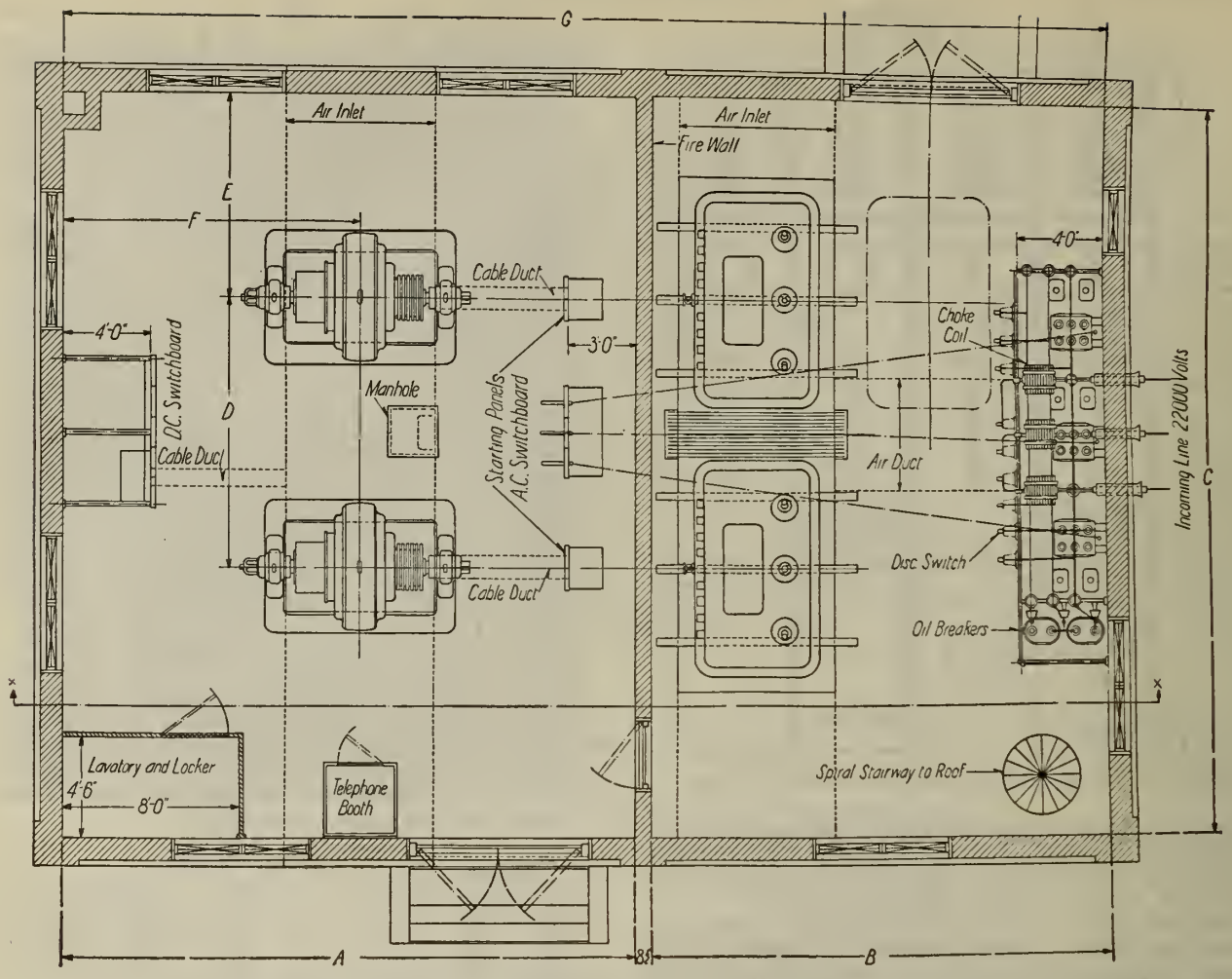


FIG. 7—SUBSTATION FOR SMALL UNITS. PLAIN REAR WALL IS TEMPORARY TO PROVIDE FOR EXTENSIONS.

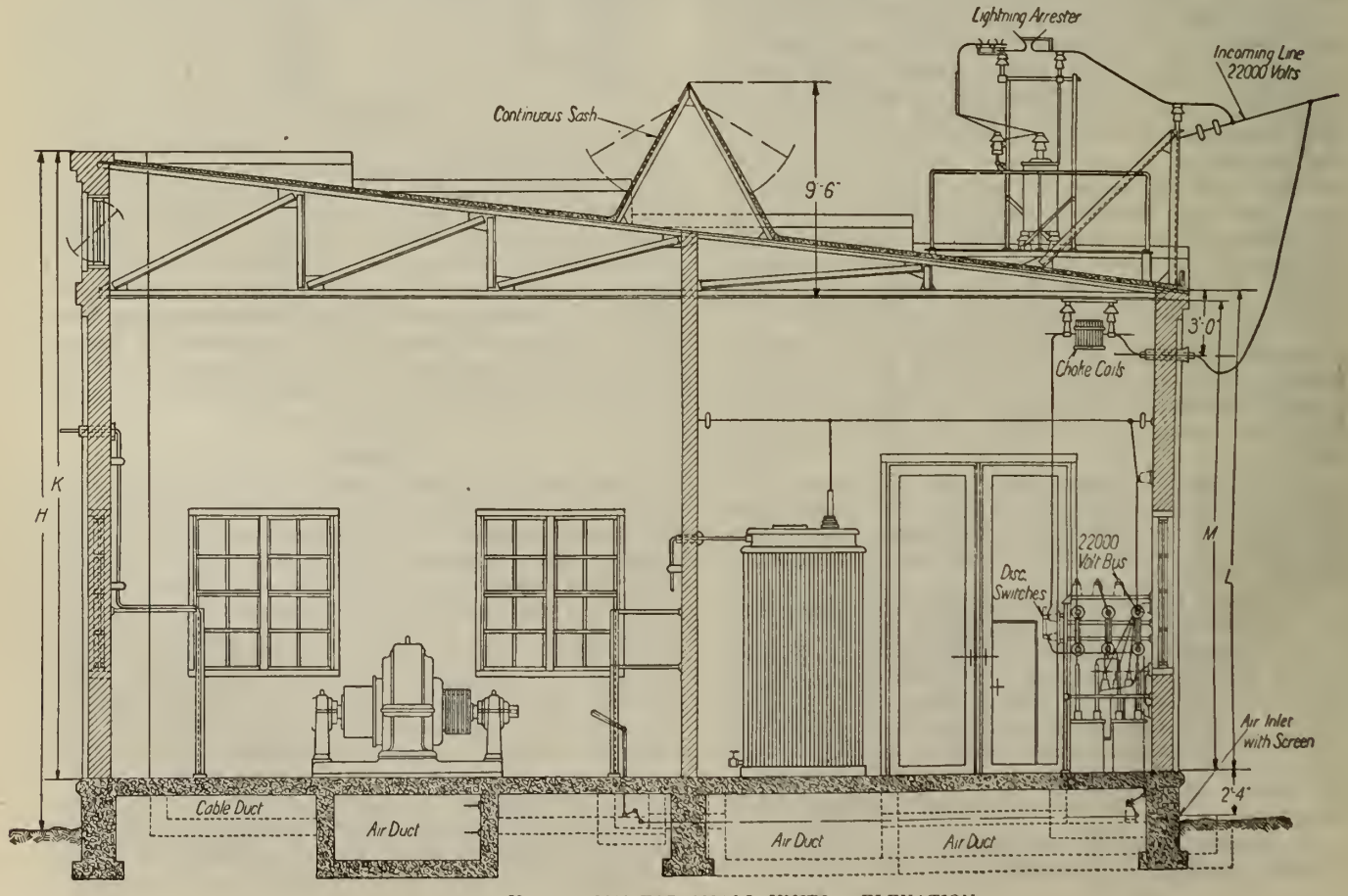


FIG. 6—SUB-STATION FOR SMALL UNITS —ELEVATION.

SYNCHRONOUS CONVERTERS SUBSTATION FOR SMALL UNITS

Table of Dimensions—600 Volts D.C.—22000 Volts—60 Cycle A.C.

	A	B	C	D	E	F	G	H	L	M
Size 00	17′ 0″	13′ 31 2″	24′	9′	7′ 6″	11′ 9″	31″	27′	21′	18′ 6″
Size 00	18′ 31 2″	15′ 0″	24′	9″	7′ 6″	12′ 9″	34′	25′	19′	20′ 6″
Size 00	22′ 0″	17′ 31 2″	27′	9′	9′ 0″	12′ 9″	40′	27′	21′	20′ 6″
Size 00	25′ 0″	20′ 31 2″	33′	12′	9′ 0″	13′ 4″	46′	28′	22′	21′ 6″

on the A.C. starting panel. During starting, the field switch should be in the closed position, thus short circuiting the field through the armature. This method of handling the shunt field not only reduces the strain on the field insulation over that obtained with the old field break-up switch with its unsightly frame wiring, but is a great convenience to the operator in starting machines quickly.

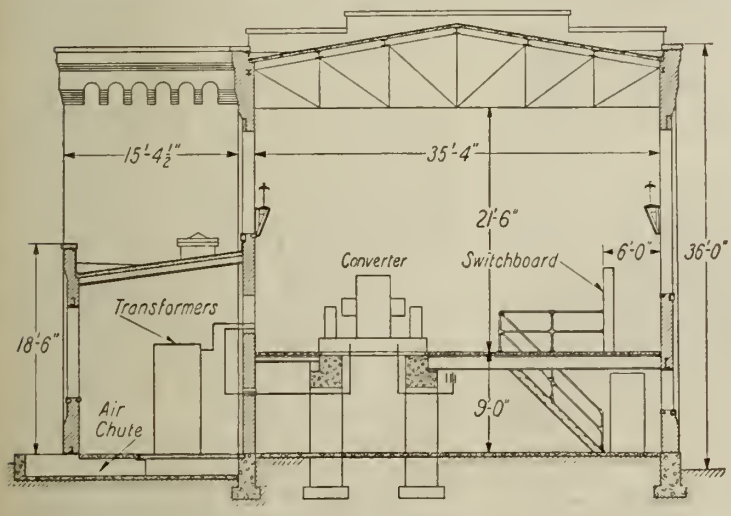


FIG. 8—CONVERTER AND TRANSFORMER ROOMS—ELEVATION.

Ratio of Conversion

Theoretically, there is a fixed ratio of conversion in rotary converters from alternating to direct current. While practically this is true, even duplicate machines may show a slight variation in ratio, due to inequality of material and allowable difference in commercial manufacture. The ratio of conversion remains practically constant, regardless of the load, neglecting a small inherent drop in the machine, and consequently, any change in direct current voltage must be obtained by a change in the alternating current voltage applied. The following table gives the theoretical ratios of transformation in converters:

Ratios of Direct Current Voltage to Alternating Current Voltage in Converters

Phase of Converter	Assuming the D.C. Voltage to be 1.00 Alternating Current Voltage Will Be
Single Phase	.707
Two Phase	.707
Three Phase	.615
Six Phase Double Delta	.615
Six Phase Diametrical	.707

To be continued

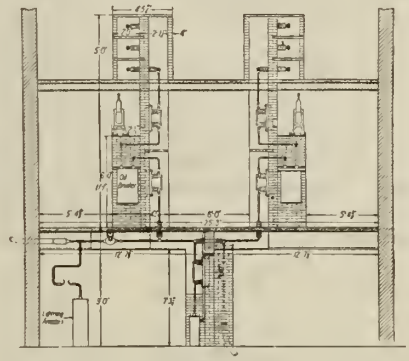


FIG. 9—HIGH TENSION ROOM ELEVATION.

PORTLAND, ORE., it is reported, will build 5,000 houses to absorb surplus labor. How long will enlightened communities tinker away and simply bridge over conditions that will spring up again when the supposed cure is removed?

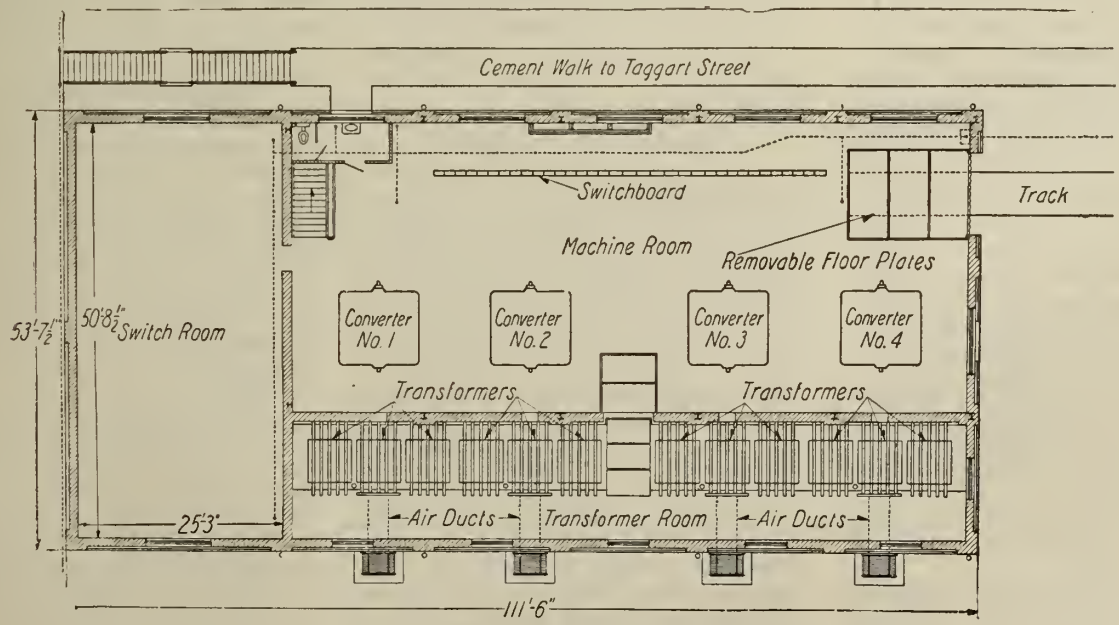


FIG. 10—SUB-STATION OF PITTSBURGH RAILWAYS CO.

IN A Chicago hotel fire 1,700 men escaped in their night attire. In such a case the pyjama habit is much more becoming than the old Mother Hubbard style of night-dress to which some of the sterner sex still adhere.

Dominion Waterpower Bill is Explained

Applies to Waterpowers on Lands Administered by the Department of the Interior in the Prairie Provinces, Northwest Territories and Parts of British Columbia Railway Belt

THE following general explanation of the Dominion Water-power Act, which passed its third reading in the House on May 19, is furnished by the Department of the Interior.

The existing legislation affecting water-powers of the Dominion, is contained in a few very general paragraphs of the Dominion Lands Act (Section 35). This section was enacted in 1908 and amended in 1914.

In the course of experience, especially during recent years, this legislation had been found to be inadequate, and it has been difficult for the Department to effect a wholly satisfactory administration of the important water-power resources of the western provinces.

While there is no radical departure from principle, in this Bill, from the very limited treatment given the subject in existing legislation, it has been found desirable to set out the general fundamental principles governing the administration of such an important asset as water-power, in an independent Act, which will leave no doubt concerning the intention of Parliament on any phase of the subject.

The Bill applies to water-powers on lands administered by the Department of the Interior in the Prairie Provinces, the Northwest Territories, and to parts in the British Columbia Railway Belt.

Briefly, this Bill provides:—

(1) That all land and water necessary for power development purposes shall remain in the Crown, and be disposed of by lease only under the Regulations to be effected by the Governor in Council;

(2) That title to water-power shall always remain in the Crown, rights to development and operation thereof being granted for limited periods only, subject to,

(a) The payment of rental for privileges enjoyed;

(b) The control of rate to consumers;

(c) The production of power to meet all public demands, and in a manner which will realize the maximum advantageous use of the resources; and

(d) The ultimate reversion of the development to the Crown, upon fair payment therefor, if at the end of the term of the concession it is considered desirable that the project be taken over by or for the general public.

(3) For expropriation by the Crown of properties necessary for power development purposes;

(4) For the extension of expropriation rights to those persons authorized to develop power under the regulations;

(5) For a comprehensive survey and investigation of the power resources of the Prairie Provinces.

Provisions for the details of administration is left largely to the Governor in Council. This is considered necessary because the principles governing these details have, owing to the rapid strides in the art and practice of hydraulic and electric engineering and to the complexity and almost indefinite ramifications of the interests involved, not yet been definitely and finally worked out in any previous jurisdiction. As is well-known, the administration of water-powers is interwoven with questions affecting public utility enterprises such as municipal lighting systems, electric railways, etc., and principles affecting these problems are still in a formative stage.

In other countries, particularly France and the United States, where the investigation, administration, and development of water-power has been given a great deal of close study by Government, it has been found very difficult to enact suitable water-power legislation, largely because attempt was made to provide in proposed legislation for too much detail. It is now recognized that the most satisfactory way to enact water-power legislation is to assert general principles only in enactments and permit therein considerable latitude for the elaboration of detail by the governmental administration. This Bill leaves the establishment of appropriate water-power regulations to the Governor in Council, who can, subject to the general principles of the Bill, amend the regulations from time to time as the accumulated experience of Government officers may recommend, in order to meet investigations in engineering practice and the expansion of the use of hydro-electric energy.

Importance of Legislation

As an indication of the importance of appropriate water-power legislation for the Prairie Provinces, it might be pointed out that there is over 4,365,000 horse-power available of development, made up as follows: Alberta, 471,000 h. p.; Saskatchewan, 576,000 h. p.; Manitoba, 3,218,000 h. p. These figures are of course, exclusive of the large power possibilities within the Northwest Territories. On the Winnipeg river alone in the province of Manitoba, departmental investigations show that there are nine power sites capable of development and affording an untimate total production, under regulation conditions, of nearly 500,000 h. p. Competent engineers state that their power situation on the Winnipeg river is unique and can probably not be duplicated anywhere on this continent. Having in mind that the power capacities of this river are sufficient to meet all the requirements of a population of 3,000,000 people, and that it is all within 75 miles of Winnipeg, it will be realized that adequate water-power legislation is a vital necessity, if this unique and unequalled situation is to be preserved and protected in the best interest of the public for this and later generations.

Another power situation of immediate importance, to which the legislation will apply, is that on the Bow river in the Province of Alberta, where at six power sites, all within 65 miles of the City of Calgary, it is possible to develop about 60,000 h.p.

In the provinces of Manitoba and Alberta there is at present invested, approximately, $15,000,000 directly in hydro-electric undertakings, and there is under contemplation in the immediate future hydro developments which will involve a capital expenditure of several additional millions.

Key To Industry

The war has shown beyond peradventure that cheap, dependable power is the key to all industry. Governments of every allied country have been giving special attention to the general problems of power production, with the primary object of determining definitely the various available sources of power, and to provide for their co-ordinated and concomitant development and use, in order that the power needs of the countries may be met in the most advantageous and economical manner.

Statistics show that Canada enjoys a position with regard to power, both developed and potential, second to no other country. Within economic transmission range of every commercial centre in the Dominion are sources of power capable of meeting all anticipated requirements of the future, and the truly remarkable feature of this fact is that, except in the central portions of the Prairie Provinces, where there is suitable natural gas and coal, the most economical and permanent source of power is water-power.

A census of power production in Canada, but recently completed by the Dominion Water-power Branch of the Department of the Interior, discloses the following exceedingly gratifying information: there is developed and in use in Canada to-day 2,300,000 h.p. generated from water. This is equivalent to a development of 276 h.p. per 1,000 population. Norway and possibly Sweden are the only countries where the per capita utilization of water-power exceeds that of Canada.

Of the total power developed, 1,725,000 h.p. is generated in hydro-electric central stations for sale, while some 350,000 water horse-power is utilized directly in the pulp and paper industry in adition to 100,000 hydro electric power purchased from the central stations.

In the central station industry alone —that is to say, the industry having to do with the development of electrical energy for sale—90 per cent. of the power is derived from water. This percentage is extraordinarily high, and is indicative of the extent and availability of the water-power resources of the

Dominion and of the remarkable degree in which their adaptability for central electric station work has been appreciated in principle and realized in practice. The Yukon develops 97.4 per cent. of its primary central station energy from water. Ontario develops 95.7 per cent.; Manitoba, 95.2 per cent.; Quebec, 94.9 per cent.; and British Columbia, 89.8 per cent. These high percentages result from the fortunate location of our hydro-electric resources close to the centres of population, industry, and commerce throughout the Dominion.

Huge Sums Invested

In the hydro central stations throughout the Dominion there is directly invested to-day $285,000,000. This does not take into consideration the vast amount of capital invested in interests which are dependent for their maintenance and operation upon power secured from the central stations, nor does it include the capital invested in water-power plants other than central electric stations. The figures are, however, indicative of the vast dependence which the Dominion has already come to place upon its water-power resources and is an assurance of what the future holds in store.

If the remarkable expansion in the development and use of our water-power resources is to be projected in the future, there must be adequate legislation and administration. The Dominion Water-power Bill is intended to furnish this used in so far as the provinces of Manitoba, Saskatchewan and Alberta, and the Northwest Territories are concerned.

EXTERNAL CORROSION OF BOILER

A unique case of external uniform corrosion occurred to a coke-fired Galloway boiler which supplied steam to gas works. There was not the least indication of moisture in the flues or of corrosion due to dampness, and the inside of the boiler was in an apparently perfect condition, but while the inspector was sounding the shell plate with a hammer his suspicion was aroused with regard to the side plates at the back end of the boiler, and after a careful re-examination it was decided to drill the shell plates just below the side flue covering. Originally these plates had been 7-16 in. thick, but it was now found that they had been reduced to 3-32 in. at the back end, and to about 5-16 in. at the forward end, but only for a width of about one foot below the side flue coverings. Under the brickwork there was practically no corrosion. It was also noticed that the outside of the shell plates was covered with a pale-reddish scale, which on examination was found to consist of dehydrated sulphate of iron (green vitriol or copperas) and red oxide of iron. Our chemist then examined the boiler and found that this sulphate scale extended from just beyond the bridge all over the heating surface of the boiler except where it was protected by flue dust and ashes. It was thickest at the upper portion of the side flues. The only previous case of this form of wasting of which we had any knowledge was reported in 1888 as having occurred at some Belgian works, but the reported details were too few to be of any practical use. It was at first thought that the coke with which these boilers were fired had been slaked with water containing sulphate of ammonia, but it was definitely established that town's water had always been used. Except, therefore, that these boilers were fired with coke, their treatment was the same as that of any other boiler.

A careful enquiry was then made into the question of the production of sulphuric acid and its power of corroding iron. It can hardly be said that it solved the mystery, but its results may prove of future use, and will be briefly recorded.

When coke or coal is burnt, the sulphur contained in these fuels is converted into sulphur dioxide (SO_2) known as sulphurous acid or anhydride, which has the well-known smell of burnt sulphur, and this is generally associated with traces of sulphur trioxide (SO_3), also known as sulphuric anhydride, a gas which escapes from fuming sulphuric acid. Dry sulphur dioxide (SO_2) will not attack steel or iron unless heated to near redness, which heating could not possibly have taken place in the flues of the boiler under consideration. We have, however, had a few serious cases of wasting by SO_3, due to the use of mechanical stokers, an intensely hot flame and local accumulations of scale close to the furnace flanges. These parts of the furnace must have become overheated and were attacked by the sulphur dioxide to such an extent that they finally wore through and leaked. The conditions in the side flues of the present boiler were such that this action could not possibly have taken place, and attention was therefore centred on the sulphur trioxide.

This gas can be produced from sulphur dioxide by mixing it with air and passing the mixture over a catalytic agent, the most common one being moist nitric acid in the lead chambers of sulphuric acid works, or platinum sponge, but red oxide of iron was found to be an almost equally efficient catalytic agent, for by merely dusting the inside of a glass tube with rouge (red oxide) and heating it, a mixture of the dioxide and air was readily converted into trioxide. Seeing that some makers paint their boilers with red oxide before sending them out, it is possible this oxide might effect the conversion, but it is difficult to explain why thousands of other boilers which were also painted red did not suffer like the present one.

Sulphur trioxide like the dioxide will not attack cold iron, and it is doubtful whether it will attack it when heated. On the other hand, when the trioxide is mixed with water, the mixture is known as sulphuric acid (oil of vitriol) which will attack iron very energetically if it contains an excess of water. After a careful study of the vapor tension of this acid the conclusion was arrived at that the corrosion in this boiler had not been active while the boiler was in use, but that sulphur trioxide or perhaps sulphuric acid had been absorbed by the scale on the boiler plates, and then when the boiler was lying idle and was cold, moisture from the atmosphere had been absorbed by the very hygroscopic calcined green vitriol until a fairly dilute sulphuric acid had been formed. This would be prevented from trickling down the sides of the boiler plates, because, being in contact with them, it would attack them and form more green vitriol crystals which would remain in place. The suggestion therefore is that the elements of sulphuric acid were formed while the boiler was at work, but that the actual corrosion only took place when the boiler was idle.

As already mentioned, cases like the above seem to be extremely rare, but possibly, now that attention has been drawn to this one, similar ones will receive special attention, and a careful watch should be kept on boilers which are burning coke. If similar cases should be discovered and the corrosion checked in time, the space devoted to this one will not have been wasted.—C. E. Stromeyer in Memorandum to Manchester Steam Users' Association.

It is not generally known that sea lions played a most important part in sea warfare. The British Admiralty used these animals to hunt U boats. First the animal is trained to follow sounds from the water's depth. After graduation it is put overboard whenever U boats are believed to be in the vicinity of the ship. These animals proved a decided success and well worth the trouble spent in training.

* * *

Now comes the long-spouted oil can for lubricating revolving shafting, without going up to the danger zone. You merely stand on the floor, place this special oil can in position, press a button and out comes the oil. The inventor if this new can claims that dozens if not hundreds of lives will be saved with his device.

* * *

Salonika will become one of the most important ports of the near East if improvements started by the Greek Government are carried out. Expenditures of $100,000,000 are planned, and include a city water supply, drainage and sewer works, dock extensions, railway stations and underground railways, 100 miles of new streets with housing developments, theatres, etc.

* * *

If equal parts of copper and antimony are melted together it forms an alloy of a beautiful violet color, which takes a nice polish, but, being too hard for many purposes, a substitute can be produced by taking an iron casting and copper plating it, after which immerse it for a moment in a solution containing antimony.

What the Mechanical Soot Blower Accomplishes

The Following Article Gives Results of Actual Detailed Tests of Mechanical Soot Blowers in a Modern Power Station—The Importance of Keeping Tubes Free From Soot is Emphasized

By ROBERT JUNE, Mechanical Engineer

THE economies effected by the use of mechanical soot blowers, due to reduction in quantity of coal required, increased boiler efficiency and increased steaming capacity, have been generally recognized by engineers in recent years. Owing to inherent difficulites, however, there have been very few detailed tests made. As those here recorded are in the opinion of the present writer the most accurately carried out, and the most complete ever made, it is believed that they will prove of considreable interest to engineers everywhere.

During the past winter one of the big American railways, the name of which cannot at present be disclosed without breach of confidence to certain of its engineers, decided that the cost of producing power at one of its large shops was excessive and that the possibilities of effecting a reduction through the medium of mechanical soot blowers should be thoroughly investigated.

Power is supplied to the shops from two plants, designated as East Boiler-room and West Boiler-room. The equipment in the first consists of 14 B. & W. boilers of 520 h.p., and in the second of 14 Bigelow-Hornsby of 625 h.p. One boiler of each type was selected and Diamond soot blowers chosen for the purposes of the test.

Boiler Equipment

The B. & W. boiler known as No. 530 is one of the inclined header type, having three longitudinal drums, 252 four-inch tubes and equipped with the B & W. superheater. The total heating surface, including superheater, is 5,734 sq. ft. and manufacturer's rating is 520 b.h.p. Steam pressure is 196 lbs. gauge and safety valve blows at 200 lbs. See diagrammatic sketch of this boiler, Fig. 1.

Boiler No. 530 has under it a Roney mechanical stoker, as have all the B. & W. boilers. This stoker is of the overfeed type, with inclined grate, having an area of 94½ sq. ft. The stoker is operated by means of a small Westinghouse engine. Induced draft only is furnished by four fans under the stack, which can be grouped by means of dampers in various combinations. The fans are regulated by Mason regulators of the usual balanced pressure type. The boiler was equipped with a standard five element mechanical soot blower, as shown on the sketch.

Bigelow-Hornsby boiler No. 544 in the West boiler-room was the one selected for the trial on this side of the plant, consists of ten groups or units of inclined tubes in the front over the furnace, and ten groups of vertical tubes in the back of these with vertical type Foster superheater in between. Each group or unit of tubes contains twenty-one 3¾ inch steel tubes, so that there is a total of 420 tubes in the boiler. All tubes fit into so-called unit drums. In each of these the ten top drums are connected to the main cross drum. The total heating surface of boiler is 7,322 sq. ft. Manufacturer's rating is 625 b.h.p. steam pressure and safety valve setting are similar to that on the B. & W. boilers. See Fig. 2.

The stoker under this boiler is of the Taylor seven retort, underfeed type, having a grate area of 105 sq. ft, inclined grate. Forced draft was supplied to this stoker by 1x3 Sturtevant turbine-driven multivane double inlet fans, under control fans by means of roller chain, but in this test the forced draft and stoker drive was separated and stoker was driven by one of the Westinghouse engines recently installed on the boiler room floor for the driving of stokers. Induced draft was obtained by means of fans located at the uptake to the stack.

The soot-blowing equipment on this boiler consists of six elements versus five on the B. & W. boiler and are located as shown in the sketch. The perforations in the elements A, C, D, and F are arranged in five groups of four holes each on the opposite side of the pipe, and five groups of two holes each on the opposite side of the pipe. The elements are set so that the issuing streams of live steam will play in along the tubes. Element B has a set of evenly spaced holes on one side only, similar to the B. & W. elements. This is essentially a baffle blowing element and the stop with which it is equipped prevents the hand wheel from being turned to a position where the jet will play directly on to the baffle to the detriment of the latter. Superheated steam is used on this boiler, the supply being taken from the point in the boiler outlet just before the main valve. In other respects the installation is similar to that of boiler No. 530.

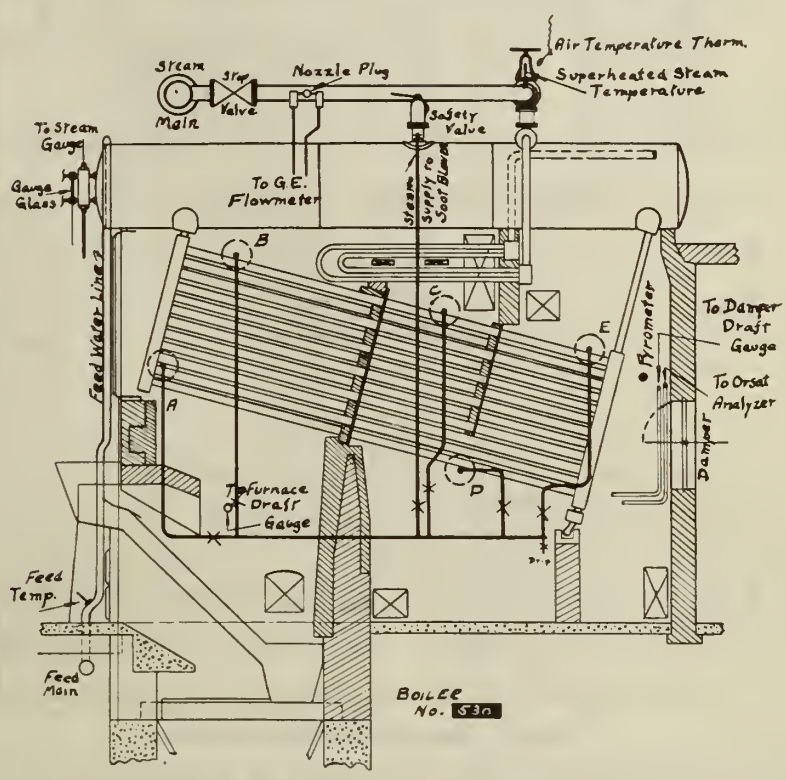
SOOT BLOWER INSTALLATION SIMILAR TO THAT IN WHICH TEST WAS MADE.

Instrument Equipment

On boiler No. 530 the steam output was obtained by means of a General

Electric flow meter, recording, and integrating type, with nozzle plug installed at the boiler steam loop on the roof of the boiler. Consumption of coal was obtained by means of the traveling weight hoppers used in the regular service, each filling of the boiler hopper being obtained by weighing and indicating on the card the weight of larry before and after filling the boiler hopper. Superheated steam temperature by means of an indicating mercury thermometer placed in the steam loop near the boiler stop valve, and a similar range thermometer for obtaining the steam temperature was suspended from the valve hand wheel. Steam pressure in the drum was obtained from the steam gauge used in the regular service on the boiler front. The temperature of the boiler feed water was obtained by means of an indicating mercury thermometer placed in the 2½ inch feed line about one foot from the boiler-room floor. The uptake of the flue gas temperature was obtained by means of a six foot Thermo electric pyrometer inserted through a hole in the side of the boiler wall and arranged to extend across the damper. A mercury thermometer was suspended on the boiler wall to obtain cold junction temperature. For obtaining carbon dioxide in the flue gas a ¼ inch pipe was run through the boiler wall, across the breechine, with a horizontal extension containing a number of evenly spaced perforations. This pipe was brought out and led to the compressed air inspirator and a small portable gas analyzer. Draft at the damper, over the grate, and in the furnace was obtained on a two pen recording draft meter. No indicated readings were obtained. All of the above, together with the regular water gauge glass on the boiler front, constitute the testing outfit on this boiler.

On boiler No. 544 steam flow was obtained by means of two meters, one an integrating recording indicating General Electric meter, already installed and used in previous tests, the other a newly installed Bailey boiler meter. Weight of coal was obtained from the traveling weight hoppers and larry tickets, as in the case of boiler No. 530. A revolution counter was placed on the Taylor stoker to count the revolutions of the main power shaft. The thermometer for obtaining superheated steam temperature and that for obtaining feed water temperature were placed in thermometer wells in their respective pipes at the top of the boiler as in previous tests. The uptake temperature was obtained from three pyrometers inserted into the flue above the damper and inserted at 4, 5 and 6 feet respectively. The cold junction temperature was obtained by means of an indicating thermometer suspended over the cold junction of the pyrometers. Steam pressure was obtained from the steam gauge in regular service on the drum. A steam correction thermometer for obtaining the superheated steam temperature corrected. The carbon dioxide of flue gas was obtained by means of a sampling tube already installed and used in previous tests in conjunction with a standard Orsat gas analyzer. Draft over the furnace and at the damper was obtained on the indicated gauge. Pressure in the wind box was indicated on the lower gauge and on the recording pressure gauge. In addition to the above, the Bailey meter indicated the draft over the furnace and the air flow through the boiler. The latter being obtained by means of two 1½-2 inch pipe connections, one to the combustion chamber over the furnace, and the other in front of the damper at the same height as the first. The various items indicated above, and constituting the testing apparatus on this boiler, are shown in the accompanying sketch.

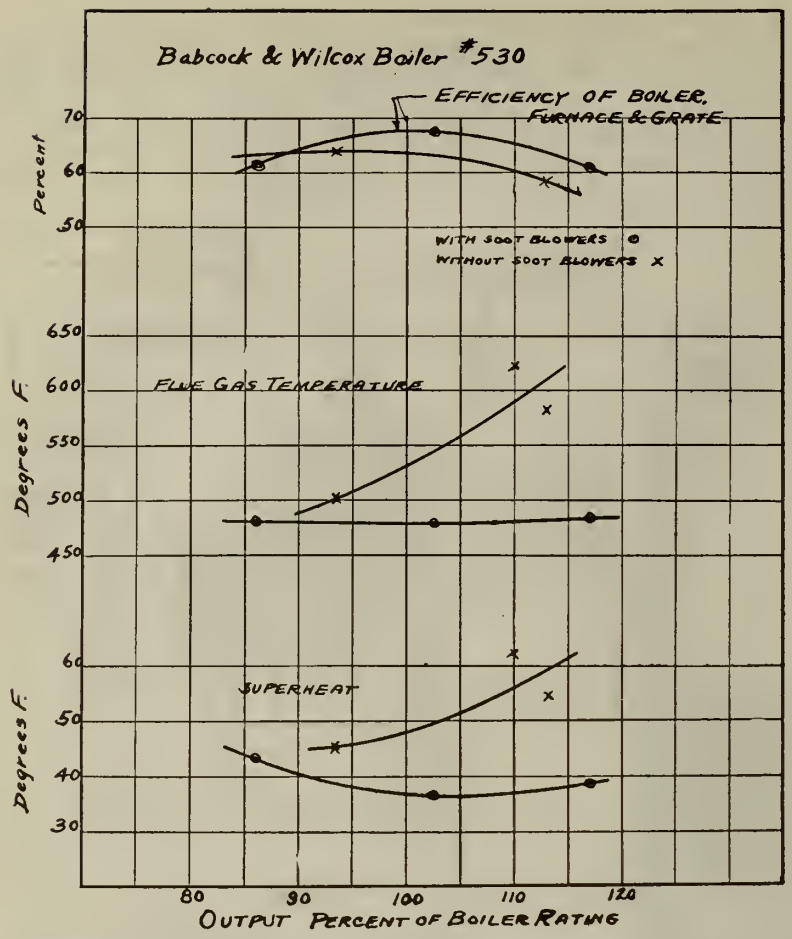


BABCOCK AND WILCOX BOILER WITH B. AND W. SUPERHEATER, SHOWING ARRANGEMENT OF SOOT BLOWING ELEMENTS AND LOCATION OF INSTRUMENTS AND CONNECTIONS FOR TEST PURPOSES.

Method of Test

1. Boiler No. 540 was taken out of service November 15, 1918, for cleaning and installation of the new soot blowers. The boiler was thoroughly cleaned inside and out, and after the new soot blowers were installed the boiler was cut in on the line Feb. 3rd, 1919, at 6.00 a.m. Between this time and Feb. 6th, the setting was allowed to warm up thoroughly, and the new soot blowers were operated three times a day to keep the heating surface clean. The test began on Feb. 6th at 9.30 a.m. The method was to run a series of tests without the soot blowers, attempting to grade the runs from 75 per cent. load to about 200 per cent. load, each run to extend for 24 hours. This was to be followed immediately by series operating the soot blowers, duplicating the loads and conditions of the first series as closely as possible. This boiler was operated mainly by the regular boiler-room operating crew, requiring little supervision by the man in charge of the test. The hopper was filled promptly at the beginning of the test. The fire was cleaned whenever necessary by the fire-room crew.

Readings were taken every twenty minutes by the tester of the following quantities: Steam flow, steam temperature, steam pressure, temperature of the feed water, flue gas temperature, draft in the furnace, and at the damper; the level of the water in the gauge glass, and an analysis of the flue gas for carbon dioxide only, this being sufficient for the purposes, and lack of time not permitting a complete analysis of the gas. The fire room crew were guided by the steam flow meter in maintaining the load, and also by regulating the opening at the dampers on other boilers. During the test, with soot blowers, the latter were operated every six hours. The operation consisted of turning on the steam in the supply header, then in turn turning on the steam in each element and by means of the chain around the hand wheel turning the element three times in both directions as far as possible. This operation for the entire boiler occupied between ten and fifteen minutes. At the completion of each run the fire was burned down and cleaned before the next run was started. When attempting to make Run 4 on this boiler, at about 200 rating, it was found not possible on account of the combination of the following reasons: The coal was very poor; draft at the damper was not available for all the boilers, which were in line, and it developed that the boiler setting leaked quite badly at the front doors.

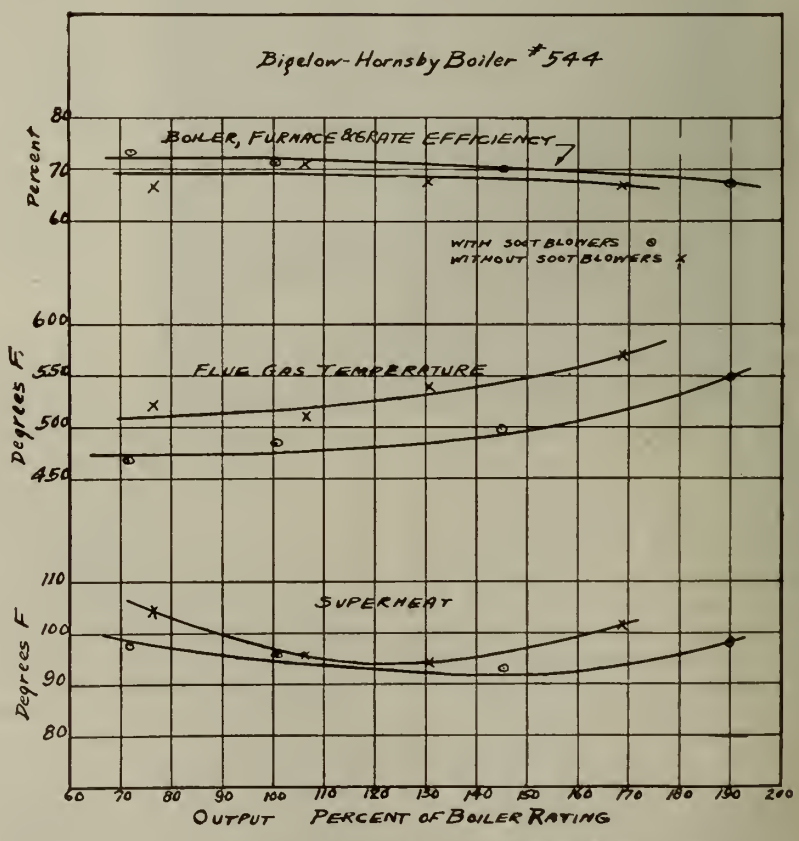


GRAPHICAL SUMMARY OF RESULTS OBTAINED IN PERFORMANCE TEST OF SOOT BLOWERS, BOILER NO. 530.

Therefore, only six runs were made on this boiler, three with and three without the soot blowers. During the runs without operating the soot blowers the boiler was not cleaned at all, since in regular service the frequency of cleaning by the hand lance is only about once every four or five days. In this way actual operating conditions were reproduced as nearly as possible. The test may be called, in fact, a test of the boiler for its operating capabilities.

Boiler No. 544 was cut out of service November 22nd, 1918, for thorough cleaning and installation of the new soot blowers. After this was completed the boiler was cut in on the line at 5.00 a.m. Feb. 3rd, 1918. Boiler setting was allowed to warm up thoroughly and soot blower was operated both to familiarize the operator with the instrument and keep the heating surface perfectly clean. The actual test was started Thursday, Feb. 6th, at 9.00 a.m. On this boiler the fire-room crew did not take such particular pains to maintain the load as in the case of No. 530. The fire-room crew worked in conjunction and under the supervision of the man in charge of the test. Load was maintained by means of observations of the steam flow and the air flow pens on the new Bailey meter, regulating the damper opening, wind box pressure, and other boilers on the line in order to do this. The duration of each run was 24 hours as on No. 530. At the beginning of each run the fire was cleaned and the hopper filled. The tail grate was cleaned whenever found necessary by observation of the fire. This varied from about every two to four hours, depending on the load. The operation of the soot blowers was exactly similar to that on No. 530.

On this boiler eight runs in all were made, the first four being with soot blowers and the second four being without the soot blowers, attempting to reproduce the conditions of the first four as nearly as possible. In doing this, the fire-room crew and the tester were guided by the average conditions attained in the first four runs. Readings were taken every 20 minutes, starting on the hour and ten minutes before readings were taken on No. 530. In the case of this boiler, as also in the case of No. 530, the steam utilized by the soot blowers was not registered by the steam flow meters, owing to the fact that the meter connections to the boiler are placed at a point which is not passed by the steam used in the soot blowers. In boiler No. 544 the steam was used along the inside walls and bridgewall to decrease the accumulation and adhesion of clinker. This is a connection in operation during regular operation and was left so during the test; this steam also was not taken into account by the steam flow meter. Readings taken were as follows: Steam flow, air flow, and furnace draft by gauge, wind box pressure, the speed of the stoker line shaft, the



GRAPHICAL SUMMARY OF RESULTS OBTAINED IN PERFORMANCE TEST OF SOOT BLOWERS BOILER NO. 544.

TABLE I.

Principal Data and Results of Tests on Bigelow-Hornsby Boiler No. 544 With and Without Diamond Soot Blowers. Grate Surface of Taylor Stoker (width 12' 7", length 8' 4") = 105 sq. ft. Total Heating Surface (excluding Superheater), 6250 sq. ft.

		With Soot Blowers.					Without Soot Blowers				
		Test No. 1	Test No. 2	Test No. 3	Test No. 4	Composite of Tests No. 1 to 4	Test No. 5	Test No. 6	Test No. 7	Test No. 8	Composite of Tests No. 5 to 8
1	Date started(x)	2-6-19	2-7-19	2-8-19	2-9-19	Feb. 6 to 9	2-10-19	2-11-19	2-12-19	2-13-19	Feb. 10 to 13
2	Duration, hours	24	24	24	24	96	24	24	24	24	96
3	Average steam pressure, lbs. per sq. in. gauge..	191.3	191.3	197	193		188	191	192.8	192.6	
4	Temperature of Feed Water, Degrees F.....	203	199	192	179		196.9	191	186.3	183.0	
5.	Aver. Steam Temperature, Deg. F., corrected...	481.7	480.6	478.6	483.1		487.7	497.7	479.1	486.1	
6	Aver. Superheat, Deg. F.	97.3	96.2	92.0	98.0		104.6	95.4	94.1	101.2	
7	Aver. Uptake Gas. Temp., Deg. F., corrected...	470.0	484.5	496.0	548	499.6	523	509.5	540.5	569.8	535.7
8	Aver. CO_2, Per Cent.	10.6	10.6	11.0	11.6		11.7	12.95	12.2	11.8	
9	Moisture in Coal, Per Cent.	1.10	0.97	0.60	0.65		0.92	0.70	0.65		
10	Total Coal as fired, pounds	36,110	50,680	73,275	102,515		40,570	55,670	72,235	97,320	
11	Total Coal, dry, pounds	35,713	50,190	72,835	101,849	260,587	40,197	55,280	71,765	96,765	264,007
12	Dry Coal per Hour, lbs.	1488.0	2092.0	3034.8	4243.7		1674.9	2303.3	2990.2	4032.0	
13	Dry Coal per Sq. Ft. of Grate Area per Hour, lbs.	14.17	19.93	28.90	40.4		15.95	21.95	28.45	38.3	
14	Total Actual Evaporation, lbs.	331,032	463,176	663,000	834,144		349,512	485,808	595,128	762,048	
15	Factor of Evaporation	1.120	1.120	1.128	1.144		1.128	1.129	1.135	1.141	
16	Total equivalent evap. from and at 212° F., lbs.	370,756	518,757	747,864	954,261	2,591,638	394,248	548,477	675,470	869,497	2,487,692
17	Equiv. Evap. per Hr. from and at 212° F., lbs.	15,448	21,615	31,161	39,761		16,427	22,853	28,153	36,229	
18.	Equiv. Evap. per Hr. from and at 212° F., per sq. ft., heating surface	2.47	3.47	4.98	6.35	(96)	2.63	3.66	4.51	5.78	
19	Rated capacity per hr. from and at 212° F., lbs.	21,563	21,563	21,563	21,563	2,070,048 (hrs.)	21,563	21,563	21,563	21,563	2,070,048 (96)
20	Percentage of Rated Capacity, developed, %....	71.6	100.2	144.7	184.6	125.2	76.3	106.1	130.8	168.2	120.3(hrs.)
21	Equivalent Evap. from and at 212° F., per lb. of dry coal	10.39	10.32	10.26	9.38	9.96	9.81	9.92	9.41	8.98	9.42
22	Heating value of 1 lb. of dry coal, B.T.U.....	13,827	14,042	14,223	13,572	13,840	14,255	13,268	13,403	12,995	13,350
23	Efficiency of Boiler Furnace and Grate, %	72.7	71.3	70.0	67.1	69.8	66.8	72.7	68.0	66.9	68.4

(x) Test 1 started Feb. 6th at 9 A.M. Each succeeding test started one hour later in the day than the preceding one.

number of revolutions of the stoker power shaft, steam temperature, feed water temperature, flue gas temperature, on three pyrometers, cold junction temperature, air temperature, steam pressure and carbon dioxide in the flue gas.

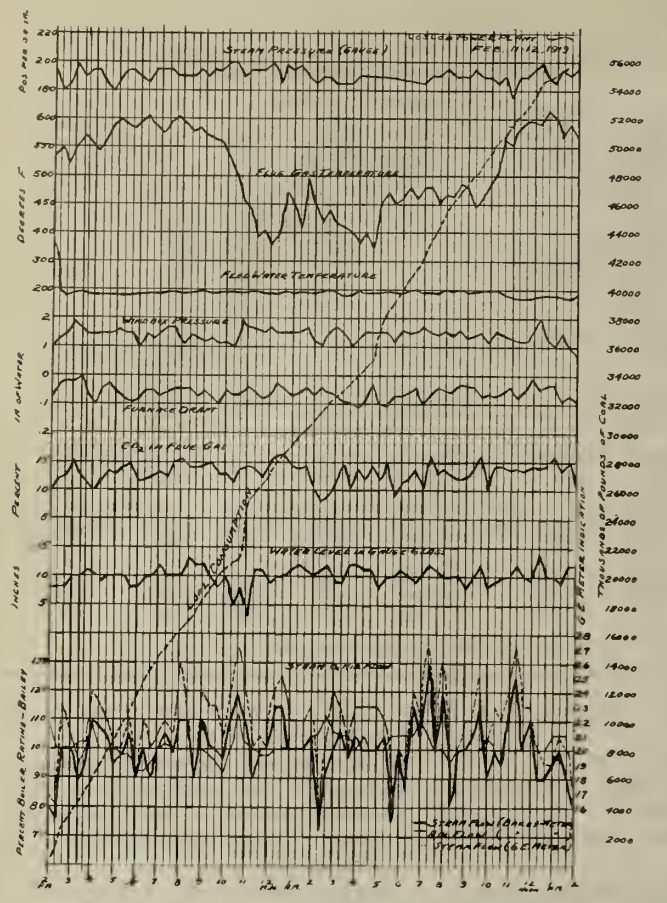
Forced draft was obtained from No. 3 blower, which was isolated from the other blowers by closing the division damper. It was kept running throughout the entire test and the draft to the boiler was regulated by means of the control at the boiler. Since the stoker drive was independent of the blower, being driven by No. 5 stoker engine on the boiler-room floor, the rate of coal feed was varied at will to suit the needs of the load.

Sample Calculations

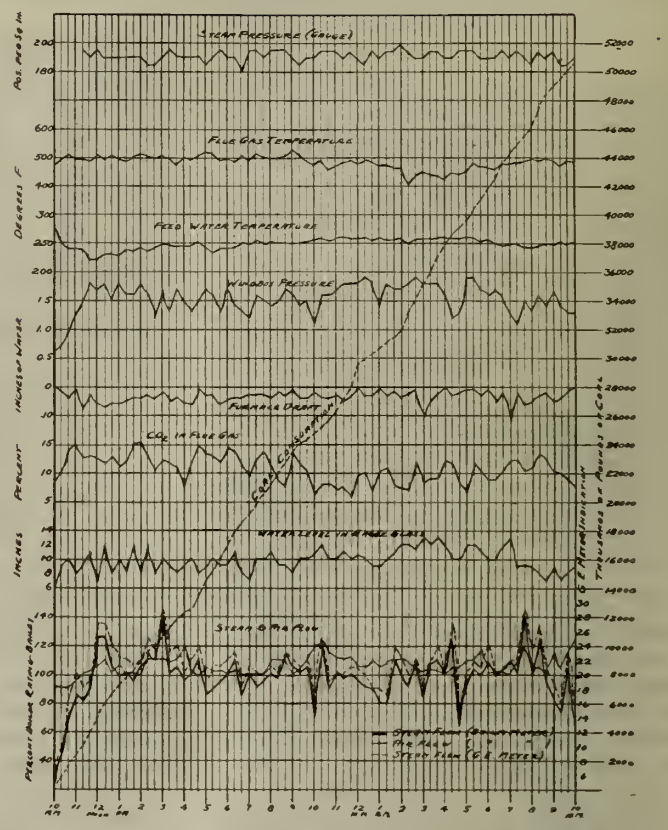
The following are the calculations for arriving at the results of Run 4 on boiler No. 544, which extend from Sunday, Feb. 9th, at noon to noon Monday, February 10th, 1919.

The numeral in parenthesis following each item corresponds to the items having similar numbers in the tabulated results:

1. Average steam pressure, lbs. per sq. in. gauge (drum).
   Average of 73 readings on log sheet, 193 (3).
   Absolute pressure: 193+14.7=207.7 lbs.
2. Average temperature of feed water °F.
   Average of 73 readings on log sheet —179 (4).
3. Average superheated steam temperature.
   Observed temperature average of 73 readings: 476°F.
   Steam correction: .000085 x (476—250) 476—107) = 7.1°F.
4. Average superheat, °F.
   Temperature in Drum corresponding to 207.7 lbs. absolute pressure—385.1° F (from steam tables).
   Average superheat: 483.1 = 98°F (6).
5. Uptake gas temperature °F.
   Highest of three averages for three separate pyrometers
   Observed temperature average 73 readings—522°F.
   Correction for cold conjunction temperatures (Calibrated at 75°F.) 101—75 = 522 plus 26 = 548 (7).
6. Average CO^2 (per cent.).
   Average of 73 readings from log sheet —11.6° (8).
7. Proximate analysis of coal:
   Moisture .... 0.65 %—9
   Volatile .... 22.05 %
   Mixed carbon ..... 65.95 %
   Ash .... 2.12 %
   B.t.u. 13,572
8. Total coal as fired, pounds:
   From larry tickets, 102,515 (10).
9. Total dry coal fired, pounds.
   Moisture in coal—102,515 x .0065 = 666 lbs.
   Total dry coal = 102,515—666 = = 101, 849 (11).
10. Dry coal per hour, pounds:
    Item 9 / 24 = 4,243.7 lbs. (12)
11. Dry coal per sq. ft. of grate area per hour:
    Area of grate: 105 sq. ft.
    Item 10 / 105 = 40.4 (13)
12. Total actual evaporation:
    A .By Bailey boiler meter:
    Steam pressure at orifice gasket (assuming three pounds drop-through superheater)—190 lbs. gauge. Average reading of steam flow pen for 24 hrs. (See photostat of Bailey meter chart)—174.4%.
    Actual weight of steam per hour for 190 lbs. and 98° superheat (corrections according to Bailey meter instructions).
    1.744 x 20,200 x .990 x 995 = 34,-703 lbs. hr.
    B. By General Electric flowmeter:
    Average pen reading from flowmeter chart—6.8. Multiplying constant: (From manufacturer's instructions):
    6900 x .829 x 1.115 x 1.0 x 717 = 5119.1.
    Actual weight of steam per hour, 5119.1 x 6.8 = 34,810 lbs. average.
    Average of Bailey and General Electric—34,756 lbs. per hr.
    Total steam output for 24 hours as meter: 34,756 x 24 = 834,144 (14).
13. Factor of Evaporation:
    (From steam tables)—1.444 (15).
14. Total equivalent evaporation from and at 212°F. pounds. Item 12 x Item 13 = 954,261 (16).
15. Equivalent evaporation per hr. from and at 212°F.
    Item 14 / 6250 = 39,761 pounds (17).
16. Equivalent evaporation per hr. from and at 212°F. per sy. ft. of heating surface:
    Item 15 / 6250 = 6.25 (18).
17. Rated capacity per hour from and at 212°F.:
    625 B.h.p. x 34.5 = 21,563 (19).
18. Percentage of rated capacity developed:
    Item 15 / Item 17 = 184.6% (20).
19. Equivalent evaporation from and at 212°F. per lb. of dry coal:
    Item 15 / Item 10 = 9.38 (21).
20. Heating value of 1 lb. of dry coal: 13,572 B.t.u. (from item 7) (22).
21. Efficiency of boiler, furnace and grate:



GRAPHICAL LOG, SOOT BLOWER TEST, BOILER NO. 544, RUN VI., TUESDAY, FEB. 11, 2 P.M., TO WEDNESDAY, FEB. 12, 2 P.M.



GRAPHICAL LOG, SOOT BLOWER TEST, BOILER NO. 544, RUN II., FRIDAY, FEB. 7, 10 A.M., TO SATURDAY, FEB. 8, 10 A.M.

Item 19 x 970.4
——————— = 67.1% (23).
Item 20

Calculation of Composite Results for Runs 1 to 4 on Boiler No. 544 With Soot Blower

1. Average uptake gas temperature.
   Final corrected uptake temperature for each run added together and averaged, 499.6°F.
2. Total dry coal.
   Total dry coal for each run added together, 260,587 lbs.
3. Total equivalent evaporation from and at 212°F.
   Sum of equivalent evaporation for each run added, 2,591,638.
4. Rated capacity from and at 212°F. lbs.
   96 hours (for 4 runs) x 21,563 = 2,070,048 lbs.
5. Per cent. rated capacity developed:
   Item 3
   ——— = 125.2%.
   Item 4.
6. Equivalent evaporation from and at 212°F. per lb. of dry coal:
   Item 3
   ——— = 9.96 lbs.
   Item 2.
7. Heating value of 1 lb. of dry coal.

This was determined by weighing the calorific value for each run according to the proportion of the total coal consumed during that run, as follows:

1	2	3	4
	Dry Coal consumed per run, lbs.	B.T.U. of 1-lb. Dry Coal.	Per. Cent. of Total Dry Coal Consumed. (1 divided by total)	Portion of B.T.U. Assigned to composite 2 x 3
Run 1	35,713	13,827	13.7%	1,890 B.T.U.
Run 2	50,190	14,042	19.2%	2,700 B.T.U.
Run 3	72,835	14,223	28.0%	3,970 B.T.U.
Run 4	101,849	13,572	39.1%	5,280 B.T.U.
		Composite Heating Value		13,840 B.T.U.

8. Efficiency of boiler, furnace and grate:
   Item 6 x 970.4
   ——————— = 69.8%.
   Item 7

A summary of the principal data and results of the test on boiler No. 544 is given herewith as Table 1. The same material has been tabulated for boiler 530, but as it does not materially differ, it is not here included.

Referring to boiler No. 544, it will be seen that the ratings attained in the run with soot blowers varied from 71.6% to 184.3%, or normal, with an average of 125.2% for the four runs. The ratings without soot blowers varied from 76.3% to 168.2%, with an average of 120.3%. This again indicates a fairly close duplication in the second series of conditions in the first series. It may not be out of place to say here that although it was attempted to hold certain definite average conditions in the first series, and this was not as successful as could be desired, yet the second series was a duplication of the first as nearly as possible, because the entire test was to be comparative one between two methods of boiler operation under similar conditions.

Item No. 23 on the summary sheet for this boiler shows an average combined efficiency of 69.8% with soot blowers in operation, as against 68.4% without the soot blowers. This is an actual gain of 1.4%, due to soot blowers.

The average value of the flue gas temperature for the series with soot blowers, 499.6 deg. F., against 535.7 deg. F. without the soot blowers. This represents a decrease of 36.1 deg. using soot blowers, as in the case of boiler No. 530, means that with the soot blowers in operation, the boiler has absorbed more heat from the gases, due to cleaner heating surface, than without the soot blowers. The effect on superheat, as indicated in the graphical summary, was about the same as for boiler No. 530, but not so marked.

It has been stated previously that with the present practice of cleaning the boilers with the hand lance, each boiler is cleaned every four or five days. In the tests on boilers No. 530 and No. 544, without soot blowers, in order to reproduce this condition, the series was started with the boiler heating surface clean and then left without any cleaning during the series. If the series had been

extended for, say, an equal period, or longer, and if during that time the regular hand method had been used to clean the boilers on the regular schedule, it is very probable that a still greater rise in flue gas temperature and still greater decrease in combined efficiency would have resulted. This statement is made because it is believed that with the present hand method, owing to the fact that all soot is not removed, there is a gradual accumulation on the heating surface, the longer the boiler remains in service. Therefore, based on the above, it is safe to say that the results obtained were conservative, that a more exact test along the line indicated would show better results.

In addition to the above, may be mentioned the fact that operation of the soot blowers does not require the banking or shutting down of the boiler, while in order to remove the soot by hand method it is necessary to shut down the boiler for two or three hours, during which time the boiler setting cools and must be warmed up again. Here is a loss which is eliminated by the use of soot blowers.

It has been stated that the steam used by the soot blowers was not included in computing boiler efficiency. In other words, the boiler was charged with this steam. On the other hand, since no steam was used in the tests without soot blowers, the boiler was not charged with steam for this purpose, but it is equivalent that in a long series, as in actual practice, considerable steam would be used for cleaning by hand lance, which would have to be charged to the boiler, therefore further decreasing the combined efficiency.

In conclusion it should be noted that these tests were conducted in a manner calculated to indicate a minimum, rather than a maximum improvement by the use of soot blowers. It would have been fairer, in the writer's opinion (he was not connected in any way with the making of the tests) to have refrained from using the soot blowers at all before making the tests without soot blowers, using the hand lance only to clean the boilers at the regular periods of cleaning. Had this been done, the boilers would not have had the advantage of being thoroughly cleaned by the mechanical blowers when they entered the hand-hose test.

Table II contains a summary of the benefits, exclusive of decreased labor and labor turn-over, of using the soot blowers. It shows that even under the conditions given, the soot blowers would pay for themselves in a comparatively short time.

August 25th of this year is the centenary of the close of James Watt's life. At a meeting of the engineers of Birmingham (the city of his adoption) it has been decided to erect a James Watt Memorial Building to serve as a museum, and also to endow a professorship of engineering, to be known as the James Watt chair, at the University of Birmingham, for the promotion of research in the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy.

TABLE II.

Comparison of Composite Results With and Without Diamond Soot Blowers.

	Boiler 530	Boiler 544
Decrease in average uptake temperature with Soot Blowers	88%	36.1%
Percentage gain in efficiency of boiler, furnace and grate with Soot Blowers	2.15%	2.05%
Value of saving of coal per year based on 1918 consumption and prices—		
In West Boiler Room		$8,559.86
In East Boiler Room		5,503.19
Total saving		$14,063.05

GROUP OF DELEGATES AND EXHIBITORS AT THE C.A.S.E. CONVENTION, BRANTFORD.

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POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power, and to the design and operation of Refrigerating Machinery.
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Perpetual Motion

EVERY so often someone who should know better, someone with engineering experience and training, brings forth some perpetual motion scheme, usually in its conception as old as the hills. Sometimes it is an electrically-heated boiler, steam engine and generator and sometimes a generator and motor, variations being rung in by juggling the speeds of the machines or having them different. Most of these false conceptions as to the availability of energy arise through the confusion of speed of rotation with work.

Perpetual motion, as envisioned by its devotees, is distinct from the engineering principles often forming the basis of somewhat chimerical schemes for the utilization of the power inherent in wave motion or, as suggested by a correspondent writing to an American scientific paper, the utilization of the residual energy of tap water before it enters the sewer. Such things have as their basis some germ of engineering fact but fail through their application to things of little account.

Such is not the case with perpetual motion and anyone who has an idea, in its essence more foolish than the search for the philosopher's stone, transmuting base metals into gold, would be well advised to hie himself to a secluded corner and apply the principle of the conservation of energy to his own thoughts and to their misguided conceptions.

The nearest approach to a source of inexhaustible energy obtained without effort is found in the action of the radio-active elements, and in this case, enormous as is the store of in intra-atomic energy and lengthy as is its life, it is not everlasting but slowly diminishes and is created at the expense of the radio-active element itself, the final product being lead of a slightly varying atomic weight.

Using Power of the Tides

THE feasibility of securing a supply of electrical energy from the tidal waters in the coastal rivers of Britain is again being made the subject of close study. For some time this question has been approached more as an academic perennial than as a practical accomplishment.

Judging from figures that are now out there has been a real move made. J. Smith & Co., engineers of Glasgow, have worked on the idea for years, and are well posted on all needful data. The river Severn at Pitshead, for instance, supplies (on paper as yet) 4,773,730 H.P. The Dee, in North Wales, at Point of Air, Manai Straits, and the river Mersey above Liverpool Docks—show a total of 5,651,984 H.P. It is claimed that by this scheme power could be generated and sold at a fraction of the present prices.

An explanatory guide to the tidal waters power scheme has been prepared by Mr. Smith, who points out that on all rising tides the head water runs through turbines into inside of weir; on all ebbing tides the water runs through turbines to outside of weir. All doors are closed at low water, keeping out the rising tide; also at high water, keeping in full tidal water. All rivers start turbines working at half tide rising or falling. This gives the half tide head for the working of the later half. There being about three hours between the time of high water at the weiring point in the Severn and the other rivers, this gives three hours' run for the Severn, starting at half rising tide—say, 17 ft. head—inside water being at low water and finishing at high water, 34 ft. minimum tide. The other rivers being now at half rising tide, they take over the working from the Severn until high water on their rivers.

The scheme has in view the furnishing not only of power, but of light to all the homes in Britain.

It's The Net That Counts

MR. DOOLEY was one of the leading restaurant keepers in a small town. Recently he purchased a cash register. The documents of the first trade to be recorded were a 27-cent check and a five dollar bill, the proud proprietor rang up $5.00 and paid out $4.73 in change. When the next customer presented his check it was for 35 cents and a $10 bill was passed over the counter. Dooley operated on the $10 key. Thus things progressed throughout the day. That night, upon checking up, he discovered according to the machine that he ought to have $250.00 on hand, although a careful inventory revealed only $17.30.

"Terrance," said Dooley to his assistant, "have yez taken anything out in the new cash machine to-day?"

"Shure," said Terrance, "I took me carfare home."

"And where d'yez live," inquired Dooley, "Australia?"

Like Mr. Dooley, many a man in charge of a business is ringing up gross profits without the faintest idea of what his net profits really are. And like Mr. Dooley, if he keeps on hammering the gross receipt button, he is "going to have a disappointment in his life," as the fortune tellers say, for after all it's getting the net that counts.

Mr. Wills Maclachlan was elected one of the vice-presidents of the American Institute of Electrical Engineers at the annual meeting of the Institute held in New York, May 16.

* * *

Mr. F. T. Kaelin has been appointed chief engineer of the Shawinigan Water & Power Co. He was formerly assistant chief engineer, and joined the staff in 1902, coming to Canada from Switzerland.

* * *

In considering belt efficiency, grip and tension are terms often confused. Increase of tension certainly gives a firmer grip, but additional strain is thereby thrown on the driving shafts. An increase of grip due to suitable dressing is free from that disadvantage.

* * *

SOME wise men have it all figured out that people should produce more and save more. With the first suggestion no person is going to find fault, but with the latter there is good reason to start an argument. Will some of the wiseacres please go into detail and show how anything can be saved while everything necessary to existence camps on a peak-load basis?

* * *

A French patent has been granted to P. L. Weston, for the use of thin steel or iron belts on magnetized pulleys for the transmission of power. The magnetization of the pulleys is effected by windings lying in helicoidal slots on the surface of the pulleys. The thickness of the belt should not exceed about 0.06 times the diameter of the smallest pulley.

* * *

With a steel belt of 1-6 in. thickness making contact over an arc of 145° on a pulley of 10 in. diameter running at 4,000 R.P.M., it is possible to transmit more than 200 H.P. per inch width of belt. With a pulley of 50 in. diameter running at 800 R.P.M., a belt of 1 in. width will transmit 1,000 H.P. Steel belts may be run at speeds of 18,000 ft. per minute, so that this method is suitable for speed reduction with turbines.

* * *

The use of electricity in industry saves both fuel and labor. This fact is recognized throughout the world to-day and in order to secure these advantages practically all the nations are now considering plans for the electric generation of power. In England, Belgium and France, among others these plans are being prepared by official commissions, so that a tremendous activity in electrical power development may be expected following the advent of peace. In all cases the ideal in view is a broad one to use electricity for all possible power purposes, including railway operation.

* * *

The science of measuring has developed to such an extent for industrial purposes, in connection with gauge making, that science has been called in to devise a commercial application of the wave length of light as a standard. As a standard of length the length of a wave of light is admirable. It is a standard which cannot change with time, which can be duplicated anywhere in the world at any time; one which cannot be stolen, lost, or destroyed, and one which is susceptible to a greater accuracy than the standard meters or yards deposited in Government institutions.

* * *

Refinements in manufacture and the consequent refinements in gauges, etc., have reached such a stage that accuracy approaching the millionth of an inch has been possible. It is interesting to visualize the magnitude of a millionth of an inch. For instance: If we will visualize a round piece of steel one foot long, projecting horizontally from a vise and one-half inch in diameter, and a common house fly alight on the end of the bar, the conditions are such that the bar is deflected or sprung downward by the weight of the fly approximately one millionth of an inch. Engineering experience and observations with light waves prove this fact.

* * *

The effective pulling power of a belt is the difference in tension between the tight and the slack sides. Thus it is obvious that the greater the grip of the belt on the pulley, which increases proportionately with the arc of contact, the greater is the power that it will transmit. Hence it follows, that a belt running slack provided it grips the pulley firmly, will give a better grip over a greater arc of contact than a tight belt. Some forms of belting possess less elasticity and resiliency than others. The value of a pliable belt lies in the fact that the tension on its slack side may be decreased in a much greater degree than when a hard belt is used.

* * *

A Good Testimonial

We don't take in washing, but here's a story on the sales department. The other week a lady called up and asked to have an electric washing machine sent up on free trial, as we were offering at that time.

An attendant went along with it, and he doffed his coat and got to work on the wash. In no time the work was done, and then milady called us up and said:

"Thank you so much for the washing machine. I was leaving to-night for Calgary and I could never have got my washing done. Will you please send up for it before 5 o'clock?"—B.C. Buzzer.

* * *

Paper has been used extensively in Germany for driving belts and it is interesting to know that knitted or plaited belts of paper yarn have been found to stretch more than those of woven fabrics, the warp threads in the latter running straight. Woven belts are most suitable for steady-running machinery at moderate speeds, but are liable to wear away at the edge on stepped pulleys and when frequently changed from fast to loose pulleys and vice versa by belt forks, unless the latter are provided with anti-friction rollers. Single ply woven belts are only about half the strength of those of equal thickness made by lapping several layers of fabric together. A force of 10 H.P. can be transmitted by a 4-in. belt. The belts are made of paper alone or with a core layer of cotton or wire mesh, secured by sewing the inlay, reducing the tendency to stretch and increasing the working life of the belt.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

35. What surfaces, owing to their shape, require no bracing to resist an internal pressure?

36. Classify the stays used in bracing boilers?

37. How are crown bars usually constructed?

38. What means are adopted to give warning when a screwed staybolt breaks?

39. State how the crown sheets of combustion chambers of marine boilers are generally braced?

40. How are the tube-sheets of high pressure boilers braced?

41. How are stay-tubes fastened to the tube-sheets?

42. What is an Adamson ring joint?

43. What good feature is embodied in corrugated furnace flues?

44. Explain the purpose of boiler tubes; state by what process they are made and how they are designated.

45. What process of manufacture produces the best steel boiler tubes?

46. State the purpose of a combustion chamber?

Questions Answered

Question 29. Explain the purpose of the steam dome. (b) How are steam drums connected to the boiler and what provision is made in the latter case for expansion?

Answer (a)—It forms an auxiliary steam reservoir. (b) In the case of a single boiler, preferably by one nozzle placed in the centre; in the case of a battery of boilers the header is usually connected to each boiler by a curved pipe sufficiently long to permit free expansion and contraction.

Question 30.—Explain the purpose of the mud drum.

Answer.—As implied by the name, it is a receptacle for the collection of mud and sediment.

Question 31.—What is the purpose of manholes, and how should they be placed so as not to weaken the shell unduly?

Answer.—To admit a man to the inside of the boiler, manholes should have the long axis parallel to the girth seams when placed in a boiler shell.

Question 32.—How are steam domes attached to the boiler and what are the advantages of properly constructed dome bases?

Answer.—(a) Either by flanging the dome body, or by using a dome base, and riveting. (b) They form an excellent means of reinforcing the boiler shell, and are strong where a flanged dome body is weak.

Question 33.—Explain the purpose of nozzles as applied to boilers?

Answer.—They serve to reinforce the sheet and form a convenient means of attachment for pipes and fittings.

Question 34.—Explain the purpose of stays or braces.

Answer.—They strengthen a plate not strong enough in itself to resist the pressure.

THE PERFORMANCE OF THE MOTORS THAT CROSSED THE ATLANTIC FIRST

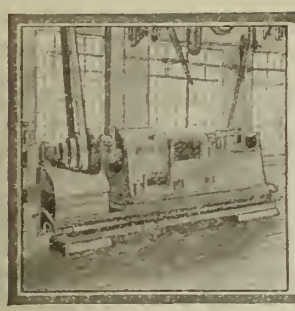
The crowning triumph for the Rolls-Royce aero engine is the first direct Atlantic flight, accomplished in 15 hours, 57 minutes, on a Vickers "Vimy" plane. Not the least remarkable part of the feat is the high average speed maintained, viz., 117½ miles an hour. Evidently the two Rolls-Royce engines fitted to the Vickers Vimy plane must have worked perfectly throughout the 1,880 miles flight.

It has been calculated that if the Atlantic crossing were completed in 20 hours by one Rolls-Royce engine running at an average of 1,800 revolutions per minute, its performance would be as follows (in a two-engined plane such as the Vickers Vimy the operations would naturally be doubled): Each engine will make 2,160,000 revolutions, and each piston will travel up and down the interior of its cylinder a total distance of 440 miles. As the Rolls-Royce engine has 12 pistons they will in all travel 5,280 miles. The valves will be operated some 25,920,000 times in each engine, the magnetos and sparking plugs having to deliver the same number of sparks for the ignition of each engine.

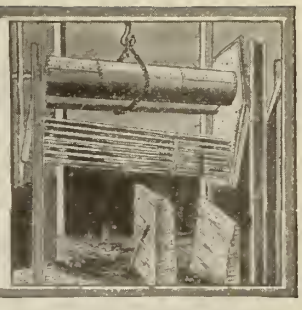
The recent history of the Rolls-Royce aero engines discloses one or two very interesting facts.

On Nov. 11, 1918, when the armistice was declared, there were in possession of the R.A.F., Rolls-Royce aero engines of a total horse power of over 1,000,000, which far exceeded that of any other make of aero engine in use. Previous to armistice day, Nov. 11, 1918, there had been constructed 122 Handley-Page bombers of which no less than 113 were fitted with Rolls-Royce engines. Prior to the same date, 1,524 complete Bristol Fighters had been delivered, of which number 1,364 were also equipped with Rolls-Royce engines. Rolls-Royce engines were used exclusively in the planes of the London-Paris Government courier service for the conveyance of the ministers, officials and despatches to and from the Peace Conference, the speed record between London and Paris, viz., 75 minutes, standing to the credit of the Rolls-Royce aero engine. The only two aeroplanes which have flown from England to India were both fitted with Rolls-Royce engines.

When a steel article with a metallic coating is scratched or abraded so that a small area of steel is exposed, the two metals will, in the presence of atmospheric moisture, form a galvanic couple or cells in which a current will be set up. The metal, which is electro-positive to the other, will be oxidized, while the electro-negative metal will remain uncorroded. When the coating is zinc, it is the zinc which will be oxidized. If, however, the coating be tin, which is electro-negative to iron, the steel will be attacked. Therefore tin as a protective coating is useful only so long as the coating remains everywhere continuous. Aluminum makes a good protective coating for steel. In the method called calorizing the metal object is placed in a mixture containing aluminum and heated up to 900 to 950 degs. C. By this means a coating of aluminum which penetrates into the iron is obtained.



NEW POWER PLANT EQUIPMENT



GASOLINE MOTORS FOR STATIONARY WORK FOR DRIVING CENTRIFUGAL PUMPS AND ELECTRIC GENERATORS

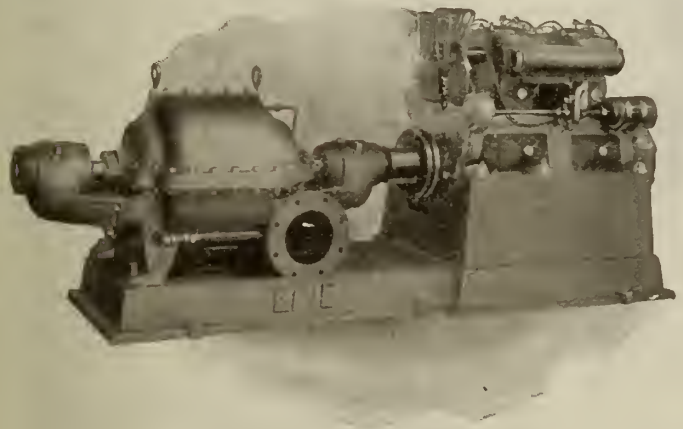
The Sterling engine, manufactured by the Sterling Engine Company, Buffalo, New York, and designed for driving centrifugal pumps and electric generators, a development of their marine product, has been manufactured for over 14 years. The racing engine, built by this company, has held the world's speed record for eight consecutive years.

The records made by the motors, and the reputation they have gained in the marine field for exceptional power and longevity, has led to the redesigning and adaption of the engines for stationary work, and to-day there are numerous units installed in townships, villages, and manufactories as standby plants for fire protection; driving centrifugal pumps and generators. The motors are admirable for this service, as they develop their rated power at a speed most desirable for the work.

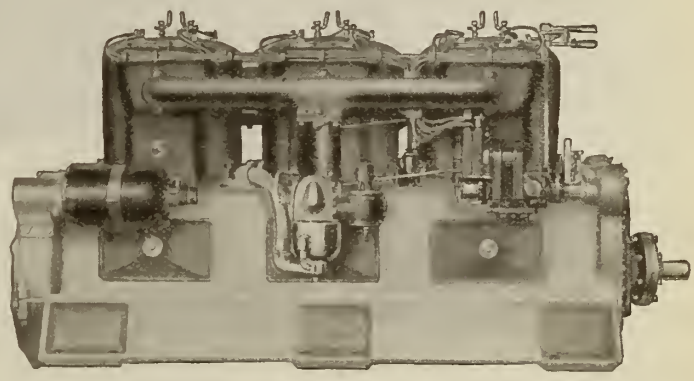
Neat enclosure of all moving parts of the models FC and EC is arranged in the design, and there is unusual provision for accessibility. All covers are easily removed and attached, and ample space is provided in which to make adjustments if required. The engines are remarkably smooth running and quiet, as vibration has been practically eliminated. Longevity is assured through the extensive use of drop forgings for camshaft and connecting rods, and for bearing caps, crankshaft and camshaft gears, in addition to which bronze and aluminum castings of great tensile strength are specified throughout the motors, the material being the best procurable. The manufacturing of such engines requires up-to-date machinery and efficient machine shop methods, and in Sterling's accurate dimensions are adhered to so that parts ordered in replacement will always fit properly. The testing is rigorous and severe, and the motors are "run in" a considerable time before shipment.

The models FC and EC 17-25 h.p. motors incorporate a hollow crankshaft force feed lubricating system, oil being pumped to all main and connecting rod bearings through the crankshaft, admittedly the most advanced and efficient system in use to-day. An oil sight gauge and an oil pressure gauge are provided, so that one has a constant check on the oiling system.

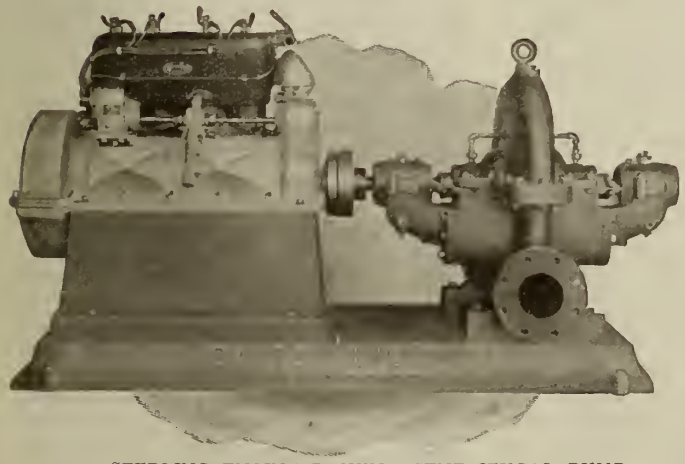
The equipment of electric starter and electric generator, with battery, assures power immediately to meet any emergency. This power is constant as the motors may be depended upon to run satisfactorily for long periods at maximum r.p.m. under full load.



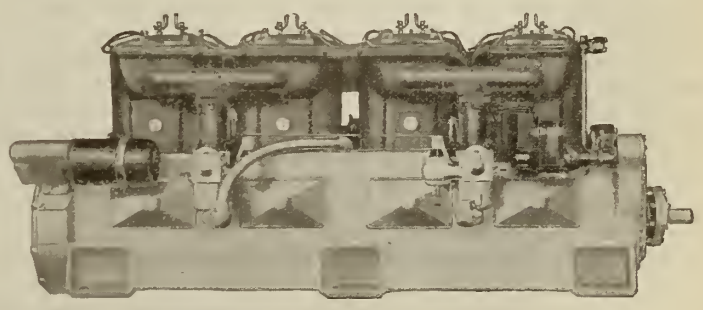
PUMPING UNIT FOR LOW HEADS.



SIX-CYLINDER STERLING POWER PLANT UNIT.



STERLING ENGINE DRIVING CENTRIFUGAL PUMP.



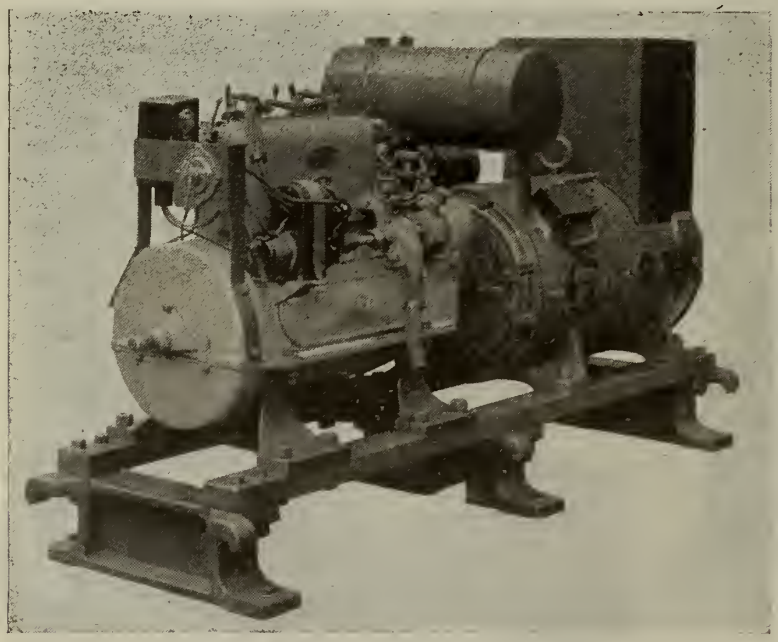
EIGHT-CYLINDER POWER PLANT UNIT.

The Sterling Line of Stationary Engines

Model	Cylinders	Bore	Stroke	R.P.M.	H.P.	Base
FC*	4	5½"	6¾"	800-1200-1400	55-85-100	Iron.
FC*	6	5½"	6¾"	800-1200-1400	85-125-145	Iron.
FC*	8	5½"	6¾"	800-1200-1400	115-170-200	Iron, lower. (Bronze, upper.
FC*	8	6¾"	9"	800-1000	240-300	(Iron, lower. (Bronze, upper.
DC-12	2	5½"	7"	400-500	12-15	Iron.
EC 17-25‡	4	3¾"	5½"	600-1000-1200	17-25-30	Aluminum.

*Regular equipment includes electric starter generator (single unit).
‡Regular equipment includes electric starter-and generator (2 units).

Model FC motors having T head cylinders are regularly designed to turn anti-clockwise facing the flywheel end,



STERLING ENGINE DRIVING GENERATOR.

but can be furnished for clockwise rotation if desired The drive is taken from the crankshaft, which projects from the after end of the motor, and which is machined for mounting a flexible coupling. The models DC and EC can be arranged for drive connection at either end. The EC and DC motors being of the L head type are built to turn anti-clockwise only. The construction of the base enables a simple foundation. Where a radiator is used an air-cooled exhaust manifold with an expansion joint between each cylinder casting is provided; however, a water-jacketed exhaust manifold creates less heat, and is a protection for the operator this type of manifold being installed where a supply of water is available.

THE FRACTURE OF A FURNACE WHILE ITS BULGE WAS BEING SET BACK

Expertness in setting back bulged furnaces has improved very much of late. This is probably partly due to the increasing number of cases, due to war conditions, and partly to the difficulty of obtaining plates for replacing damaged furnaces. One of two cases which ended in failure should, therefore, prove of interest as it indicates the dangers to be avoided. When the bulges are relatively slight they are usually set back cold, but when deep they are heated by fires, usually by Wells lamps, set back hot and finished-off cold. In one case during the cold finishing-off process on a bulged furnace, a circular piece of plate measuring 10 in. diam. burst out of the furnace plate. The nature of the fractured surface left no doubt that the fracture was an instantaneous one, except over a length of about 1½ in. where the edges of the plate were slightly bent. This curious piece of plate is to be seen in our museum. The following is the most probable explanation of this mishap: In 1886 I ead a paper before a meeting of the Institute of Civil Engineers in which a large number of experiments were discussed which proved clearly that both wrought iron and mild steel have a common critical temperature, usually called blue heat, because bright steel or iron changes color through straw to purple or blue, at which temperature the material, although softer than when cold, is in a rotten condition and usually breaks if bent. If the bending be stopped before either breakages or cracks occur, and if the sample be put aside for a short period and the bending continued, or the sample straightened, then it is almost sure to break. Other mechanical manipulations while the steel is "blue hot" will also impart to it permanent brittleness. Thus on the occasion of the reading of the above paper, a bar of mild steel about 1 in. wide and ½ in. thick had been bent double at one end while cold in order to demonstrate its ductility or toughness, the other end of the bar had been polished and warmed between heaters until it commenced to change color from straw to purple and blue. While at this temperature it was placed under a steam hammer and reduced in thickness from ½ in. to ⅜ in., and was then laid aside for the meeting, at the end of which it was struck against a small anvil and broke in two. The ends of this sample were preserved and retested after waiting about 30 years, when they were still found to be as brittle as at first. Evidently age nas no beneficial effect on improperly worked steel; it can only be restored to its originally good condition by annealing. These experiments explain why the application of heaters to flanges, and other parts of boilers which have to be slightly bent, very often leads to cracks, which are called mysterious, because the true cause, the heaters, are either not mentioned or have been forgotten. Now what had happened in the present furnace mishap was very simple. The bulge had been heated by a Wells lamp. The centre was said to have been red hot, and there must therefore have been a circular zone over which the temperature was a "blue heat" during the time that the bulge was being pressed back. The setting back appeared to be perfectly satisfactory, but next day it was thought that a further improvement could be effected by re-applying ram pressure on the cold plate, with the result that the plate fractured in a circular line through the zone which had been made permanently brittle by being bent while "blue hot." It is therefore evident that in future, if furnace bulges have to be heated before being set back, they should be re-heated after they have been set back.

The annual output of thirteen billion gallons of petroleum in the United States consists of 1,800,000,000 gallons of kerosene and about twice as much gasoline, the remainder being gas oil, distillate and light and heavy residuals.

* * *

Where great power is applied slowly, particularly when space is at a premium, the worm-and-wheel drive is seen at its best. Another advantage of this type of drive is the ease with which it can be kept oiled. Perhaps greased would be a better term because the worm frequently works in grease. The whole drive is usually enclosed in a grease-tight box, though which passes the driving shaft.

* * *

In a certain plant the technical magazines which are received are first read by the engineers in the office. They are then placed in a box made especially for this purpose, at the employees' entrance. Any worker may take one at a time home, and after reading it, return it to the box so that other employees may read it. This scheme is worthy of more general application.

The Operators' Point of View

POUNDS OF AIR REQUIRED PER POUNDS OF STEAM GENERATED, INSTEAD OF POUNDS O FAIR REQUIRED PER POUNDS OF COAL

Those who have not given this matter any thought would do well to analyze the following:

After a little experimenting with com mon draft gauges, I found that the quickest action of the liquid in the tube took place when they were connected up as shown by enclosed sketch. I noticed that a very small hole in the fuel bed, or by opening the fire-door slightly, the action of the liquid in the tube was almost instantaneous. It then struck me that some means of measuring the amount of air admitted to the furnace would be of more value than a CO_2 recorder as a guide to the fireman, due to the fact that its action would be much quicker: But herein the problem that confronted me was that some means of knowing the amount of coal being fed to the furnace, the B. T. U.'s contained therein, etc., must be known.

Well, bearing in mind that the B. T. U.'s in the coal is the direct means of generating steam, and that it was and is a simple matter to make a beautiful CO_2 chart, but who is going to make the steam? It seldom happens that the fireman who makes the nice chart makes the most steam. So again with "a steam flow meter in mind" it then was only necessary to find the difference in the amount of air required in proportion to the number of B.T.U.'s in the coal.

First take the following, the two extremes of carbon and hydrogen which form practically all our commercial fuels in various ratio, we find the number of B. T. U.'s per pound of oxygen combining with hydrogen is about 7,800, while that of oxygen combining with carbon is about 5,400 B. T. U., a difference of only about 28 per cent.

Now in actual practice we find the fuel containing the highest percentage of its combustible in the form of hydrogen is natural gas, having about 25% by weight, on the other hand anthracite coal or coke having little or no hydrogen. Figuring this out you will find that the number of B. T. U.'s per pound of air required to burn these two fuels is only about 7 per cent.

Now again figuring from many of the commercial coals used in our power plants the difference in B. T. U.'s developed per pound of air is between 2 and 3 (%) per cent., say 2.5 per cent., which is much closer than any of the power house men expect to have the air regulated to the furnace.

Now from this it is seen that a problem presents itself, but which is quite easily solved. It is the aim and object of everyone dealing with the generating of steam in a boiler by the use of coal to transmit to the water in the boiler the largest possible number of B.T.U.'s contained in the coal. The most of this work depends on complete combustion, which of course depends on the amount of oxygen entering the furnace, consequently the amount of air.

Now, as before stated, the number of B. T. U.'s developed from the ordinary fuels per pound of air vary only 2.5 per cent., it stands to reason that the pounds of air required per pounds of water evaporated or steam generated must be in very close relation.

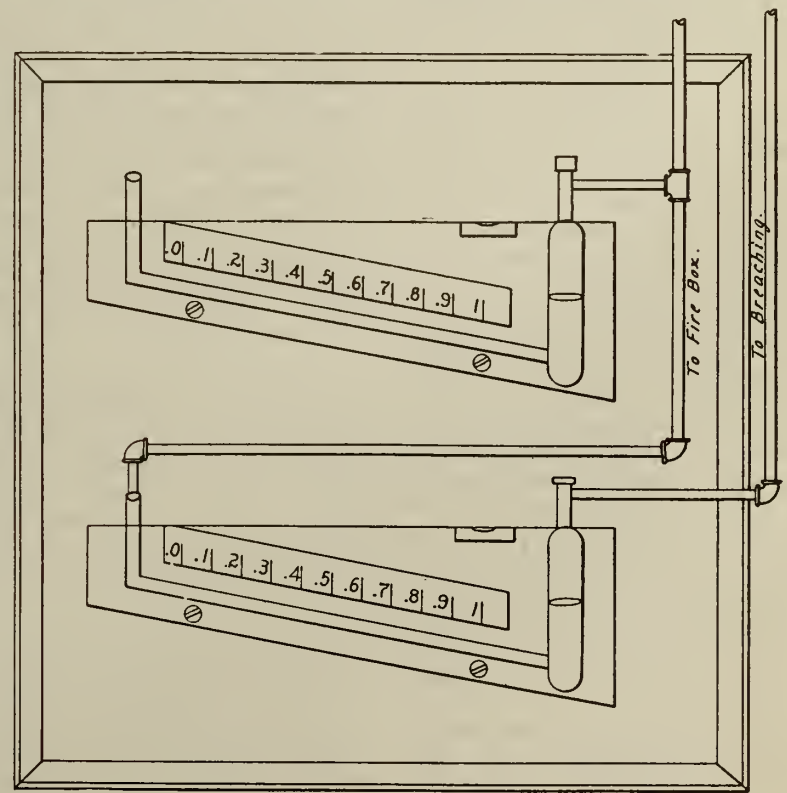
Or in other words the amount of air required per B. T. U.'s developed from any commercial fuels has a direct bearing on the number of pounds of steam turned out. And any variation from the above means a loss of efficiency in the boiler. This of course holds true only when the boiler, etc., is in good order, but once the highest efficiency has been established and the combustion in the furnace has been found to be perfect, or nearly so, "there will be an exact amount of air required in proportion to the steam generated regardless of the character or quality of the fuel." "And any variation from the above will result in a loss of efficiency."

There is now manufactured a boiler meter, and which has been on the market for about three (3) years, that measures the flow of air to the furnace, the flow of steam from the boiler and records the temperature of the flue gases. Also if desired can be fitted with a pointer that will record the condition of the fire. So in conclusion I would suggest that anyone interested in boiler and furnace efficiency would do well to analyze the above and if found as stated, which they no doubt will, can not do otherwise than recommend the use of these "Boiler Meters," as long as the word "efficiency" is used in the boiler room.

—F. F. McNeil.

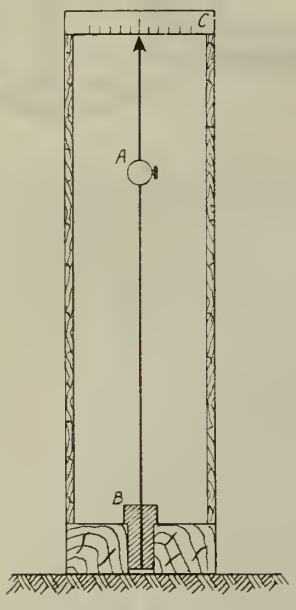
A HOME-MADE SEISMOGRAPH

Something somewhat out of the line of POWER HOUSE work, but that is,



CORRECT METHOD OF CONNECTING DRAFT GAUGES TO A HAND-FIRED FURNACE.

nevertheless, very interesting and can be made by all power house workers is a very easily made, simple seismograph. It is quite as sensitive as an expensive factory-made one. Of course, it makes no written record; neither will it show a horizontal shock. The raising or lowering of the ball A will lengthen or



SEISMOGRAPH.

shorten the time of the stroke. The upright is a piece of spring steel wire, firmly fastened at the bottom. All the joints on the frame must be made rigid, so that none of them will absorb any part of a vibration of the earth. The least earth vibration will cause the point at C to move over quite a space. It must be remembered that the seismograph must be placed upon the earth, or on a solid foundation in direct contact with the earth.

JAMES E. NOBLE.

PLASTER OF PARIS FOR GROUTING

The grouting under one of the main bearings of a twin engine broke down and further tightening of the anchor bolts proved of no use.

As the engine could not be shut down long enough for concrete to be depended on to set hard enough, resort was had to plaster of paris.

The men who undertook to do the grouting had never handled the stuff before, so they mixed a batch big enough to do the job, with the result that it "froze" on them before they got nicely started. Their method of working was revised and the grouting poured. It held so well that the other side was done also.

The disadvantage of the plaster is that it must be handled so quickly. Only a quantity that can be poured from the dish or pail immediately on mixing should be prepared at one time. Plaster mixed with a little more than half its weight of water will make a paste that will not run. Additional water is necessary to make it suitable for pouring.

Its advantage lies in the fact that it sets quickly, making it suitable for hurry-up jobs.

As for its strength there need be no worry, as it will stand a pressure of 500 lbs. per sq. in., one hour after pouring and in twenty-four hours it will stand over 1,000 pounds, finally reaching a strength of over 2,300 pounds.

R. McLAREN.

POWER PLANT KINKS AND OTHERS

By J. E. McCormack

When two or more bicyclists are out riding and one meets with an accident which disables his front wheel it is sometimes possible to remove the damaged wheel and its mudguard, then remove the mudguard from the rear wheel of the other or one of the other bicycles (which we will call No. 2) and slipping the front forks of No. 1 straddle of the hind wheel of No. 2, attach both pairs of forks to that wheel (that is, its own pair and the front pair just mentioned). This makes practically a three-wheeled tandem. Both riders can thus ride and pedal, but the rider in front must steer for both. The two mudguards and the damaged wheel may be carried along as excess baggage. It may not always be necessary to remove the two mudguards. It depends on how much room there is after both forks have been placed on the one wheel. This method is not original with me. It came to me through a machinist, but whenever I have mentioned it to members of the bicycling public it has been received as though new information. It may, however, be well known in some sections.

* * *

To prime a pump that has a suction hose on, I have seen this method succeed on the first trial after a lot of time had been fruitlessly spent trying to prime from above by pouring water into the pump through a tee on the discharge pipe connections.

The lower end of the hose was raised to the level of the top of the pump and the whole filled with water. then when starting the pump the hose was allowed to drop into the normal position below. In future trials I never knew this method to fail.

Another method, but used in connection with a hoist (as in prospecting, etc.), is to attach a tub of water to the cable of the hoist and raise it to the level of the pump, then with the pump hose coiled up in this, start the pump and when it begins to take water properly lower the tub quickly into the water below by the aid of the hoist—the hoistman acting on the pumpman's signals.

* * *

A suitable sized iron hand wheel taken from an engineer's old globe valve can be used when boring small holes by hand. Bits with tapered square shanks to fit a carpenter's brace are used and the shank inserted in the square hole in the hand wheel. I like this better than a gimlet to bore with. All makes of valves of one size do not have hand wheels exactly alike, but generally a wheel from a ½-inch valve is suitable. The hole should be large enough to take a good hold on the bit shank but not large enough to let the shank pass through far enough to chafe the palm of the hand.

* * *

When putting a cork into a bottle one generally gives it a little twist in one direction. This gives the fibres a set or trail backwards and when removing the cork again, twisting it in the opposite direction to which it was twisted while inserting tends to give these trailing fibres a slight expanding clutch action, whereas twisting in the same direction as when inserting maintains the trailing position of the fibres and so the cork comes out easier accordingly. I have found the same rule to apply to metal parts which screwed together. When stuck they will sometimes start by turning on them with a wrench in such a way as to, if possible, screw them further in when they had already refused to budge the other way without danger of breaking. I have used this kink occasionally for several years and believe that it applies more especially to brass than to iron and least to steel.

* * *

One who works more in metal than in wood, but sometimes in either or both, occasionally bumps up against a small job in wood-working where a fine-toothed saw is desirable but owing to being seldom required is not purchased. In such cases a hack saw for iron is more apt to constitute a part of the outfit. This was the case with me and I tried the hack saw by way of experiment. The results have led me to use it several times since in small jobs of fine work in wood. It sticks a little sometimes in basswood but in most woods, especially the hard woods, it works very well. If it has been used for metal previously it must be cleaned to avoid discoloring the wood during the first few cuts. This is not recommended as a substitute for a fine-toothed wood hand saw if there is enough fine work to make it worth while keeping the proper saw on hand, but it may be better than buying a new saw to seldom be used. The hack saw cannot take the place of a medium or coarse-toothed hand saw.

Figures have been given out showing the way in which costs of running the British railways have been mounting up. The present estimate of increased cost in working the railways during the financial year ending March 31, 1920, as compared with 1913, was from 104 to 109 millions, made up of war wages and other concessions, 57 millions; 8-hour day and new concessions recently gratified or still under discussion, 20 to 25 millions; and extra cost of materials and coal, 27 millions.

Care and Management of Lead Secondary Cells

By S. BUTLER

FROM a careful study of the chemical action in a lead storage cell published in a previous issue of POWER HOUSE, and the physical results of that action, one should be able to determine what treatment such a cell should get in order to obtain the best results, and the most efficient service. There is no piece of a power plant equipment that will deteriorate at so rapid a rate as the lead storage on secondary cell. The main points to be avoided are the following:

(1) For rapid charging and discharging.

(2) Use of impure electrolyte.

(3) Use of too dense or too light electrolyte.

(4) Overcharging.

(5) Overdischarging.

The disregarding of any one of these five points means disaster to the battery sooner or later, most likely sooner. A battery attendant should have some idea of elementary chemistry at the least, as well as the electrical side of the work. We will now take up the five different points in their rotation.

(1) Too rapid charging and discharging will lower the ampere hour capacity of the cell, due to the chemical action being too violent. The active elements

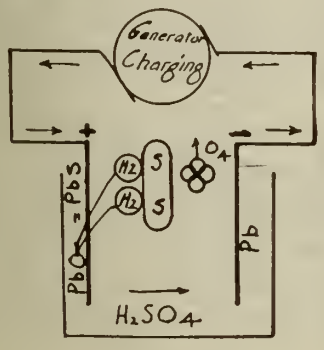


FIG. 1.

are not properly deposited on the plates and a deposit is likely to be thrown down in the bottom of the cell; this deposit, getting too high, would come in contact with the bottom of the plates and give trouble by short-circuiting them. If at any time this should occur the plates would have to be taken out and the deposits removed. This means a considerable amount of labor and a loss in the use of the battery, which cannot always be put out of commission.

Too rapid discharge. In the previous issue, diagram one should convey the thought that lead sulphate, $PbSO_4$, plus water (H_2O) is being formed, and if the lead sulphate is formed too rapidly it would be uneven in its formation, and the expansion not being evenly distributed the plate would buckle and loosen the active material, causing it to fall from the lead grid, and to come in contact with the other plate. This would give serious trouble. Or it may form a deposit of $PbSO_4$, lead sulphate, over the active material and the cell will become dead. It also lowers the density of the electrolyte due to so much water being formed. Manufacturers of storage cells usually allow a capacity of from 50 to 60 ampere hours per square foot of positive plate area, counting both sides of the plate. This capacity is computed on an eight-hour charge and discharge rate, which means that the normal rate of charge or discharge should be $\frac{50 \text{ to } 60}{8} = 6$ or 7 amperes per square foot of positive plate area, so you could take 6.5 amperes per square foot as a normal point.

Point No. 2. Use of impure electrolyte. This is where the operator would find a knowledge of chemistry a good asset. We will take up the acid part of our electrolyte first. In the manufacture of sulphuric acid, after it passes from the iron pyrites, FeS_2, to sulphur dioxide, SO_2, to the SO_3 stage, it is formed entirely in lead chambers and therefore carries with it a certain amount of lead sulphate, $PbSO_4$. Chemical pure sulphuric acid should test 1.84, temp. 59°F. Lead sulphate can be detected by distilling a small quantity in a test tube over a bunsen burner; the lead sulphate will remain at the bottom of the tube. Lead sulphate is slightly soluble in concentrated sulphuric acid, and the dissolved portion precipitates upon diluting the acid with water. Lead sulphate dissolves at a common temperature, 1 part $PbSO_4$ to 22,800 parts pure water, and is less soluble in water containing sulphuric acid. Lead sulphate can be removed by allowing the electrolyte to remain still for forty-eight hours after mixing the acid with water. Care should be taken to always put the required amount of water first, then add the acid, steadily stirring with a stick.

We will now consider the water in the electrolyte. Special attention should be given to this part of the electrolyte. Mostly all water contains some soluble foreign matter, mostly alkalies. Distilled water only should be used and filtered water avoided. Filtration being a mechanical operation, will only remove the suspended impurities. Any foreign matter held in solution can only be taken out by distillation. For example sodium coming in contact with sulphuric acid would form sodium sulphate, Na_2SO_4. Lime would form calcium sulphate or gypsum, $CaSO_4$. Traces of copper would form copper sulphate or blue vitriol, $CuSO_4$. Traces of iron would form ferrous sulphate or green vitriol. These are soluble salts. The latter two would cause local action in the cell.

Point No. 3. Too dense or too light electrolyte. The density of the electrolyte largely depends upon the conditions under which the battery has got to work. Example: A battery kept on float that is being run in conjunction with a charging generator, as a station control, or as a booster set for traction work. Such a battery could have a much

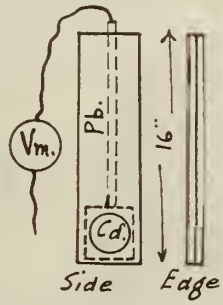


FIG. 2.—CADMIUM CELL TESTER.

denser electrolyte, because a battery under these conditions would never get a heavy discharge. And if at any time it should, it would not have to stand in that condition for any length of time. The advantage the battery would have is, it would have a higher E.M.F. or voltage and a decreased internal resistance; also a better discharge rate. If your working conditions are such that the battery may have to stand for any length of time in a discharged condition, then a lighter electrolyte is better, as the chemical action of weaker acid would not be so violent and the sulphating less. But the E.M.F. or voltage would be lower with an increased resistance and the discharge rate not so good; so it is well to know under what conditions the battery has to work.

Point No. 4. Overcharging. By referring to diagram No. 3 of the previous article, it will readily be seen that the H_2O part of the electrolyte has been formed up with the $Pb(SO_4)$ into sulphuric acid, H_2SO_4, leaving us with a positive plate of PbO_2, lead peroxide, and a negative plate of Pb or spongey lead, PbO_2 being the highest oxide which it is possible to form. This is where the battery should come off charge, but for example we will still keep on charge. The accompanying diagram will convey to you some idea of what is going to happen. The plates will turn a very black brown or nearly black in color. Re diagram S, sulphur combines with H, hydrogen, in the ratio as hydrogen and oxygen (H_2S) (H_2O) and form H_2S hydrogen sulphide. Hydrogen sulphide readily attacks lead compounds and forms PbS, lead sulphide. Hydrogen sulphide being a highly soluble gas would not be noticeable in the room. This action in time would ruin the plates.

Point No. (5) Overdischarging. This is a point that wants very careful atten-

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.
Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	38 81	35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto ...	$4 25
Steel bars, base, Toronto ...	4 25
Steel bars, 2" to 4" base...	5 50
Best grades	15%
Iron bars, base, Montreal ..	3 75
Steel bars, base, Montreal..	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 6 55	$ 6 00
Sheets, Black, No. 10.	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 80
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal"s Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN B

¼ in. .....$	14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in. .....$	13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palaeine	22½
Machine oil, per gal.	27½
Black oil, per gal.....	16
Cylinder oil, Capital.....	58
Cylinder oil, Aeme	39½
Standard cutting compound, per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil.....	39½
Petroleum fuel oil	10¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....	$2 20
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....
Connelsville Foundry Coke...	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers.....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less...	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square blank .....add	$0 75
Nuts, square, tapped ....add	1 00
Nuts, hex. blank.....add	1 00
Nuts, hex. tapped.....add	1 25
Copper rivets and burrs, list less	15
Burrs only list plus	25
Iron rivets and burrs 40c	05
Boiler rivets, base ¾" and larger .....$	8 50
Structural rivets, as above..	8 40
Wood screws, flat, bright..	75
Wood screws, O.&R., bright	77½
Wood screws, flat, brass....	55
Wood screws, O.&R., brass..	55½
Wood screws, flat, bronze..	50
Wood screws, O.&R., bronze	47½

MISCELLANEOUS.

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals 18	to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English	0 35
Gasoline, per gal., bulk ...	0 33
Benzine, per gal., bulk....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.....	0 03
Rosin "G," per lb.....	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon...	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in. ..	$42 50	$43 00
Plain sheets, base 16 oz. and heavier ..	46 00	44 00
Copper sheet, tinned, 14x60 in., 14 oz. ..	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6x4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$	0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard ..... 10% extra.

WASTE

White.	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored.	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. .....add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper .....$	22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided ....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila..	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs...	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

Fifty Subscriptions from One Firm

THE International Business Machines Company, of which Mr. Frank E. Mutton is vice-president and general manager, subscribed to 10 copies of THE FINANCIAL POST some months ago—these copies to go to their travelling salesmen. Now this company has increased the number of these subscriptions to 50 because the results of the experimental subscriptions have proved so satisfactory.

FRANK E. MUTTON

Mr. Mutton explained that the object of putting THE POST in the hands of the men of his company was to keep them intelligently acquainted with general business conditions in Canada. He said he knew no better paper than THE POST for the purpose. It would seem that his men have responded fully to effort made to keep them well informed about Canadian business affairs—so much so that the management have added 40 other men to the original 10 to receive THE POST.

When Mr. Mutton was with the National Cash Register Company as its Canadian manager, he was the king of all managers in the matter of sales records. In this position he achieved a big reputation built on solid achievements. He learned salesmanship in a school where competition was of the hottest kind, and where the competitors were brilliant men. Giving Mr. Mutton full credit for superior personal qualities and energy of the most ardent kind, it is taking nothing away from him when it is said that not a little of his success was due to his intimate and sympathetic knowledge of the other man's business. And he taught the men associated with him as salesmen to know the point of view and requirements of the men they called on to sell machines to.

As vice-president and general manager of the International Business Machines Company, Mr. Mutton is putting into operation an idea used by him in past days with brilliant results—he is causing his salesmen to know the business and requirements of their prospective customers. To establish points of contact swiftly and surely is one of the open secrets of successful selling.

In the case of **your** solicitations of customers and desired customers, it is excellent strategy to have your salesmen so well informed about business conditions generally, and about the interests of the men they canvass, that they will be able almost instantly to relate their proposals to the interests of the buyer. When a salesman shows himself intimate with the interests or business or objectives of the man whose order he wants, he is immensely strengthened as a salesman, and his percentage of successful canvasses goes steadily up.

Our definite suggestion to you is: Subscribe to THE POST yourself, and learn from its pages how your salesmen or executives can draw power from this newspaper. Then, having acquired the sought-for knowledge, subscribe to THE POST for each man in your service who can profit you by knowing what is in THE POST each week. If Frank Mutton and other prominent executives are making a success of THE POST as a salesman's aid, it is reasonable to suppose that other managers of salesmen and executives can likewise employ THE POST as a producing agent. And so we ask you to sign and forward the coupon below.

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tion as it will be found that the electrolyte is getting lighter and the PbO_2, lead peroxide, is being burned into lead sulphate, PbSO. For example, the specific gravity at full charge being 1.215 should not be allowed to drop below 1.195, a drop of 20 points, and the voltage would be about 2.2 and should not go below 1.8 or 1.9. Voltage readings should be taken when the battery is either on charge or discharge at the normal rate. The normal discharge rate is preferable, as there will be less liability of discharging too low. Voltage readings taken when a battery is not working, that is on open circuit, give no indication as to the condition of the plates, as the voltage does not depend on the size of the plates, so long as there was any lead peroxide on one plate and spongy lead on the other, the electrolyte about 1.200, the voltage readings would be about 2.2 volts, you would be getting the potential differences between the plates. There is one point of warning for the safety of the attendant, and that is he should never under any circumstances carry an open flame or strike matches in the battery room.

The Use of the Cadmium

Voltage readings taken with the cadmium stick are the most accurate readings. The voltage on a fully charged cell from cadmium to lead peroxide is 2.5 volts, and from cadmium to spongy lead zero. With the use of this stick a faulty plate can be localized in a cell. The accompanying diagrams give the construction of the cadmium stick. Procure 1 piece of hard rubber one and a half inches wide, 1 sixteenth of an inch thick, 1 piece of cadmium ⅝ by ¾, sweat or solder to a thin lead wire about No. 14 or 12 gauge, drill ½ inch hole near the bottom of the hard rubber, equal distance from the centre to one side of the rubber. Then cut a groove marked by dotted lines, to receive the lead wire; the lead wire could be hammered a little flat for convenience. Mark the centre of the hard rubber at either ends as a guide. Put the hard rubber into boiling water, keep it there until it becomes pliable. You will then be able to bend the hard rubber in the centre, where you put the marks at either end as your guide. Put your cadmium and lead wire in its place and squeeze together between two pieces of board in a vise or clamps. Should the rubber begin to set hard, place it again in the boiling water with its contents and resume the pressure. You should have no trouble in making one of these stick, and you will be well repaid for your trouble, as no battery attendant's kit is complete without one.

BOOK REVIEWS

The Construction of Graphical Charts, by John P. Peddle. The McGraw Hill Book Co. Price $2

Much of the work of calculation done by the engineer and designer is in the repeated calculation of a limited number of formulae to a variety of different conditions, which involves merely the substitution of different variables in identical equations. Any mechanical means for performing this operation expeditiously will not only lead to a saving of time and mental wear and tear but will also minimize the chances for error. Such a device is the chart or nomagram, and the present work enters into its construction in a very clear and practical manner. Believing that the subject should be particularly useful to the practicing engineer who is often a trifle rusty in some parts of his mathematics, an effort is made to simplify the mathematical treatment. A series of illustrative problems has also been worked out in detail as it was thought by the author that these would afford a clear insight into the methods and a better understanding of the difficulties likely to be encountered than would be possible from a purely theoretical analysis. In the second edition of the work now presented a chapter on the use of determinants, in the plotting of graphical charts, has been added.

Contents,—

Charts plotted on rectangular coordinates; the alignment chart; the hexagonal index chart; proportional charts; empirical equations; stereographic charts and solid models; the use of determinants.

The Electric Range Handbook; the Society for Electrical Development, Inc., United Engineering Societies Bldg., New York; Price $1.50

The handbook is a complete compilation of authentic electric information and data. Its purpose is to guide and help solve the problems of central station managers, who have realized the importance of the range load and who are contemplating the active development of this class of service. The text has been reviewed and approved by several range authorities. Chapter I takes up the characteristics of the electric range load, compares the range with other household appliances and discusses cooking rates and their justification. The problem of financing extensions and installations are also dealt with. Chapter II. deals with the electric range itself and together with its construction takes up its advantages in the home. Chapter III. is a historical resume of electric cookery and enters into the characteristics of electric heat as applied to cookery. The range load, from the standpoint of the central station. is taken up in Chapter IV. both from the standpoint of investment and also as to the characteristics of the load.

Merchandising methods are dealt with in the following chapters, selling points, advertising and maintenance also being dealt with. The last three chapters deal with water heaters, commercial cooking apparatus and general information. To those having to do with the promoting of electric range load this handbook is commended.

Electrical Aids to Greater Production; Allen M. Perry—The McGraw-Hill Book Co., Inc., New York

Eighty per cent. of the power used in making munitions has been applied electrically. The war has brought to the engineer in the industrial plant, to the chief electrician of such plants, and to the consulting engineers, who laid out and designed the electrical equipment for industrial work many new opportunities. The present volume has been written out of the experiences of men engaged in this work and the best of this practice has been assembled and compiled from articles which have appeared from time to time in the "Electrical World" on industrial problems of this nature. The material has been chosen and edited, not to make a text-book but rather a practical handbook of methods, schemes and plans, which can be lifted out and adapted to a wide variety of conditions. The ranges of subjects treated of is almost as wide as are the applications of electricity to modern industry and much useful information is presented for the engineer in charge of plant equipment. Proper records are an important part in the smooth management of electrical plant and this phase of the work has been carefully covered.

Contents, Chapter I,—General Power Problems of Industrial Plants. Chapter II. — Distribution, Transformation, Switching and Protection. Chapter III. Motors, Control, Specific Applications, Troubles and Remedies. Chapter IV.—Illumination—selection of equipment, Economies and Specific Applications. Chapter V.—Electric Furnaces, Welding, etc. Chapter VI.—Meters and Measurements as applied to industries. Chapter VII.—Handling Material in Industrial Plants with Electric Tractors. Chapter VIII.—Outdoor Substations.

The Canadian Morehead Manufacturing Company, Limited, Woodstock, have issued a cloth bound booklet giving considerable data, useful to the power plant engineer and the heating expert.

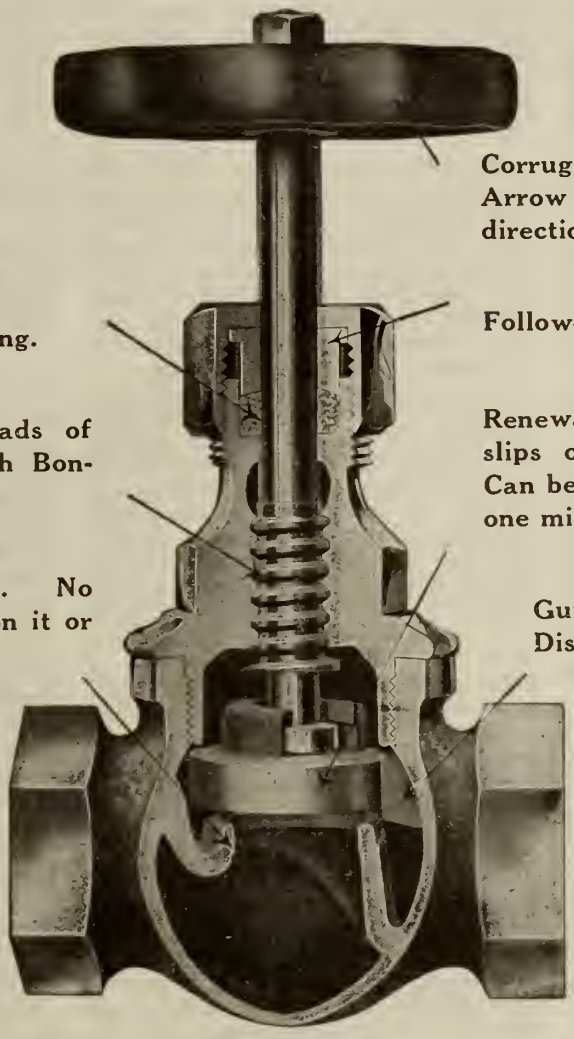
The Foster Instrument Co., Letchworth, Herts, England, have issued a very practical chart on the care and use of pyrometers. This chart, suitable for hanging up in the works, contains hints on the use of pyrometers of various types, such as radiation thermo-couple and electric resistance, and also has a useful Fahrenheit-Centigrade conversion chart ranging from 50° to 3550° Fah.

TRADE GOSSIP

Pembroke is going to have a new lighting system.

The Town of Aurora, through James, Loudon & Hertzberg, 36 Toronto St., Toronto, are in the market at once for a centrifugal pump of 750 gallons per minute capacity, to be driven by a gasoline engine.

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Follower in Stuffing Box.

Palmetto Twist Packing.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

At least Four Threads of Spindle engaged with Bonnet at all times.

Guide cast on Body holds Disc centrally over seat.

Raised Round Seat. No sediment can lodge on it or injure disc.

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The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

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Plant Closes.—The plant of the Brunner Mond Company at Amherstburg has been closed down, to stay so until labor conditions become such that business can be carried on. The plant, which is a subsidiary of the Solvay Process Co. of Detroit and Syracuse, is the largest in this country. Several hundred men are affected by the unexpected development.

Ready for Operation.—Canadian Engines, Ltd., manufacturers of stationary and portable gas and gasoline engines, grain grinders and saw frames, who were practically closed down during the war, have resumed operations, and are taking on a full complement of men. They report an abundance of business in view and that the prospects are favorable for a busy time throughout the year.

Tanning Company Extends.—Advices from Kitchener, Ont., state that the Lang Tanning Company, one if the pioneer industries of the city, will make a considerable addition to its plant. This will consist of two buildings each 100 by 200 feet, four-storey brick construction. The present staff, which numbers about 200, will be increased to 300 and possibly more when the new buildings are ready.

New Power Plant.—A huge power plant is being constructed on the Winnipeg River at DuBonnet Falls, 75 miles north of Winnipeg. The Winnipeg River Power Company, backed by Mackenzie & Mann interests, are the owners. The ultimate capacity of the plant will be 168,000 horse-power, in six units of 28,000 each. The development will take three years, and will cost $700,000.

To Attend Athens Fair.—The fair at Athens, which commences on October 13th, will contain exhibits of Canadian manufactured goods. This is the result of Mr. Lloyd Harris's efforts to interest Canadian manufacturers in the possibilities of the Balkan markets. One of the methods of placing the goods before the visitors to the exhibition is by photo, and a large number of these have been sent. The invitation to attend came through the Federation of British Industries. The Canadian Manufacturers' Association has a representative who is interviewing all manufacturers whose goods might be suitable for the Balkan trade.

The United States Rubber Co., of Canada, Ltd., has been incorporated with a capital stock of $20,000,000, divided into 200,000 shares of $100 each, the head office to be in Montreal. The company will manufacture and deal in all kinds of rubber goods. The principals are Alexander Chase Casgrain, Errol Malcolm McDougall, Leslie Gordon Bell, Sadie Conrad Demers, and Edward James Waterson.

New Pulp Mill.—Advices from Bear River, N.S., state that work has started on the new mill for Clarke Bros. The buildings will consist of a pulp mill, saw mill, boiler room and machine shop.

Simcoe.—The public utilities commission is going to buy a centrifugal pump for sewage disposal work.

Chatham.—An engineer is to be engaged to go over the situation here and report on the best plan for a waterworks system.

New Pumps for Guelph.—The Fire, Light and Water Committee have recommended the acceptance of the tenders of the Goldie McCullough Co. for the installation of a 750 gallon pump with a 75 h.p. Crocker Wheeler motor, at $2,904, also a 1,250 gallon pump with 125 h.p. Crocker Wheeler motor for $3,640. The Bawden Pump Co. secured the order for a 2,100 gallon booster pump with 100 h.p. Crocker Wheeler motor for $2,621.

Dominion Foundry to Close.—The Dominion Foundry plant at Hamilton will be closed down for two weeks in July while electric ovens are installed. Not many men will be affected, as the plant has been running light for some months. It is reported that the company intends to operate rolling mills in the course of a couple of months.

Erect Fuel Factory.—The Anthracite Briquette Company will start building immediately on the new industrial site of the Toronto Harbor Commission a factory for the making of compressed anthracite briquettes. Large supplies of waste anthracite have been secured, and the plant will have at first a capacity of ten tons per hour. The rights of a patented binder have been secured from the United States. The use of these briquettes will, it is claimed, make a big saving in the cost of fuel. Some of the best brains of the chemical staff of the Toronto University have been connected with the process, and it is understood to be a first rate commercial proposition. The capital is all privately subscribed.

May Arbitrate Now.—Mr. F. G. Wallace, president of the Canadian Locomotive Company, Kingston, has replied to the letter sent him by the committee appointed by the City Council to endeavor to bring about a settlement between the company and its striking employees. Mr. Wallace, in thanking the committee for its kind offer, says that the time is not opportune for outside intervention, and continues as follows: "Had we refused to meet our employees, your committee might have been of great assistance, but our men fully understand that they can arrange a meeting with us at any time they so desire. Under these circumstances you will readily see that it is impossible for us to avail ourselves of your kind offer." The Strikers' Committee has written the Council's Committee that it is ready to negotiate its differences.

Company Reorganized.—The recent reorganization of the St. Lawrence Welding Co., of Montreal, places the control of the company in the hands of W. H. Barry and A. M. Barry, president and general manager respectively; F. E. Fox being appointed a director and secretary-treasurer. L. E. Moulton is also a director of the new firm. The plant here has been enlarged and a well-equipped machine shop added to carry out the complete repairs of all welded work. A staff of boiler makers is, likewise, a part of the new organization. Every class of welding work is carried on and the firm make a specialty of oxy-actylene and electric welding repairs. They have recently purchased a new portable electric equipment for operations between Halifax and Montreal. During the present season a brisk business has been carried on, considerable repairs having been performed to the troop ships entering Halifax.

STORAGE OF COAL AND SPONTANEOUS COMBUSTION

Coal should be stored in small quantities as near to the point of consumption as possible. Small coal piles rarely ignite from spontaneous combustion. Coal should be stored near the point of use to avoid re-handling, extra transportation and the degradation of size which follows each re-handling. For these reasons the bureau would advocate storage, so far as possible, in the bins and yards of the ultimate consumer, thus dividing the risk of loss from spontaneous combustion. If large storage piles are necessary, certain general principles must be borne in mind. The generation of heat is the result of slow oxidation of the coal surface. The oxidation is much more rapid from freshly mined coal or from freshly broken surfaces. The oxidation rate increases rapidly with increased temperature. Different coals have different oxidizing rates. These facts lead to the following recommendations:—Where there is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known. Between two coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected.

The method of handling should be such as to produce the least freshly broken coal surface. The coal should be as cool as possible when piled. Piling warm coal on a hot day is more likely to produce spontaneous combustion. The coal must be kept from an extraneous source of heat. Alternate wetting and drying of coal during piling is to be avoided if possible. The fine coal, or slack, is the part from which spontaneous combustion is to be expected. Piling of lump coal where possible is therefore desirable.

In the process of handling, if the lump coal can be stored and the fine coal removed and used immediately, the practice prevents spontaneous combustion in coals which would have otherwise given trouble. The sulphur content of coal is believed by many to play an important role in spontaneous combustion. The evidence on this point is still con-

flicting, but to play safe, it is desirable to choose coal having a lower sulphur content when choice is possible.

There is a current belief that dissimilar coals stored in one pile are more liable to spontaneous combustion. The evidence on this point is also conflicting, but to play safe it is advisable to store only one kind of coal in a pile. The ground on which a coal pile is built should be dry. The foregoing recommendations are all derived from the factors affecting the heating of coal. There should be no spontaneous combustion, whatever the heating rate, provided the heat is carried away as rapidly as produced. This fact brings about the following recommendations:—

Coal piles should be made that there is ready movement of air for ventilation throughout all parts of the coal pile. This is the condition when the entire pile is made of coarse lump coal. With ordinary coal piling this is difficult. The surfaces of coal piles should be so exposed as to allow the pile to cool; or else the coal should be so stored that air circulation within the pipe is very small. When the air circulation is reduced to a minimum, as in air-tight bin, with no opening in the bottom, the oxygen of the air is soon removed and the mass of the coal lies in an inert atmosphere, except for small local circulation near the surface. Air-tight bins are usually impracticable, but the following practice is recommended to approximate these conditions:—

In making a coal pile of mixed sizes, the coal should be so handled as to make a homogeneous pile and prevent the segregation of coarse and fine coal. This frequently determines the most desirable machinery for unloading coal. It is common practice to limit the height of a coal pile, this for two reasons:—A pile too high crushes the lower layers of coal, producing more fines; the larger the pile the less the heat-dissipating surface there is exposed in proportion to the heat generating capacity of the pile. Twelve feet in height is a common limit.

Whatever precautions are taken in choice and handling of coal, provision should be made for keeping track of the temperature rise in a coal pile and for rapid rehandling of portions of a pile in case of excessive heating. In a coal pile covering considerable area, it should be so subdivided that in case of spontaneous combustion of a portion, the heat will not be transmitted to the whole pile, thus accelerating the heating of portions of the pile which normally would have remained cool.

To keep track of the temperature of coal piles, it is recommended that ½ in. iron pipe be driven vertically into the pile at distances of 15 ft. or 20 ft. apart. A maximum thermometer lowered into the pipe to varying depths will indicate the temperature of a pile opposite the thermometer.

A survey of the pile and a survey of the temperature of all parts of the pile. Actual removal need not begin during the first three months after the pile is made, and once a week thereafter until the pile has evidently ceased to heat. As soon as any portion of the pile reaches the temperature 150 deg., provision should be made for removing that portion of the pile. Actual removal need not begin until the temperate has reached 180 deg., but at these temperatures the rate of oxidation is dangerously rapid. The object of rehandling the coal is to allow it to cool below a dangerous temperature. Any method of rehandling which does not allow of cooling will only transfer the difficulty from the old pile to the new one. It is usually useless to employ water in an attempt to cool a coal pile.

Lack of provision for rapid reloading, cooling, and repiling of coal is the cause of serious loss from spontaneous combustion.

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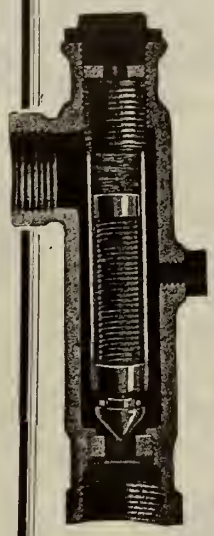

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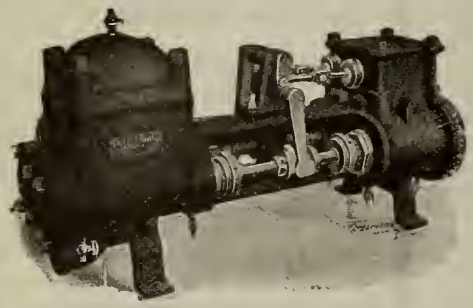

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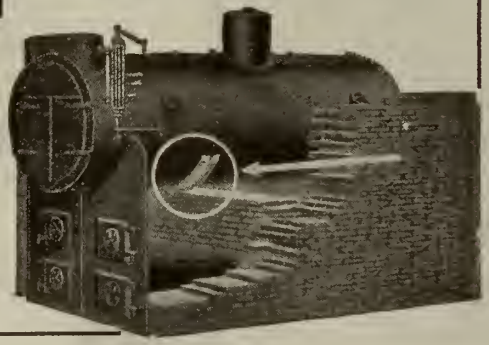

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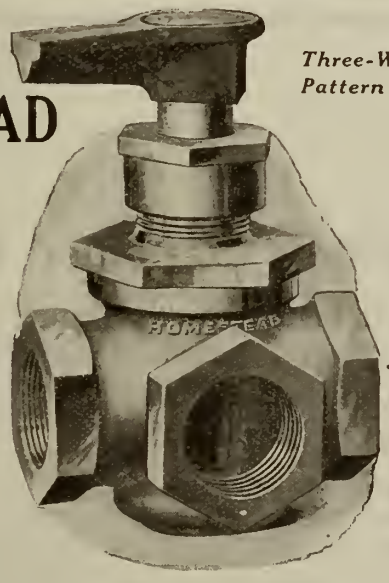

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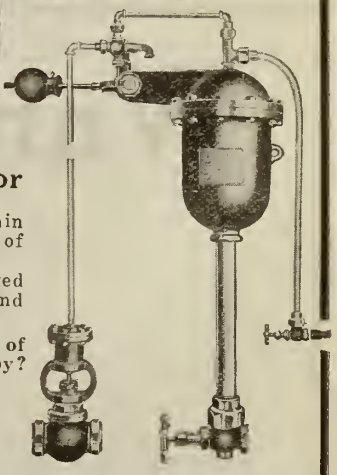

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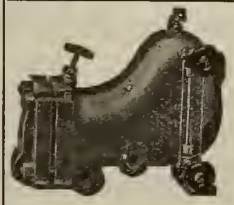

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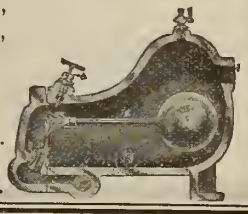

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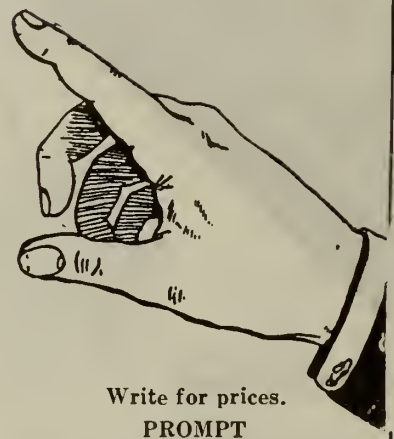

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THE Maritime Provinces did not enter Confederation very willingly and it may surprise people in other parts of the Dominion to learn that at the present time the people of New Brunswick and Nova Scotia are not altogether pleased with the results of the bargain. There is a distinct feeling among them that the advantages of Confederation have gone to the other Provinces. In the course of an article in the July issue of MACLEAN'S MAGAZINE, Thomas M. Fraser explains why this feeling has grown and the basis for it.

This article was written for the purpose of letting the other provinces know that the feeling exists but it will be of intense interest to people in the Maritimes. Be sure to read it—"The Spirit of the Maritimes."

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An article on the political aspect of the Eastern Provinces and the achievements of their leading statesmen.

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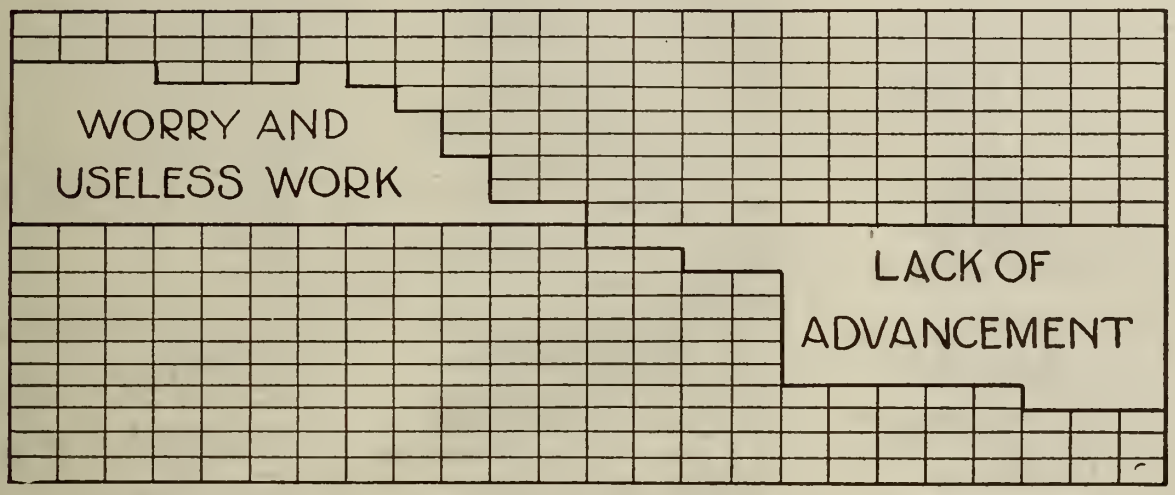

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Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufactnring Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufactnring Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
PULLEYS
Bond Engineering Works, Toronto, Ont.
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.
PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Antomatio Regulator Co., St. Louie, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
S. F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Pemberthy Injector Co., Windsor, Ont.
RAGS
Shell Bar Boico Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Limited, Toronto, Ont.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
REGISTERING MEASURES
S. F. Bowser Company, Limited, Toronto, Ont.
RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
RECORDING INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.
REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.
REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal
Defender Automatic Regulator Co., St. Louis, Mo.
Chanlin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co. Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.
ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.
SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.
SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.
SMELTER LININGS
Beveridge Paper Co., Montreal, Que.
SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.
SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.
SPROCKETS, COMPENSATING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.

Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Mason Regulator & Engineering Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertolt, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
S. F. Bowser Company, Limited, Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.,
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS (UNDERGROUND STORAGE)
S. F. Bowser Company, Limited, Toronto, Ont.

TANKS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

TRAPS, STEAM AND WATER-LINE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Montreal.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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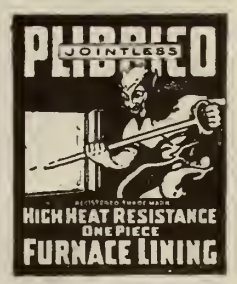

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All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G. MACDIARMID, Minister of Public Works and Highways

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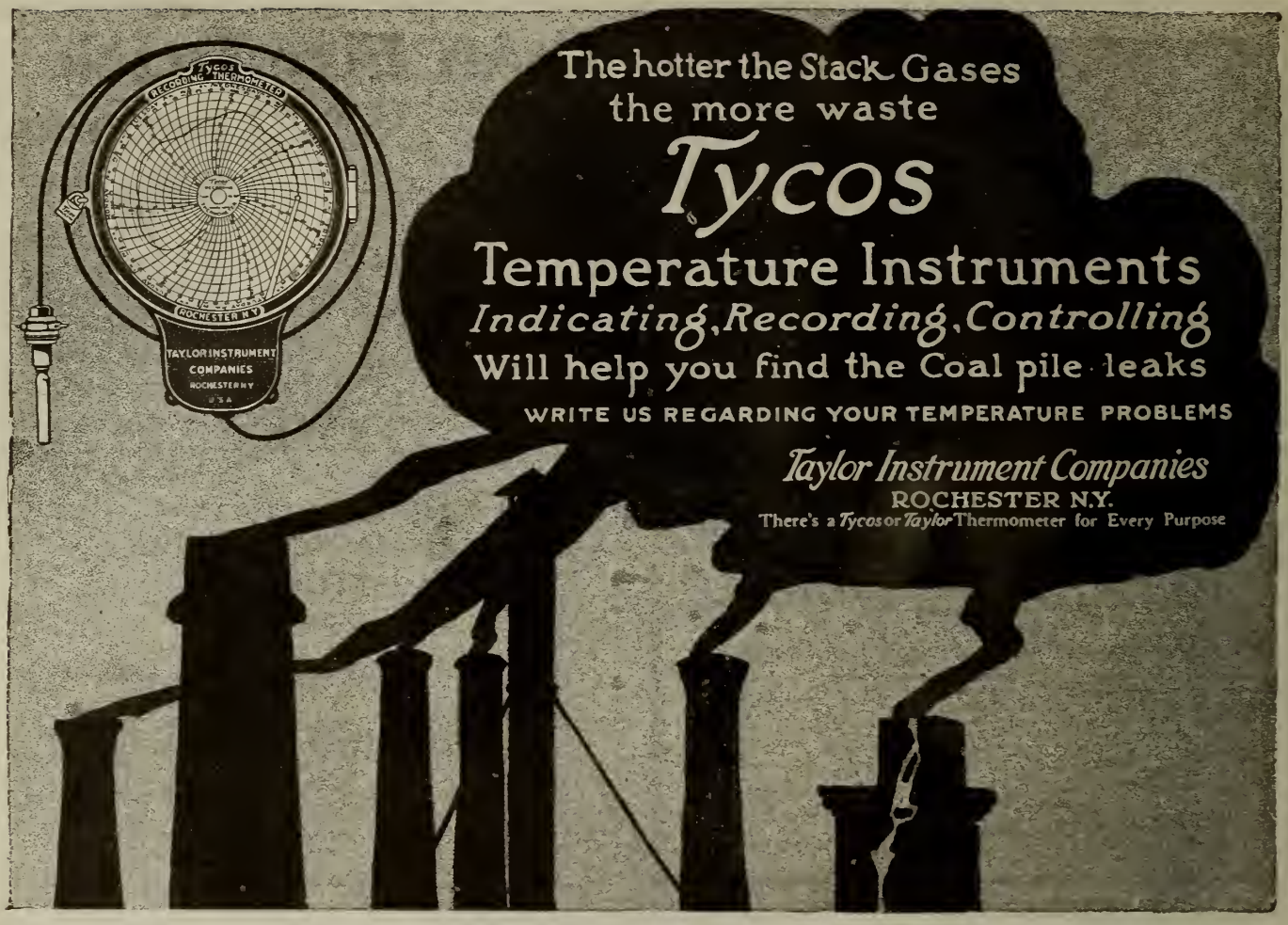

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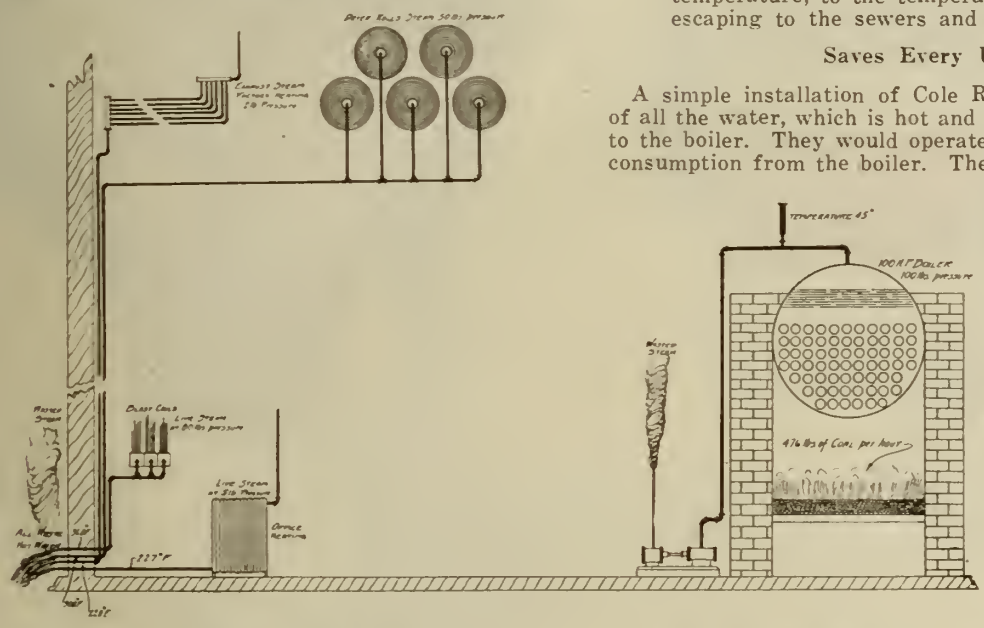
This Is To Show You How "Cole" Return Traps Save Your Fuel

Just study the diagram. Does your plant operate like this? We hope not.

You note how all the water of condensation from every source is lost. Discharged into the air, or into the sewers.

Pumps Require Steam

There is a constant loss of good hot water and steam taking place here. This lost water and steam is replaced through a Feed Pump or Injector, into the boiler.



Let Us Help You

If your plant operates under anything like these conditions as far as condensation return is concerned, we want to hear from you. If you are interested in saving fuel, in saving yourself useless work and worry ask us to have one of our condensation experts call on you.

More Data to Come

In our next ad. we will illustrate other conditions which obtain in steam plants, and which you should be aware of, where constant losses are occurring, and which only need pointing out to the Factory Executive to have them corrected.

The pump takes the water from the source of supply, and it is cold water generally.

To operate the Pump or Injector, the boiler must produce an enormous amount of steam, compared with the work done. This steam is generally wasted to the air.

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A simple installation of Cole Return Traps would permit of all the water, which is hot and pure, being returned direct to the boiler. They would operate with practically no steam consumption from the boiler. They would replace the costly Feed Pump and by returning the hot water to the boiler, would save a considerable amount of fuel in making steam.

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Approximately, the amount of fuel which is wasted in a plant such as this, operating a 100 H.P. boiler at 100 lbs. pressure would equal 30 per cent. of the total fuel burned under the boiler.

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The cost of the installation in your plant would be very nominal, and under such conditions as the diagram shows, would save enough fuel to pay for itself in about three months, or less, and every succeeding three months would put a similar sum of money in cold cash in your employer's bank account.

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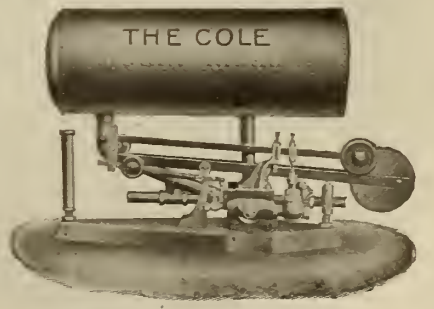
Don't you think your employer would thank you for pointing out how this waste could be saved? Showing him how to save good money?

We have Bulletins, which contain interesting information to enquirers generally, and you should have them.

Write us for any further information on the "Cole" Return Trap.



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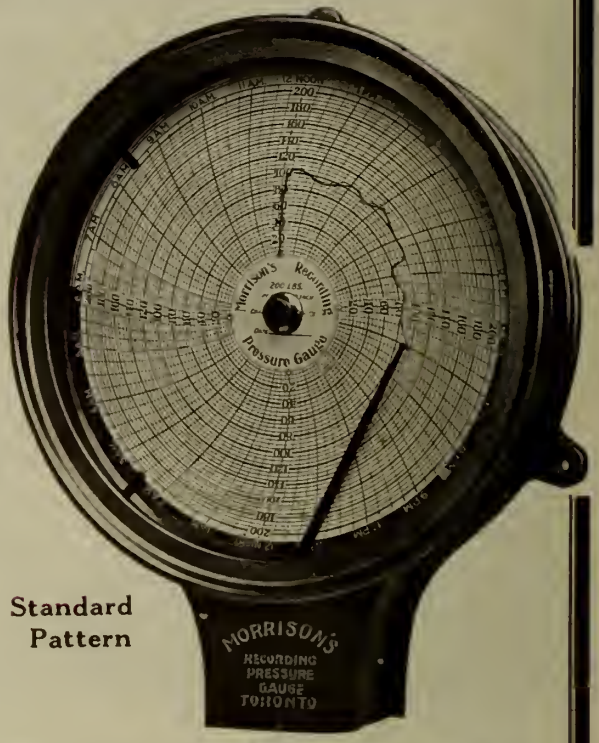

Standard Pattern

It is well known that fluctuating pressures mean firing that is not economical, causing waste of fuel, and possible damage to Boilers due to strain. It means loss of Engine efficiency, for, Engines are designated for a definite throttling pressure, it causes irregularity and wastefulness when Steam is used for Heating, Drying, or other purposes. Extreme fluctuation results in insufficient power, explosions, and other accidents.

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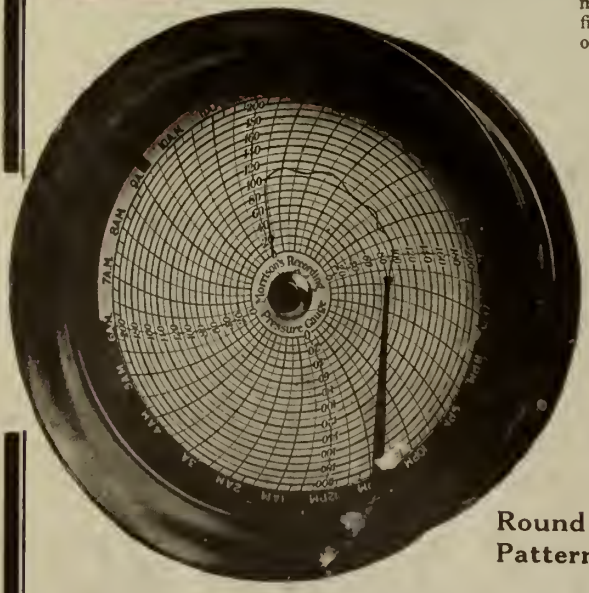
To the Owner, its installation usually results in reduced Coal Bills. It settles pressure troubles and adds to the life of boiler and equipment, in addition to which it insures safe operation.



Round Pattern

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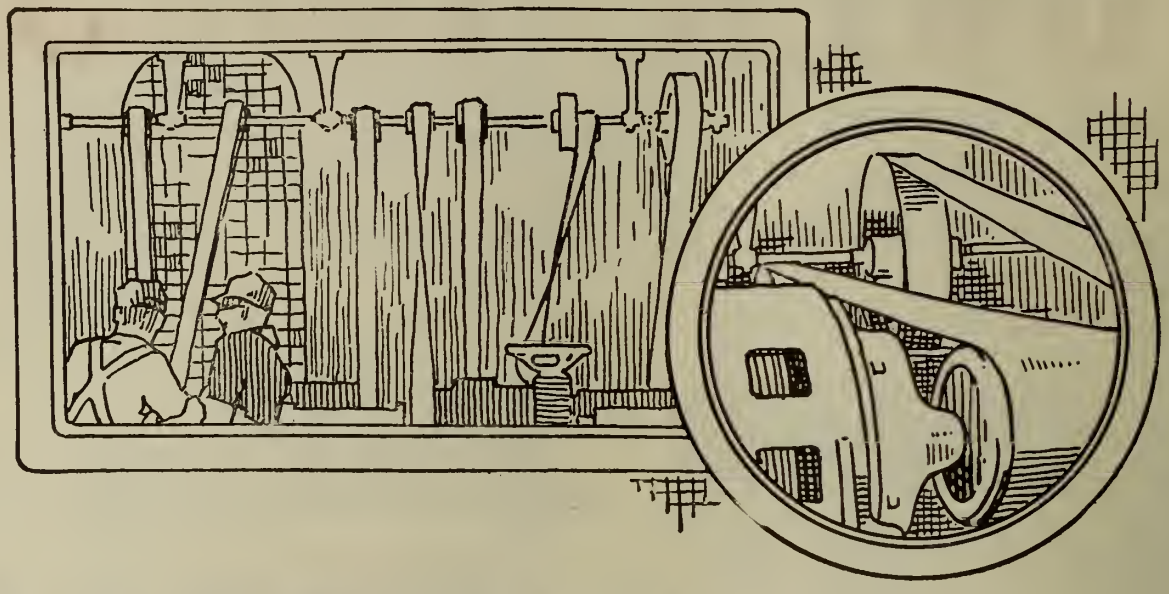

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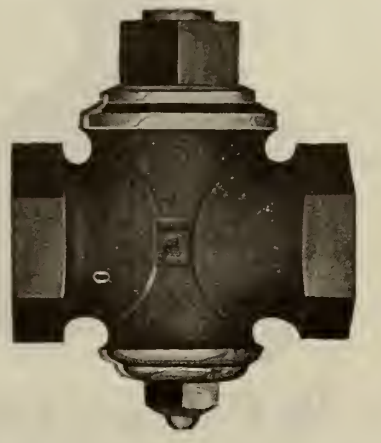

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London and Toronto

Canada

TALBOT

Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)

"Talbot" Boilers have these advantages:
They weigh only one-quarter as much as an ordinary boiler of equal H.P.
They take up only one-seventh as much space as the ordinary boiler.
They require no brickwork.
They burn **cheap fuel oil.**

Two 1000 H.P. boilers for immediate delivery from stock.

Tubes are easily replaced under reduced steam pressure.

Built in all sizes from 50 to 4000 H.P.

Canadian Manufacturers and Sales Offices:

Montreal General Tool Co., Limited

675 Notre Dame Maisonneuve
MONTREAL, P.Q.

HOMESTEAD
Quarter-Turn Valves

Full Pipe Area

No Obstruction

Smooth Passage

Opened by Quarter Turn

No Pressure Loss

Homestead Quarter-turn straightway Valves offer practically no resistance to flow, and cause no pressure drop. Seatless in construction—no scoring or wear under pressure. No bottom nut or other adjustment necessary. Homestead Quarter-turn Valves have replaced Globe and angle valves in thousands of plants on steam, water, air, gas, oil, acid and other pipe lines.

Let your plant be next

Homestead Valve Manufacturing Co.
HOMESTEAD, PA.

"Now that Federal Restrictions Are Removed We Will Extend the Plant and Install the Jeffrey Improved Carrier."

"The war and consequent government supervision will have a tremendous influence on power plant operation. The entire industry readily fell in line with the U.S. Fuel Administration and many long-standing wastes were eliminated.

"Reconstruction activities will call for a vast amount of labor, both skilled and unskilled. Consequently, wages will continue high, so that mechanical equipment will be far more economical wherever it can be applied. War-time wages have caused our coal and ash-handling costs to climb almost out of sight.

"The JEFFREY Carrier, which is built in six sizes, will handle 30 to 160 tons of coal or ashes an hour for far less costs. The plant will be cleaner and more efficient and the men will be glad to be released from this disagreeable duty."

Catalog No. 210-4 describes completely the JEFFREY Carrier. Write TO-DAY for your copy.

THE
Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL
CANADA

Handle it Mechanically

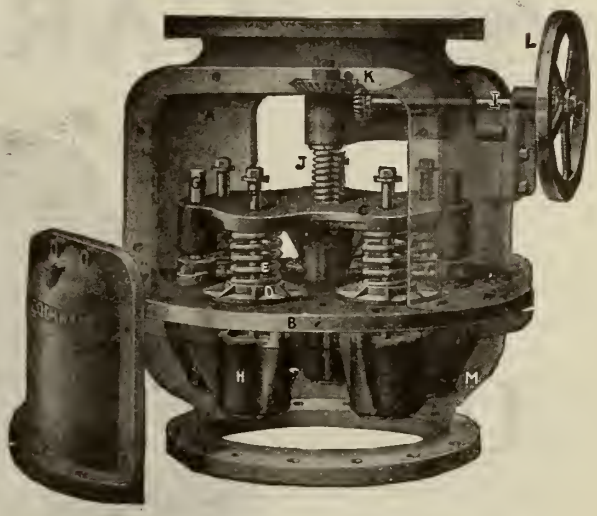
"DID YOU SEE IT AT BRANTFORD"

Some Pointers regarding the Cochrane Multiport

THE COCHRANE MULTIPORT

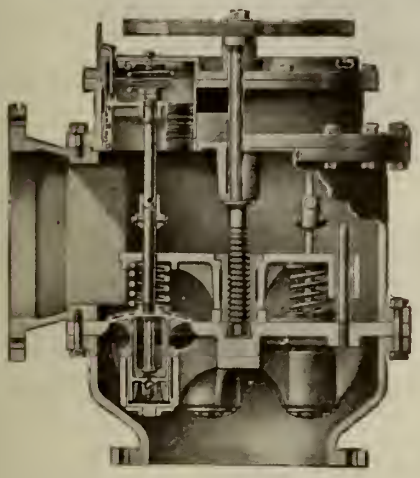
Is an improved Safety Valve
for the Exhaust Steam System

A UPPER CASING, having two removable doors, providing easy access to disks for regrinding, and to springs for removal, etc.
B VALVE PLATE, carries dash pots which guide and cushion the valves, and which are bored simultaneously with seats, insuring alignment.
C PRESSURE PLATE, motion limited to prevent exceeding a predetermined pressure.
D BRONZE VALVE DISKS. Cast integral with dash pot plungers.
E NICKEL-PLATED STEEL SPRING. Can be changed if a different back pressure is desired.
F BRASS LIFTING SPINDLES. Serve to lift disks off seats when exhausting free to atmosphere.
G BRASS SLEEVED GUIDE POSTS for pressure plate.
H DASH POTS. Bronze lining secured by nut on bottom.
I STEEL SHAFT for revolving bronze spindle; not required in horizontal form.
J BRONZE SPINDLE for raising and lowering pressure plate.
K BRONZE GEARS, not required in horizontal form.
L ADJUSTING HAND WHEEL. Valves are also arranged for control from distance by chains, extension shaft, hydraulic pressure, electric motor, etc.
M LOWER CASING.



Interior View, Fig. 1 000, Cochrane Multiport Safety Exhaust Outlet Valve.

WHEN used in back pressure service, it protects piping, radiators, feed water heaters, cooking kettles, absorption ice machines, low pressure turbines or other appliances, against abnormal rises in pressure whenever the amount of steam supply from the engine exceeds the ability of the exhaust system to condense or otherwise dispose of that steam.



Section of Cochrane Multiport Flow Valve for use in connection with Mixed Flow Turbine. Prevents condenser vacuum from backing up into the engine exhaust line and drawing in air through leaks, etc.

COCHRANE MULTIPORT VALVES for Vacuum Service are installed between engines or turbines and condensers. They serve not only to protect against abnormal rises in pressure, but they also provide a convenient and natural channel for the escape of steam during non-condensing operation. They are thoroughly water-sealed to prevent the entrance of air into condensers.

The main idea in designing the COCHRANE MULTIPORT has been to secure absolute safety by providing a number of channels of escape for the steam, so that the chances of all becoming inoperative at once are infinitesimal, at the same time doing away with the excessive list and severe hammering upon the seat inseparable from heavy single-disk valves.

In accomplishing this object, we have taken advantage of the opportunity to make the valve easily adjustable, that is, by varying the position of the pressure plate the tension of the springs may be adjusted for any back pressure desired. Where installed in connection with heating and drying system, it is thus often necessary to carry the maximum back pressure only for a few hours in the morning, while at other times the steam consumption of the engine is reduced by lowering the back pressure. With nearly all other valves, this is utterly impracticable.

The introduction of the pressure plate and spring principle into back pressure valve design also enables us to make the valves strictly foolproof, that is, it is impossible to overload or tamper with the valves, since the limited travel of the pressure plate determines the maximum back pressure. Inasmuch as there are no moving parts directly connected to the disks extending outside of the valve casing, overweighting, tying down or accidental obstruction are eliminated, likewise sticking through over-tightening of glands.

The method of control also makes it convenient to install appliances for operating the valves from a distance, as by means of a long shaft, a chain and sprocket wheel, hydraulic pressure, or by electric motor. That is, it is not necesasry to climb a ladder or to go up on the roof in order to change the back pressure, if you have a MULTIPORT. In atmospheric service, it is sometimes convenient to be able to open and close the valves from the switchboard, which can be arranged for with this type of valve.

In vacuum service, these valves offer perfect facilities for throwing over from non-condensing to condensing operation, especially in connection with reciprocating engines, since the engine may be allowed to exhaust through the valve until the moment when the main gate valve between the exhaust line and the condenser is opened, upon which the small disks will seat immediately without allowing an inrush of air thereby avoiding all danger of losing the vacuum and of having to prime the condenser over again. COCHRANE MULTIPORTS are built for all situations, that is, vertical pipes, horizontal pipes and angle pipes.

Special types of COCHRANE MULTIPORTS are supplied for preventing the vacuum from mixed flow turbines reaching back into the engine exhaust line, with consequent impairment of vacuum due to the drawing in of air through leaks in the engine exhaust piping, through piston rod packings, etc.

ASK FOR BULLETIN 601

CANADIAN ALLIS-CHALMERS

HEAD OFFICE: TORONTO LIMITED

Branch Offices: Montreal, Quebec, Halifax, Ottawa, Hamilton, London, Cobalt, South Porcuoine, Winnipeg, Calgary, Edmonton Nelson and Vancouver

GARLOCK

PUMP VALVES

The service of pump valves depends upon the compounds as well as the consistency and cure of the valves. The compounds used in Garlock pump valves have been established after years of trial in actual service and under the most severe conditions. Pump valves should always be used for the purposes for which they are intended. The following are a few of our leading styles and grades of valves:

Style No. 139—For medium pressure cold water.
" " 175—For high pressure cold water.
" " 182—For warm or greasy water.
" " 108—For hot water.
" " 105—For boiling water.
" " 154—For air compressors and condensers.

We guarantee our pump valves to give satisfactory service when used under conditions for which they are intended.

THE GARLOCK PACKING COMPANY

HAMILTON, ONTARIO

Branches:

Montreal, Quebec - - - 342 St. James Street
Toronto, Ontario - - 404 Continental Life Building
Winnipeg, Manitoba - - - - Galt Building
Calgary, Alta. - - - 211 Eighth Ave. W.

"What *is* packing anyhow?"

Our salesmen frequently comment on how often their friends, outside the business, ask the question—"What is Packing?"

Some of the ideas as to the meaning of the word are very amusing in their vagueness and it is very seldom that the average man realizes just what a big part this product plays in the efficiency and economy of the industrial machinery that is making the world better for us all.

So for all its seeming insignificance the story of what packing is would seem to be well worth telling and well worth reading by anyone.

* * *

AS a starter, consider Packing as something like the "washer" in your kitchen faucet. It prevents leakage—or ought to.

Now whenever steam is put to work—or water, gas, brine, or ammonia—packing is needed. It is needed to prevent leakage where gleaming rods slide smoothly in and out of cylinders, for leakage here means not only loss of steam or water, but actual waste of power.

And inside the cylinders of pumps, packing again saves power. With perhaps two hundred pounds pressure on one side of the piston, and a vacuum on the other, piston packing prevents leakage past the piston.

And sheet packing, cut or molded into gaskets, prevents leakage at joints of surfaces or piping.

So, fundamentally, packing guards against leakage.

But when it works against moving surfaces, packing is subject to wear—or it goes "dead," and loses its elasticity. This means replacement, shut down machinery and expense. So the buyer of packing must ask not only "Will it prevent leakage?" but also "How long will it last?"—which of course depends on the material and workmanship put into it.

And there's a third question, which the engineer will ask if you don't, "How much friction does it cause?" For some packings prevent leakage merely by filling up the packing space as solidly as possible. Naturally such packing binds the moving rod—sometimes even scores it—and acts more or less as a brake. It is such serious faults as this that Johns-Manville has overcome through intelligent packing design.

So packing is not a thing to be bought at random — the right choice will save money by preventing leakage, by conserving power, and by its longer life.

As the pioneers in packing development we have placed packing design on a scientific basis, and out of experience, observation and facts have established a complete and standardized line that meets every plant requirement from among the minimum number of packings. Only in this way can packing be made to give a maximum of service for a minimum of cost.

Here is a partial list of Johns-Manville Packings: Sea Rings for outside packed Rods; Service Sheet, an all-around-the-plant sheet packing; Universal Piston for inside packed pumps; Kearsarge boiler, man and handhole gaskets; Mogul Coil Packing for valve stems and small rods; Sirgelite Sheet for packing oils, gasoline and naphtha.

CANADIAN JOHNS-MANVILLE CO., LTD.

Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

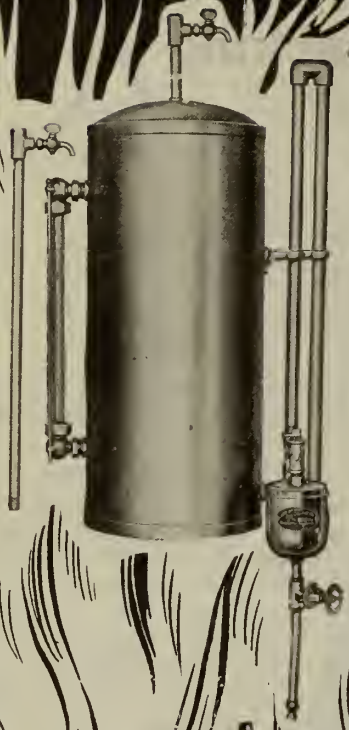
Through—

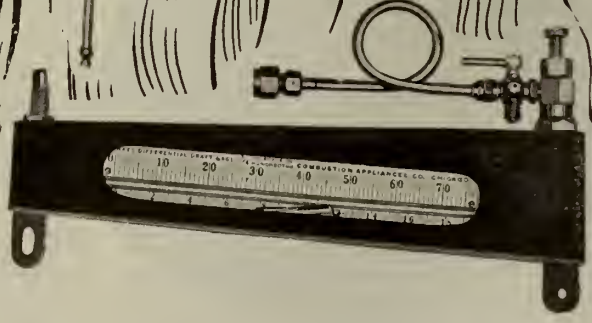
Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

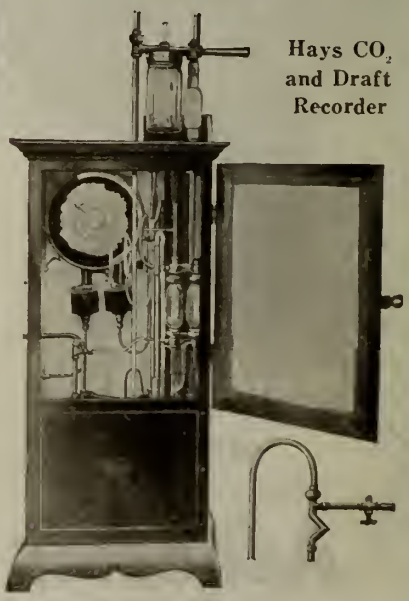
JOHNS-MANVILLE
Serves in Conservation

Lower the Cost of Steam





Hays CO_2 and Draft Recorder



More Load with Less Fuel

Hays Combustion Apparatus puts this condition within easy grasp of every power user.

It is a friend of the fireman and a very profitable investment for the plant owner. Shows at once if draft is proper—if there are holes in the fire—if settings are leaking—if firing periods are improperly timed and other causes of fuel waste.

Hays Combustion Apparatus effects a huge fuel economy because our engineers make it a point to install the type of Hays Equipment that is best adapted to your individual conditions.

Write for our booklet. It tells how easy it is to get more steam from less fuel.

The Jos-W-Hays Corporation

Michigan City
Indiana
U.S.A.

Stephen H. Payne, 30 Church St., New York, Canadian Representative

REGISTERED COPPUS U.S. PAT. OFFICE

In Glass Works

In th Glass Dirisi-n Power Plant of the National Lamp Works out in Cleveland, Ohio, they burn gas coal screenings and producer tar—difficult fuel to burn economically. Yet with the 4-18" COPPUS Turbo Blowers which they operate, full steam pressure is maintained in their 4-250 H.P. Stirling Boilers—and cheap fuel is efficiently burned. Without these Blowers, one of which is shown above, additional boilers would have been necessary last fall. With their aid, however, the heavy plant load is easily handled.

Before the National Lamp Works installed COPPUS Blowers a careful investigation satisfied them that for efficient operation, low steam consumption, and sturdy dependability, COPPUS Blowers stand in a class by themselves. And after practical proof that COPPUS Blowers are all that is claimed for them, Mr. Bretz, Plant Superintendent, expresses himself as "highly pleased with them." In the National Lamp Works, as in thousands of plants in every industry, COPPUS Blowers have proved profitable investments.

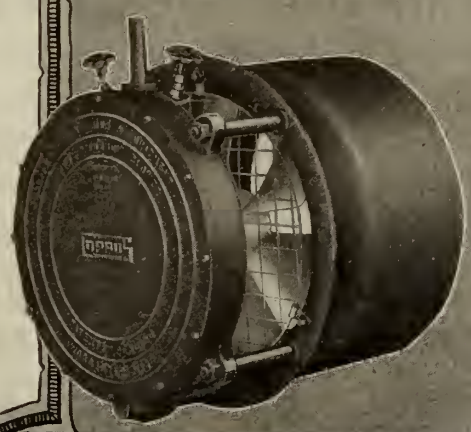
Why not find out exactly how and why *"COPPUS Equipment can save you money."* Write us and our engineers will help you solve your combustion problems. If you haven't a copy of Blower Catalog H12, write for one to-day.

The Coppus Engineering & Equipment Company

Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Turbo Blowers

341 Park Avenue, Worcester, Mass.

Agents for Montreal; Mason Regulator and Engineering Co. Agents for Winnipeg; Parkhill & Hanson, 905 Confederation Bldg.



COPPUS TURBO BLOWER

LINDE
REFRIGERATING MACHINERY

Is known and recognized the world over as

The Standard Refrigerating Machine

We have carefully studied Refrigeration under all conditions in Canada for the past 25 years and know what is best for the Canadian Manufacturer.

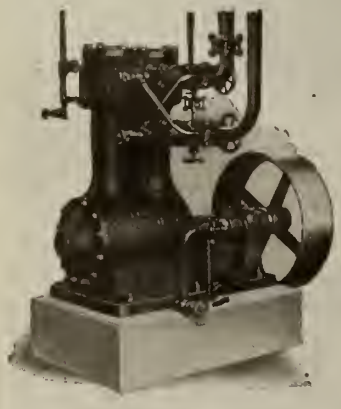
Our Machinery is "Made in Canada"

The LINDE CANADIAN REFRIGERATION CO., Limited

37 St. Peter St., Montreal, P.Q.

TORONTO WINNIPEG VANCOUVER

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

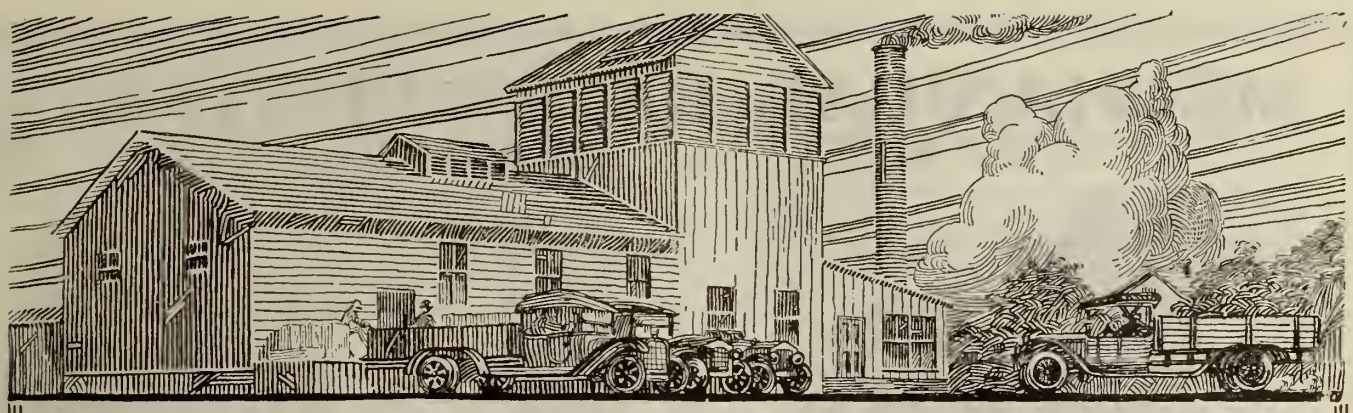
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



THE ICE MAN'S HARVEST

As the farmer's returns from the soil are based and computed on the quality and amount of seed sown, so the ice manufacturer's harvest is based on the quality and size of Ice Making plant operated.

For the farmer nature insures the harvest while FRICK Ice making equipment guarantees the ice man profitable returns.

The QUALITY, DURABILITY and *EFFICIENCY* of *FRICK Refrigerating* and Ice Making Machinery are never questioned. Superior Since 1882. Ask any user—"He knows."

Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

"We Prefer Nonpareil Corkboard"

Row creom storoge room, insuloted with Nonpareil Corkboord in the Pottstown, Pa., plant of Burdon Bros.

Burdan Bros., of Pottstown, Pa., have been in business for a good many years. During that time they have tried out a number of insulating materials. But what their experience has taught them is best told by Mr. C. C. Burdan in his letter of November 25, 1918:

"We have had considerable experience with various materials, also corkboard, for cold storage insulating purposes, and our experience has been such that we prefer Nonpareil Corkboard to any other form of insulation. In fact, our experience with the other materials has been such that **we would prefer Nonpareil even if it cost ten or fifteen times as much.** We cannot speak too highly of the Nonpareil Corkboard as an insulator."

Testimony such as this makes it easy to understand why most of the up-to-date ice cream manufacturers, ice and cold storage men, and other users of refrigeration use

NONPAREIL CORKBOARD INSULATION
FOR COLD STORAGE ROOMS

They know that cheaper materials will not be economical of refrigeration or stand up under the hard service encountered in the average ice plant. They know, furthermore, that quality considered, Nonpareil Corkboard proves to be cheaper in the long run than anything else they can buy.

Why not investigate Nonpareil Corkboard? It will cost you nothing to get full information

Armstrong Cork & Insulation Co., Limited, 504 McGILL BUILDING, MONTREAL, QUE, CAN.

Also manufacturers of Nonpareil Cork Covering for Cold Pipes and Tanks

MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS

"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively

YORK, PA., U.S.A.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 324 Craig St. West | CALGARY 605 Second St

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant*, as we find *them substantially made* and the *insulation perfect*. We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant*. We would not be warranted in throwing out the doors but would like the type hardware you supply."

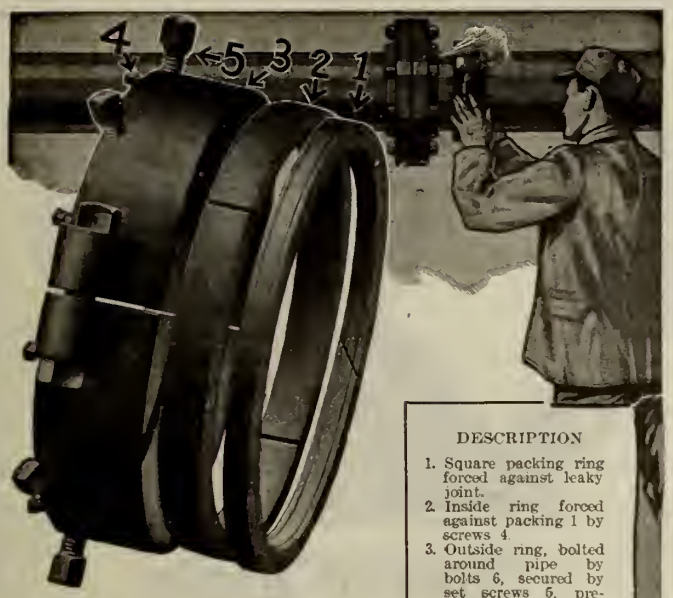
THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you*, in use at both plants, *have been in every way satisfactory*, and we think the *Jamison door is the best on the market*."

Read 'em again men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Door Co. HAGERSTOWN, M.D., U.S.A.



DESCRIPTION

1. Square packing ring forced against leaky joint.
2. Inside ring forced against packing 1 by screws 4.
3. Outside ring, bolted around pipe by bolts 6, secured by set screws 5, prevents slipping when adjusting screws 4.

Learn the Good Points of Other Yarway Products

Yarway Seatless Blow Off Valve (formerly the Simplex).
Yarway Lea V-Notch Meter.
Yarway Automatic Boiler Skimmer.
Yarway Hydraulic Valve (Caskey Patents).
Yarway Adjustable Spray Heads (C. C. Thomas Patents.)
Yarway Starting and Pressure Unloader (Richards Patents.)

Easy to Attach Even in Out-of-the-Way Places

If there is a joint leak in any of your pipe lines—steam, water, gas, ammonia, etc.—it can be stopped permanently with a **Yarway** (formerly the Simplex) **Pipe Joint Clamp.**

The thousands of them that are now in use, are saving power and money by effectively stopping costly leaks.

To test the efficiency of the Yarway, try one for 30 days subject to return.

If it does not completely stop your worst pipe-joint leak, the clamp may be returned.

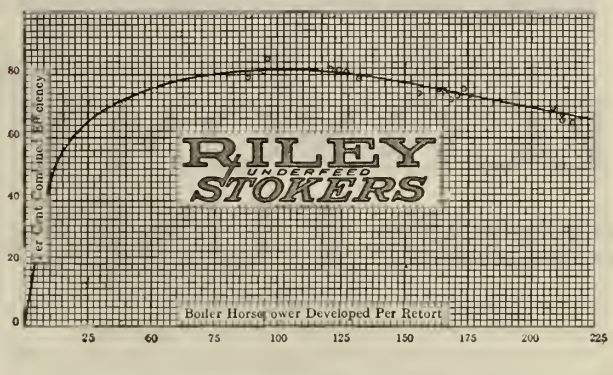
Write to-day.

Yarnall-Waring Company
7604-20 Queen Street
Chestnut Hill Philadelphia, Pa.

GORMAN CLANCEY GRINDLEY CO.
Calgary, Alberta
CUNNINGHAM HARDWARE CO.
New Westminster, B. C.

YARWAY PIPE-JOINT CLAMP
Formerly the SIMPLEX

High Efficiency



The continuous high efficiency of the Riley Stoker is due to the moving grates. These moving units not only keep the fuel bed open, porous and free from clinkers, but automatically discharge the ash and refuse.

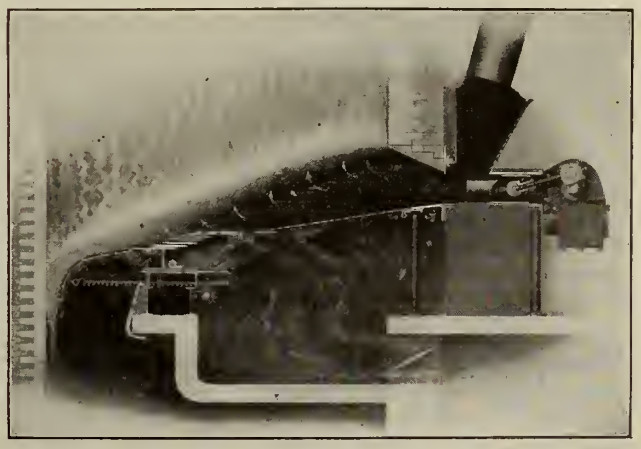
Because of the moving grates, Riley Stokers have that faculty of operating continuously at high efficiency and capacity. Fuel saving is a mechanical certainty. There can be no waste.

The efficiency curve shown above is typical of Riley Stoker performance. This curve is plotted from a series of tests conducted on a 16-retort Riley Stoker installed at the Essex Station of the Public Service Co. Why not duplicate these results in your plant? You can do it with Riley Stokers.

Riley Catalogue H-R-8 Sent on Request.

For information on Murphy Automatic Furnaces for small boilers, see July 25th advertisement or send for Murphy Furnace Catalog H M-8.

Sanford Riley Stoker Co.
WORCESTER, MASS.
British Licensees: Erith's Engineering Co., Ltd., London.
French Licensees: Erith, Leroy & Cie., Paris, France.



Don't Order Just "Fuses"--Specify

ECONOMY Renewable FUSES

There are two mighty good reasons for this—

First:—You want the utmost in electrical protection.

Second:—You want it at the least possible cost.

And that's just what you get in the Economy Fuse.

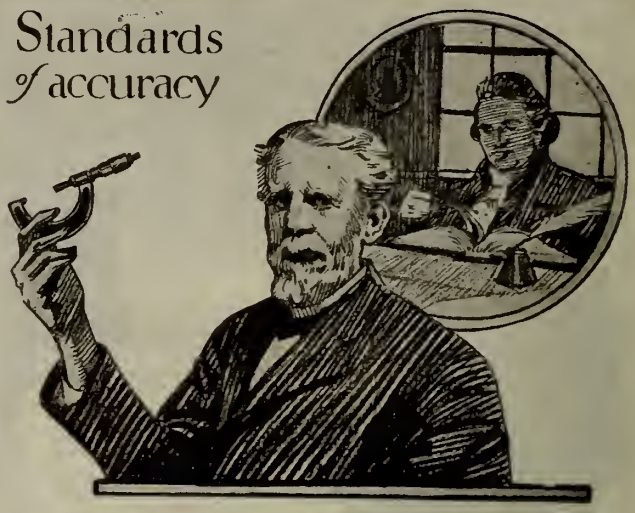
Years of performance proves that you can safely depend on it for accuracy of rating and all-around efficiency in operation.

An inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency. As compared with the use of one-time fuses, Economy Fuses and "Drop-Out" Renewable Links ***cut annual fuse maintenance costs 80 per cent.***

Sold by all electrical jobbers and dealers
Write for Catalog 24

ECONOMY FUSE & MFG. CO.
of Canada, Ltd.
UNITY BUILDING MONTREAL
Manufacturers in Canada of S. & C. High Potential Fuses—To 150,000 Volts

Standards of accuracy



Starrett Tools

are made according to the standard set by Noah Webster in 1828, when he defined accuracy—"In exact or careful conformation to a standard of requirements, the result of care or pains; free from error, failure or defect."

Catalog No. 21"CD" sent free.

The L. S. Starrett Co.
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS. 42-956

Manufacturers of

GREEN'S ECONOMISERS

and

GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

Agents for

Type "E" Underfeed Stokers
Custodis Radial Brick Chimneys
Uehling Instruments
Super Heaters
Coal Handling Equipment
Ash Conveyors
Soot Blowers
Tube Cleaners

Our engineers will be glad to submit data giving full information on any of the above equipment as applied to your own factory or power house.

GREEN'S ECONOMISER, LIMITED.
TORONTO

UEHLING WASTE METER

COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

CO2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufactnre of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company
2008 Empire Building New York City

W H O

STOOD BY THE PLUMBERS OF CANADA during the war and furnished them with goods during the most critical situation in the history of the trade?

NOT ONLY MADE MUNITIONS IN SUCH large quantities that an endless stream of shells was sent overseas to the men in the first line of defense, but kept on turning out Made-in-Canada quality plumbing brass goods for the Canadian trade?

NOT ONLY WAS THE FIRST FIRM in Canada to oversubscribe their quota in the Victory Loan of 1918, but also supplied plumbing goods needed by the Canadian merchants?

NOT ONLY DID THEIR BIT FOR THEIR COUNTRY at war, but fulfilled their obligations to their customers in Canada at the same time?

THE
H. MUELLER MANUFACTURING CO., LTD.
SARNIA, CANADA

We make Bibbs | Compression
Rapidac (quick comp.)
Self-Closing | **Basin Cocks,**

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Making Templets for Machinery Foundations

Anchor Bolt Templets—Construction and Materials—Making Preliminary Drawings for Templets—General Procedure in Laying Out a Templet—Templet for a Corliss Engine Driven Generating Unit

By BRUCE PAGE

AN anchor bolt templet (Fig. 1) is a pattern or frame usually fabricated from wooden strips ⅞ in. thick, which is used as a guide for properly and accurately locating and sometimes for holding in position the anchor bolts or the anchor-bolt casings of a foundation, while the foundation is being built up around them. Where the anchor bolts are not equipped with casings, the templet then supports only the bolts, which pass through and are supported in holes bored in the templet as indicated in the illustrations. As indicated in Fig. 2, where the bolts are provided with casings, the templet supports and locates both the bolts and the casings. Nails can be driven in the bottom face of the templet to centre the casing around the bolt. Or bushings, such as nuts or pieces of pipe, can be dropped down over the bolts and within the casings, centering them.

Occasionally, as suggested in the following paragraphs, templets are used merely as guides to indicate the locations of the anchor bolts, and do not support either bolts or casings.

Classes of templets as to methods of construction may be divided into: (a) One-section frame templets; (b) Multi-section frame templets, and (c) Built-up templets. A one-section templet is one that is complete in one piece. This does not mean that it is composed of one piece of plank, but means that several pieces of plank are fabricated to form the templet unit. Multi-section templets are those which comprise two or more sections or units. Frequently the templet required for a given foundation is so large that it cannot be readily constructed or handled in one piece and then it must be made in sections.

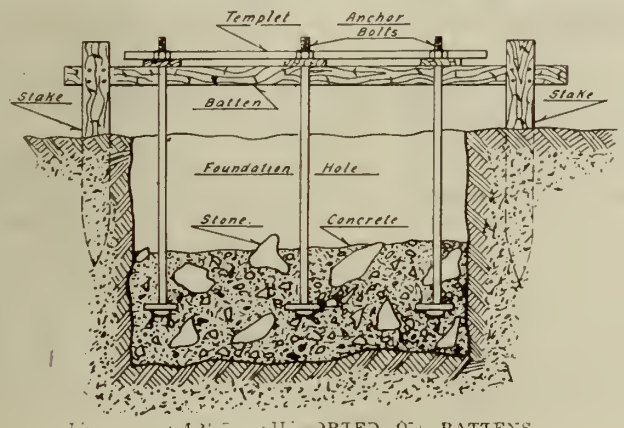


FIG. 1—TEMPLET SUPPORTED ON BATTENS.

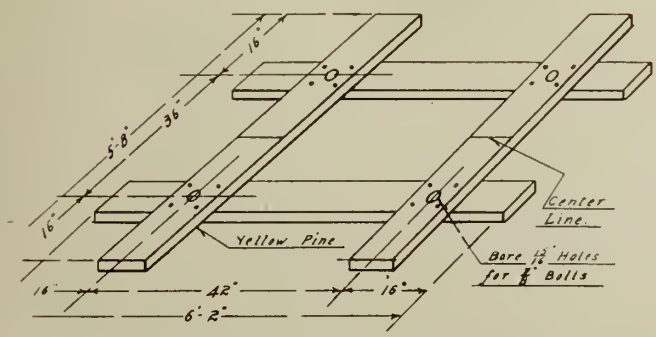


FIG. 3—TEMPLET FOR MOTOR BED PLATE.

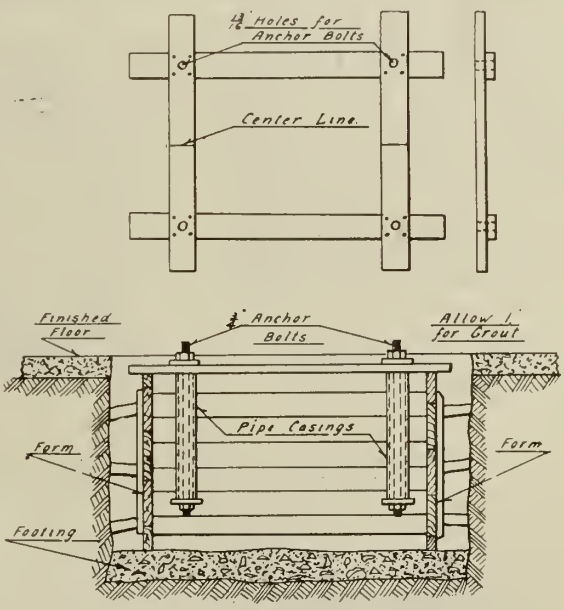


FIG. 2—TEMPLET AND FORM IN POSITION.

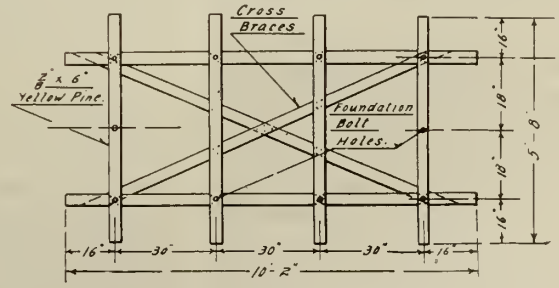


FIG. 5—ILLUSTRATING METHOD OF BRACING A TEMPLET.

Built-up templets are those that are not fabricated in the shop, but which are built up piece by piece over the foundation, the bolts of which the templet is to locate. Templets of each of these types are discussed in the paragraphs which follow.

It always pays to use a templet, even for the smallest foundations. It will practically always be found more economical to build a templet which will accurately locate the bolts in a foundation than to endeavor to locate the bolts without this guide. The templet can be made under conditions which conduce towards accuracy, and by workmen who are accustomed to making accurate measurements. But if the constructor endeavors to have the anchor bolts located "on the job" the locating will be done by masons or concrete men, and usually under adverse conditions, when close measurements are difficult to make.

The material for templets is wood or structural steel. Wood is by far the most frequently applied material because it is easy to work, and can be obtained in any community without delay. Templets fabricated from structural steel are used, particularly where the same templet is to be used repeatedly.

Wood templets are made of planks usually ⅞ in. thick, but they may be of any reasonable thickness. Almost any kind of wood can be used for making a templet, but because it is probably cheapest in the long run, reasonably clear-grained white pine (pattern wood) is most frequently used. Yellow pine, although it is heavy, makes good templets. Woods which tend to warp and distort should be avoided. As a rule the sticks composing the templet should be planed smooth on all four sides. Sometimes the sticks are planed on two faces only. For the roughest, simplest work, planing may be omitted altogether, and the rough planks used just as they come from the mill.

Steel templets are fabricated from angle or channel sections. When the templet is small, the component pieces of the templet may be held together with rivets. Where the templet is large, the pieces may be bolted together or the templet may be subdivided into riveted sections, each small enough to be readily handled, and then these sections can be bolted together to form the complete templet.

Templet drawings should be made for all except the simplest foundations. Such a drawing should be furnished the man who is to build the templet. The templet drawing (Fig. 3 shows a simple example) should indicate the length and location of each stick and the diameters of all the holes. All of the dimensions that are required for the construction of the templet should be shown. From such a drawing the carpenter can work without having to consult the foundation drawings for his dimensions and without having to make computations for himself in order to ascertain dimensions. It is certainly more economical to make in the drafting room a templet drawing having recorded on it all dimensions, than it is to render it necessary for the wood-worker to ferret out for himself the required dimensions from the machine or foundation drawing.

Templet construction is a very broad subject, hence in this article it is possible to suggest only general directions. Obviously a templet must be accurately

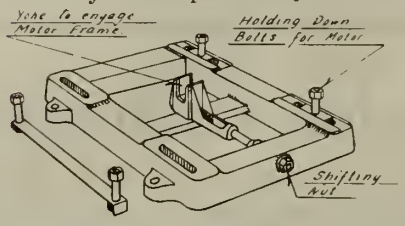


FIG. 4—BED PLATE FOR ELECTRIC MOTOR.

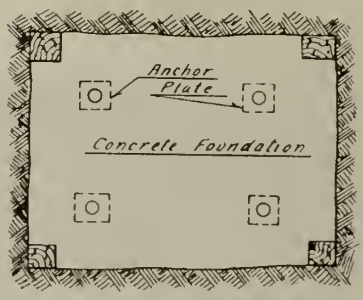


FIG. 12—PLAN OF FOUNDATION WITH POSTS EMBEDDED.

made so that the positions of the anchor bolts located by it will correspond exactly to the positions of the holes, for the accommodation of the anchor bolts, in the bed-plate of the machine. Templets may be of many different forms to accommodate different anchor-bolt arrangements. They should be composed of the fewest possible number of sticks and should be light in weight and yet substantial and rigid. The component sticks of a wooden templet are held together with flat-head wood screws, or in rough work, with clinched nails.

The general procedure in laying out a templet is about as follows: First, the principal centre line of the machine or foundation is marked with a chalk line or pencil on a smooth floor (Fig. 8) of sufficient area to accommodate the complete templet. Then the transverse centre lines are laid out in accurate relation, usually at right angles to the main centre line. Then the other minor centre lines are marked on the floor and the positions of the various foundation bolts located. Where an engine requiring dash pots is to be installed the locations of these should be indicated so that the templet can provide for their location. It is always well to show the centre line of the driving pulley or gear of the machine, if it has one, because the templet must often be located in some definite relation to some other machine or driving gear or pulley which may drive or be driven by the machine to be installed.

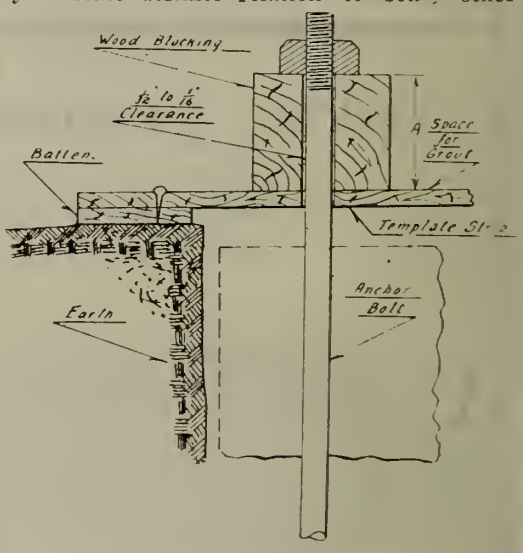


FIG. 14—ILLUSTRATING METHOD OF HOLDING UP BOLTS.

The centre lines and bolt locations drawn on a floor for a templet are shown in Fig. 8. After the centre line layout just described is completed, the pieces of plank which will be used to form the templet are fabricated over it. The layout on the floor really serves only to give the workman a general idea as to the locations that the different planks composing the templet should assume, one plank being laid centrally over the centre line and there nailed.

FIG. 8—CENTRE LINES LAID OUT ON FLOOR.

The bolt holes through the templet planks must be accurately located before they are bored, inasmuch as it is, of course, impossible to transfer their locations from the floor surface to the upper surface of the templet.

The diameters of the bolt holes through a templet should be such that there will be just enough clearance between the sides of the hole and bolt that it is to accommodate, so that the bolt will enter readily. For small bolts, pos-

sibly those of ¾ in. in diameter and less, 1-32 in. diametrical clearance is usually considered ample. That is, the diameter of the bolt hole through the templet should, for these small bolts, be 1-32 in. greater than the diameter of the bolt. For larger bolts a diametrical clearance of 1-16 in. is permissible.

Important centre lines should always show on a templet (see Fig. 3) so that they may be used in locating the templet in correct relation to the building or to existing machinery, line shafts and the like. Some erectors always arrange their templets so that a planed edge of a plank coincides with each important centre line of the templet. It is also frequent practice to use a line drawn down the middle of a plank with a scribe or a pencil as a centre line, but this method has the disadvantage that the line may sometimes become obliterated.

The construction of a 4-bolt templet for the foundation for the motor bedplate of Fig. 4, is shown in Fig. 3. For this templet, four pieces of 4 in. by 7/8 in. yellow pine, planed on four faces, were used. To hold the motor bedplate, four 7/8 in. diameter bolts were required, hence four 15-16 in. holes were bored through the templet in the locations indicated, for the accommodation of these bolts. Each of the four strips was made long enough to extend 14 in. beyond the edge of the cross-piece to which it was nailed to provide for its support on a form or battens as shown in Figs. 1 and 2 respectively.

Bracing is Necessary in Large Templets To Prevent Distortion

An example of such transverse bracing as applied to an 8-bolt templet is shown in Fig. 5. This templet is of relatively great length (10 ft. 2 in.) and it is apparent that if bracing were not provided there would be a possibility of the templet swinging out of shape and disturbing its accuracy. Examples of bracing on larger and more complicated foundation templets are shown in other illustrations.

A templet for a Corliss engine-driven generating unit (Fig. 6) is shown in Fig. 7. This unit, Fig. 6, comprises a 20 in. by 36 in. 150 r.p.m. engine direct-connected to a 375 kva. 240-volt generator. The foundation drawing and the bolt layout from which the templet drawing was made are shown in Fig. 6. Fig. 8 shows the centre line layout on the floor of the pattern shop. Over this layout the templet of Fig. 7 was constructed. Note that this templet is thoroughly braced to prevent any possibility of distortion. Note also that blocks (see Fig. 14) must be nailed on the templet strips at certain locations so that the upper ends of the foundation bolts will all lie at the correct height. Certain of the strips comprising the templet have been made long enough to extend considerably beyond its actual outline to provide for the support of the templet on the form for the foundation. This templet was made in two sections. One section, B, is designed to carry the anchor bolts for the engine proper, while section A is designed to carry the anchor bolts for the generator and for the outboard bearing. Had this templet been made in one section it would have been so large as to be unwieldy.

The construction of a templet for a machine having elevated outboard bearing is shown in Fig. 9. The foundation, with the anchor bolts in position, for which this templet was used, is delineated in Fig. 10. The elevation of the portion of the foundation, which carries the outboard bearing above the balance of the foundation, involves rather complicated templet construction, as suggested in Fig. 9. The portion of the templet supporting the outboard-bearing bolts is held on 2 in. by 4 in. struts, to which are nailed 1 in. by 6 in. ledgers or cross-pieces. Two 2 in. by 6 in. timbers extend across both of the long strips of the main portion of the templet and out past the outboard-bearing part, acting there as cantilever beams. To prevent any possibility of these 2 in. by 6 in. beams tilting, stay blocks (Fig. 9, III) are nailed on each side of the beams to the main templet strips.

The construction of a templet in the field usually involves the use of a transit. Templets for very large foundations, possibly 60 ft. to 100 ft. or more long for rolling mills or other large machines, are sometimes built in this way, In building such a templet the carpenters work under the direction of an engineer, who operates the transit. The engineer locates the foundation bolt points by referring to the foundation drawing of the machine. The stringers are first laid and fixed solidly in position, Fig. 11, and then the templet is built piece by piece by fastening the planks to the stringers in the right positions and boring therein the foundation bolt holes at the proper points. The points of locations of the holes are determined by the engineer and his assistants.

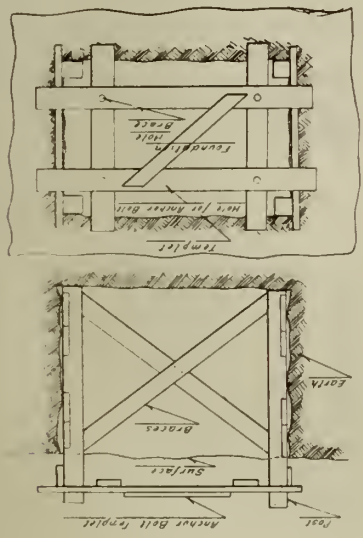


FIG. 9 TEMPLET FOR ANCHOR BOLTS OF FOUNDATION.

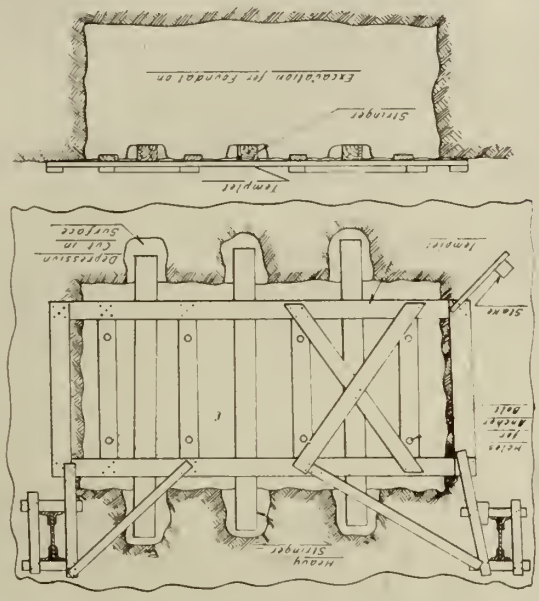


FIG. 11—ONE METHOD OF SUPPORTING A LARGE TEMPLET.

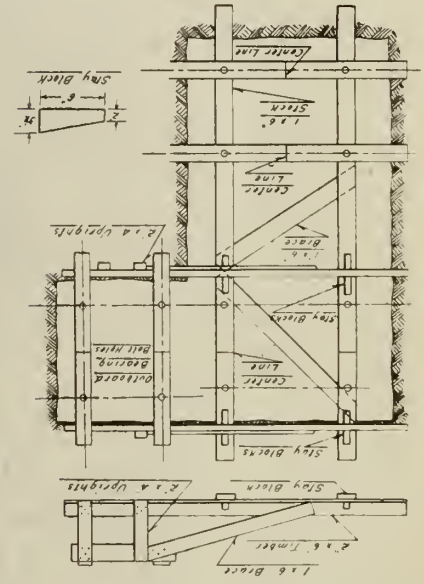


FIG. 13—TEMPLET SUPPORTED ON A FORM.

As to methods of support, there are two general classes of templets: (a) suspended templets; (b) subvened templets. Each of these methods will be discussed in detail in the paragraphs that follow.

Suspended templets are those that are supported from overhead, from the roof trusses or the floor beams of a structure or from an overhead framework erected especially to support them. Suspended templets are located high enough about the elevation of the top of the finished foundation so that men can walk under them and so that the concrete or other foundation materials may be handled below them without interference. They are frequently used for rolling mills and similar complicated foundations that cover large areas and contain many anchor bolts. A suspended templet is usually merely a frame mounted overhead with the location of every anchor bolt that is to be placed under it indicated on

its lower face by some kind of a mark. In locating an anchor bolt a plumb bob is temporarily dropped down from each one of these marks until the corresponding anchor plate has been set and secured in position at the point indicated by the plumb bob. The anchor plate then locates the bolt. Suspended templets will not, except in a general way, be treated further in this article.

Subvened templets are those that are supported from below, that is, they rest on their supports, as shown in Figs. 1 and 2. Subvened templets are sometimes called "dependent" templets, but subvened is a better word, inasmuch as dependent carries with it merely the idea of being supported, hence a dependent templet may be supported from either above or below. Subvened templets are used much more frequently than suspended templets because the subvened type can be effectively applied for all ordinary detached foundations such as those for engines, electric generators and motors, metal-working machinery and the like.

The methods of supporting subvened templets are many. Several typical ones will be described in following paragraphs. Whatever supporting arrangement is used it must be substantial and placed at such an elevation that the bolts will be maintained firmly and accurately in the locations that they are to occupy in the completed foundation. Templets may be supported on the forms of concrete foundations as diagrammed in Fig. 2. The form for the foundation is usually made of such a height that its top lies at the same elevation as that of the top of the finished foundation. The templet can be designed that its lower edge should rest on the top of this form. Inasmuch as the form should be carefully levelled and approximately aligned before any concrete is poured into it. This constitutes an ideal arrangement for holding up a templet.

Battens are used for supporting templets, for masonry foundations or for concrete foundations where no form is used (Fig. 1). Frequently the earth in which the excavation for the foundation is made is sufficiently solid that it is self-supporting, in which case the sides of the foundation hole constitute the form. The battens are nailed to pointed stakes, which are driven into the ground. Four stakes and two battens suffice for a small foundation, but a number of stakes and four battens, one on each of the sides of the foundation, should be used in the more important installations. This method is effective and inexpensive and finds frequent application for small foundations.

A method of supporting templets on stringers fastened on posts set in the corners of a foundation hole is shown in Figs. 12 and 13. This method is used only for foundations for which forms are not required. It can be applied for either masonry or concrete foundations. Four posts, one in each corner of the foundation excavation, are driven into the earth as suggested in Fig. 12. The size of the posts used is determined to a certain extent by the weight of the templet to be supported. Ordinarily, nothing smaller than a 4 in. by 4 in. post is used, and 8 in. by 8 in. sticks are none too heavy to ensure the stability of a large templet. The posts are held vertically in position by side and cross braces as shown in the sectional elevation of Fig. 13. The level at which the bolts are to be set having been determined, battens of suitable size, usually of 1 in. stuff, are nailed to the uprights. For a small foundation, two battens arranged as shown in the plan view of Fig. 13 are ample, but for large foundations four battens, one along each of the form edges of the foundation should be used. The battens are set at such an elevation that when the templet is placed upon them and the anchor bolts inserted, the bolts will be at the proper level. The hole is filled with concrete. After the concrete has set, the templet can be removed. The uprights or posts

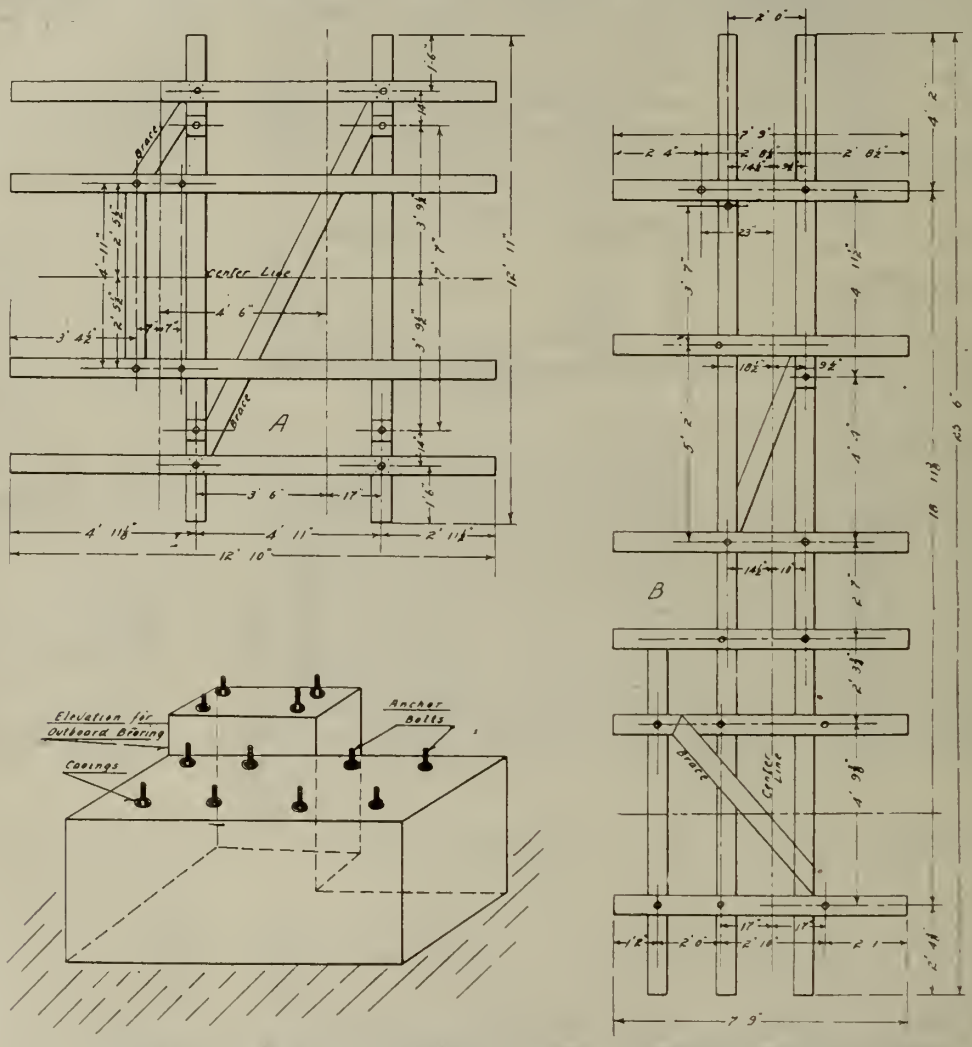
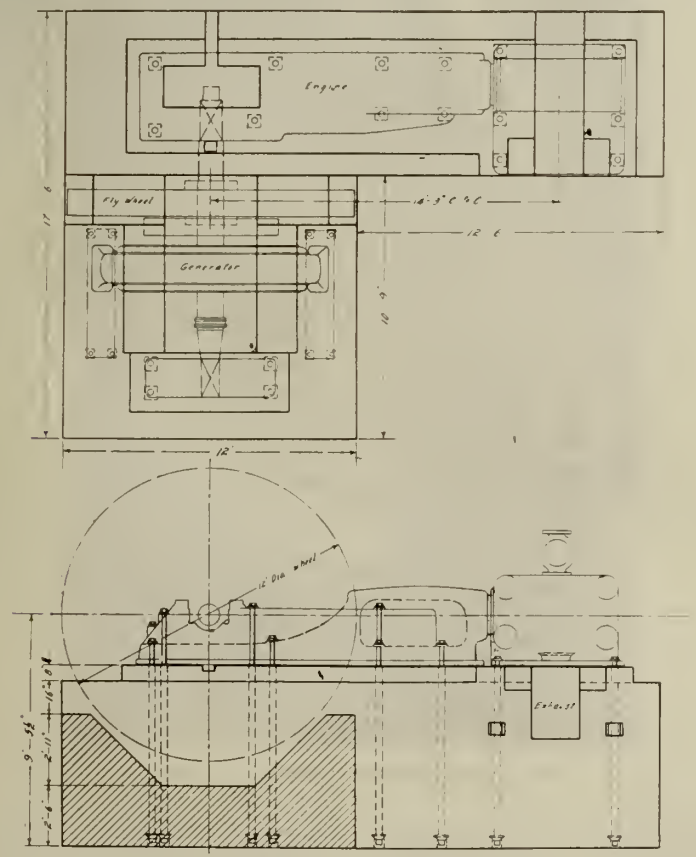


FIG. 10—PERSPECTIVE VIEW OF FOUNDATION WITH EXTENSION FOR OUTBOARD BEARING.

FIG. 7—TEMPLETS FOR LEFT HAND, 150 R.P.M. CORLISS ENGINE-DRIVEN GENERATOR.

are then sawed off flush with the foundation top. The balance of the wood is permitted to remain in the hole, the plan view of the completed foundation then being as shown in Fig. 12.

The method of supporting a templet on stringers is shown in Fig. 11. This arrangement may be effectively used for the very largest foundation. Heavy timber stringers laid across the foundation hole with their ends resting in depressions of such depth that the lower face of the templet will, when it rests on the stringers, be at the elevation of the top face of the foundation. The stringers support the templet, which in turn carries the anchor bolts. Where the anchor bolts are quite large, possibly 2 in. in diameter, their weight will be considerable, and the stringers must be so disposed that the templet, which is usually of relatively light stock, will not be subjected to excessive stresses. When the bolts are heavy the stringers should be located near the rows of bolt holes rather than midway between them as shown in Fig. 11. Where a templet is to be supported as suggested in Fig. 11, it may, unless too large, be built complete in the carpenter or pattern shop. It



FOUNDATION FOR CORLISS ENGINE.

can then be transported to the foundation hole and located accurately on the stringers.

Templets built up in the field can frequently be used to advantage, although for the ordinary foundation it is believed that the most economical procedure is to build the templet in the shop. The process of fabricating a templet in the field is as follows:

The excavation for the foundation having been complete and the footing course being in position, the exact elevation of the completed foundation top is determined. The principal centre lines of the foundation are also determined and each designated by marks on the floor, or by tight cords or wires. Then heavy timbers are laid across the foundation excavation, somewhat as suggested in Fig. 11. Ordinarily 2 in. by 6 in. or 2 in. by 8 in. timbers are sufficiently strong, and they should be set on edge like the beams of a floor. They should be arranged 24 in. to 30 in. between centres, and their top edges should lie ⅞ in. (to allow for grout) below the elevation of the finished foundation top. Cross bridges should be nailed to the tops of these timbers to retain them securely in their positions.

The beams are then overlaid along the lines where the anchor bolts are to be suspended, with ⅞ in. by 6 in. strips which are nailed to the beams. The beams must be so located that they will not interfere with the bolts. If certain bolts are to extend to a higher elevation than others they should be blocked up as suggested in Fig. 14. The exact centre lines of all of the bolts are laid out on these ⅞ in. strips. At the location of each bolt a hole is bored through the strip large enough to accommodate the anchor bolt with the clearance suggested above. Now each anchor bolt is hung in position in the templet and a wooden block of a thickness of the bed-plate (A, Fig. 14) is inserted over the head of each bolt. Then the nut on the upper end of the bolt is screwed down to the position that it should assume when the foundation is completed and the bed-plate in position. In thus setting the bolts, allowance should be made for the grout that should be poured between the bed-plate and the top surface of the foundation. After the foundation has been completed the timbers are removed.

The method of blocking up anchor bolts that they will lie at their correct elevations is shown in Fig. 14. Blocks of wood, each with a hole bored through it, short lengths of pipe or piles of washers or nuts that will slip over the end of the bolt can be used for this blocking.

TESTING OUT CIRCUITS BY MEANS OF A BELL

In testing out electric circuits about a gasoline engine and to see if they are broken or not I often use a common door bell with two copper coins, each having a hole in the centre of it, placed one on each terminal of the bell. To test if the central electrode of a spark plug is broken connect its terminal to a dry cell and connect the remaining terminal of the cell and the inner end of the spark plug electrode through the bell. This can be done by bringing the spark plug close enough to the cell that each can be put into contact with one of the coins on the bell, each touching a different coin. If desired a wire may be hooked onto one bell terminal along with the coin as the parts are generally long enough to allow this. Conductors may each be tested out in this way also. If the bell rings current is flowing. Do not attempt to connect the bell into the high tension circuit with the high tension current on it at the same time. One dry cell is generally current enough for testing for broken circuits. When uncertain which of two or more ends is the second end of a given conductor connection of the cell to the given wire and to the bell and touching the other bell terminal to each of the doubtful ends in turn will decide the question, for the bell will ring when the right end is tried. Canadian copper coins on the bell terminals wil reduce the distance between enough that the bell may be used to test and enable one to approximately judge of the strength of dry cells if the ammeter is not within easy access. Touch the cells as with an ammeter and hear how loud the bell rings but do not leave the bell ringing very long as one could weaken the cell some that way in a little while, there being no line resistance to reduce the amperage.

J. E. McCORMACK.

To Settle Dispute.—The Nova Scotia Legislature is about to introduce a bill to force the Dominion Coal Co. and the Nova Scotia Steel and Coal Co. to settle their differences. This will be done by compelling the companies to submit to a re-arrangement of their leases, which will allocate all the areas north of Sydney Harbor to the Scotia, and all those south of Sydney Harbor to the Dominion Co.

Methods of Guarding Engines and Turbines

The "Travellers Standard" Has Some Interesting Information on Different Forms of Safety Apparatus as Applied to Governors, Fly Wheels, and Rotors.

IT is often assumed that the stationary engineer has an easy job, and that his main duties consist in starting and stopping the engine at the beginning and end of the working shifts, while in the meantime he sits in a comfortable chair, smokes his pipe, and reads the nswspaper. Even the owners of power plants appear to hold this opinion in some cases, and in order to put "spare time" of engineer to profitable use they make him a sort of general factotum. The position calls for efficiency in various mechanical lines, and when some trifling job has to be done it is perhaps natural to wish it upon the engineer, because in all probability he will know just how to do it. To a certain limited extent this is all right, but the thing can easily be overdone. For example, the engineer should never be required to go to some other part of the shop or factory to repair a disabled machine or set up a new one, or to change over or add to a piping system, mend a broken belt, or do any of the other countless odd jobs that constantly require attention, in every manufacturing plant. When service of this kind is required of him, the engine is often left wholly unattended in the meantime, or perhaps the fireman or some other less qualified person is told to "keep an eye on things." A plant operated on this basis is in constant danger, because at any moment conditions may arise that will lead to a bad accident. The engine should never be left unattended, and if it is necessary for the engineer to be absent from the engine-room temporarily, some person known to be competent and trustworthy, and capable of doing the right thing in time of emergency, should be delegated to take his place.

The position of stationary engineer is an exceedingly responsible one, which calls for a high-grade, versatile man, having a broad general knowledge combined with a large amount of manual skill. He must also have had thorough training and considerable experience so that he can not only diagnose engine troubles quickly and accurately, but also superintend the work of making such repairs and adjustments as the engine may require.

The employment of a first-class engineer is the prime requisite for securing safety, but various other matters must also receive attention if the plant is to be properly protected and some of these are mentioned in the following paragraphs.

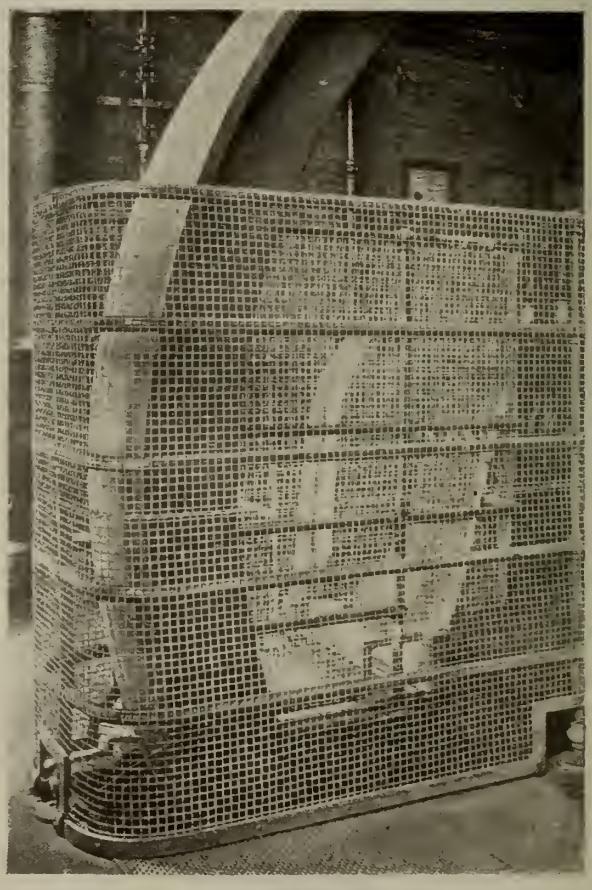
Of the more serious accidents that occur in conection with steam engines, those due to bursting flywheels are doubtless the worst, and perhaps they are also the commonest. The principal causes of flywheel explosions are excessive speed, sudden and extreme variations in the load, and defects in the wheels.

A sudden increase in the load on an engine may produce exceedingly heavy stresses in the flywheel, particularly when the wheel is merely used for steadying the motion of the engine by the storage of momentum (or of kinetic energy), and not for carrying the driving belt. The momentum of the rim in such a case tends to produce severe stresses in the spokes and the hub, and fracture may result unless the wheel is designed for this type of service, and is also in good physical condition every way. The flywheels of rolling mill engines are subject to extraordinarily heavy duty of this kind, and must be built with special reference to violent changes of speed.

Every flywheel, whether subjected to sudden variations of load or not, should be examined frequently and thoroughly, by expert inspectors, for the detection of weaknesses and defects, and the discovery of dangerous conditions associated with the operation of the engine, and immediate compliance should be accorded to the recommendations that are made in consequence of such examinations.

The speed at which a flywheel may be safely run depends upon the design of the wheel, the material of which it is constructed, and to some extent upon the conditions under which the engine is operated. The limit at which the speed ceases to be safe should be determined by the use of approved rules and formulae, and should never be exceeded, under any circumstances. A flywheel may be actually operating at a speed considerably below its maximum safe limit, but unless this fact is positively known, it is dangerous to increase the speed of the wheel without first considering carefully all the consequences of such action and calculating the additional stress that would be produced in the wheel by the proposed increase in speed. Lack of care in this matter may be followed by a disastrous explosion.

Comparatively few of the accidents that arise from excessive speed are caused by intentionally increasing the speed, however. Most of them are caused by the failure of the governing mechanism, or by a sudden fluctuation



PIPE RAIL GUARD WITH WIRE MESH.

from full load to no load (such as might be caused by the breaking of the main belt, or the failure of some of the main shafting, or the burning out of an armature if the engine is direct connected to an electric generator,) any one of which might cause the engine to race or run away.

Frequent examination of the entire governing mechanism is essential to make sure that it is in good working order. The belts of belt driven governors should be kept at the proper tension, and free from oil and grease which would cause them to slip. See, furthermore, that the key or set-screw that secures the governor pulley to its shaft is kept

GOOD GUARD FOR A FLY BALL GOVERNOR.

tight, and that the gears of gear-driven governors are in good condition. Provide suitable guards for the balls of fly-ball governors, particularly when they are located near oilers' walks or passageways of any kind. Basket-shaped guards, made of sheet metal or stout wire netting, are often used for this purpose. A good type is shown in Fig. 1.

A rope drive may be used for a governor in place of a belt drive, and it has many good features. It should preferably consist of two or three separate ropes, each strong enough to operate the governor alone. With an arrangement of this kind no harm can result in case one of the ropes breaks, and the ropes can be replaced one at a time as they become worn. In some plants, where the multiple-rope drive is used, a board or piece of sheet metal is secured in place close to the pulley over which the ropes pass. If a strand of one of the ropes breaks the flying ends will then strike the board of metal and call attention to the danger.

A positive stop should never be placed under the governor rod. When a governor rod stop is needed to facilitate starting the engine, an automatic device should be provided, which will drop out of the way as soon as the rod rises, and leave a clear path for the rod to descend to its lowest position.

A governor safety stop should be provided in connection with each fly-ball governor. This may be operated electrically or mechanically, and should be arranged so that when the governor rod descends to a dangerously low position (in consequence, for example, of the breaking of the governor belt,) a spring or some other equivalent device will be released, which will close the steam admission valve and stop the engine. Protection against over-speeding in case of the breakage of the governor belt may also be secured by using an idler pulley, which rests on the belt under ordinary circumstances, and is connected to a quick-closing valve in such a way that the steam will shut off if the belt breaks and allows the idler pulley to drop.

Automatic speed limit stops, designed to limit the speed of the engine independently, are often installed in addition to the governor, and the use of an approved device of this kind is strongly recommended; but even when it is provided no precaution should be omitted that would tend to insure the safety of the workmen and the equipment in case the automatic apparatus should fail to operate in an emergency. Some of these devices are more or less complicated in design and construction and require careful mechanical adjustment, and some of them operate by opening or closing an electrical circuit. They should receive proper care, and they should be tested frequently and regularly, to insure dependability. The character of the tests should be such as to leave no doubt with regard to the positive and effective operation of the apparatus. Frequent tests should also be made of the circuits (when electrically-operated devices are used), to make sure that there is always sufficient current to operate the mechanism effectively, and to discover possible short circuits and other electrical defects. Batteries (when they are used) should be renewed before they become too weak to furnish the needed current, and in all circuits the connections should be kept clean and tight. The wires should preferably run in conduits, but if that is not feasible they should be thoroughly insulated and effectively protected against moisture, grounding and short-circuiting.

It is important to provide the most complete protection to every part of the apparatus that serves to stop the engine automatically in case the speed should exceed the safe limit. If the apparatus is operated electrically, for example, the batteries and the conducting wires should always be located so that they cannot be damaged by a broken main driving belt, nor in consequence of any other accident that can be foreseen and which might precede or accompany the racing of the engine. This same caution applies to every other part of the apparatus that is concerned in the control of the speed, and to every method of control, whether electrical, mechanical or pneumatic. Many plants that are elaborately provided with independent engine stops show the greatest imaginable lack of forethought with respect to the protection of the apparatus against damage from the very causes that may lead the engine to run away; and a plant of this kind is poorly protected, in spite of the impressive array of mechanism that may be in evidence.

When automatic engine stops are used it is advisable to arrange them so that in case of accident they may be operated from any room or department in which power is used. This is a simple matter if the stop is of the electrically controlled type, because it is easy to run wires through the various rooms, and to install push-buttons at any number of convenient or important points; and even if the stop is not in itself actuated by electricity, a special control apparatus can readily be designed for operating it electrically from any part of the plant. Moreover, the exercise of a little ingenuity will enable one to devise simple mechanical controlling arrangements which will operate satisfactorily from points not too far remote from the engine room. Flexible wire cords passing over pulleys may often be used with advantage for this purpose. In addition to such devices, and particularly in large plants, we recommend that independent electric signalling systems be provided, to facilitate quick communication between the engine room and each of the various departments.

Push buttons (or other devices) that are provided for the purpose of stopping the engine or sigualling to the engine room from various points about the plant, should be easily and quickly accessible, and should be conspicuously marked so that they can be located instantly. All stop devices should be tested frequently and regularly, to see that they are in good working order; but severe penalties should be imposed for stopping the engine except in time of serious emergency or by express direction of the foreman or some other person in authority, and a notice stating these penalties should be posted in close proximity to every stop-device. In time of emergency the full load should be left on the engine, if possible, because this causes it to stop more quickly. In time of danger workmen often unthinkingly shut down machines that have no direct connection with the emergency and by thus lightening the load cause the engine to run longer.

When jet-condensing engies are used, automatic devices should be installed which will break the vacuum when the water in the condensed reaches a predetermined height. If this is not done, the slowing down ow the air pump, which would occur if the pump is of the attached type, might cause the condenser to become flooded, in which case the water would flow back into the engine cylinders, and the engine would probably be wrecked or badly damaged. Over-speed devices, when used on condensing engines, should be arranged to break the vacuum as well as shut off the steam.

The control lever or wheel which operates the throttle valve is frequently located directly in the plane of the fly-wheel, where the engineer is exposed to the greatest possible danger when he undertakes to stop a racing engine by shutting off the steam by hand. In some cases this cannot well be avoided without a considerable modification in the

design of the engine, but it is often, we think, due to mere thoughtlessness. When the throttle valve is located in a dangerous place we strongly recommend extending the spindle (when this is possible), so that the lever or wheel which operates it can be manipulated from a position of comparative safety.

Special attention and care should be given to the dash-pots of Corliss engines, because if these get out of order the speed of the engines will be irregular. When oiling the valve-gear a little oil should be placed in each dash pot to make sure that the piston of the dash pot fits its cylinder air-tight at all times. If this piston becomes worn so that it is no longer easy to keep it air-tight, repairs should be made at once, and when a new dash pot piston is put in special pains should be taken to see that it neither sticks nor fits too loosely, and to adjust it so that it will operate effectively. The dash pots should have the full amount of drop, and should work in complete harmony with the governor in the control of the engine. Careful attention should also be given to the packing of the stems of the cutoff valves because if the packing is too tight the valves may stick, thereby delaying the cutoff and causing the engine to speed up.

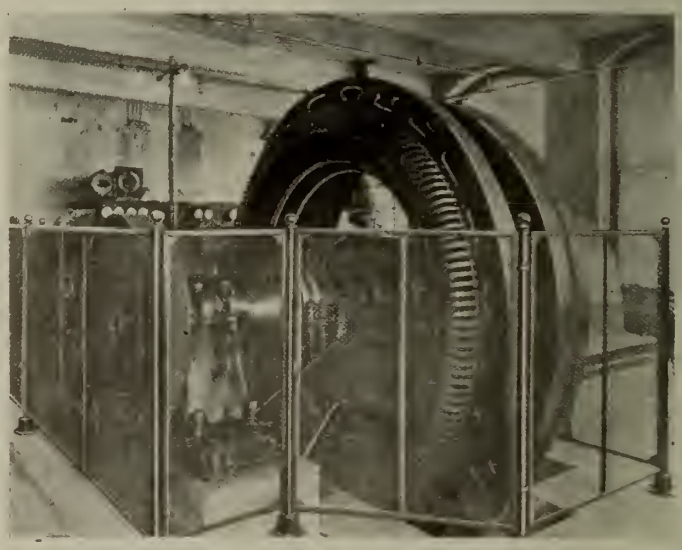
Engine flywheels should be guarded by substantial railings of pipe, angle iron or wood, or by inclosures of some other acceptable kind to prevent persons from coming in contact with them. When railings are used, and the wheel runs in a pit, a toe-board at least six inches high should also be provided, to prevent tools and other objects from falling into the pit. Inclosures may be constructed of solid, perforated, or expanded metal, or of stout and substantial wire netting. Employees should never be permitted to go inside the guard railings, for any purpose whatsoever, while the engine is running, and they should not be allowed to store oil-cans, tools, waste, or other objects inside of these railings or screens, nor to hang clothing upon them.

It is sometimes necessary to turn the flywheel over by means of a Johnson bar or some other hand turning device, and the guard rails or inclosures are often made removable at some convenient point, to permit this work to be done. This is not recommended, however. There should be no door or grate in the inclosure or railing, and any opening that may be provided for inserting and applying the Johnson bar should be limited to the smallest size that will permit the "barring-over" operation to be accomplished. (It is extremely dangerous to turn the wheel over in this way without making sure, beforehand, that the throttle valve is closed tight, and that there is no pressure in the cylinder.)

The suggestions given for flywheel railings apply also to main belts or rope drives. The ladders that are often associated with large engines should have similar railings, and all platforms or footways used in connection with such engines should be provided with standard railings and toe-boards. The same principle also applies to all walks located on or about engines, for the use of oilers and others. Substantial guards or inclosures should be provided for the cranks, cross-heads, connecting rods, and tail rods of engines, and for the ends of the main shaft if they project beyond the bearings.

It is advisable to place a heavy plate barrier guard opposite every cylinder head and close to it, so as to diminish the likelihood of injury to persons in the engine room in case any of the cylinder heads should burst. Guards of this kind should be solidly supported, but should be so arranged that they may be removed by means of a crane when it is necessary to get at the cylinder heads.

When the main driving belt of an engine breaks it is likely to do a great deal of damage, and any person who is struck by it will probably be severely injured. It is, therefore, wise to instal special barrier guards in front of such belts, to prevent property damage, injuries and loss of life in case of an accident of this kind. Barrier guards, to be effective, must be strong and solid and must also be secured in place with the utmost care, so that they will be able to successfully withstand the exceedingly severe shock to which they will be subjected in case the belt is thrown against them at full speed.



GUARD FOR DIRECT CONNECTED GENERATOR.

It should hardly be necessary to refer to the importance of keeping the cylinders of engines free from water, yet piston rods are frequently bent and cylinder heads are often fractured in consequence of neglecting this simple and elementary precaution. The water may back up into the cylinder from the condenser (as already described above) or it may come over with the steam in consequence of foaming or priming in the boilers, or it may accumulate in the cylinder from the condensation of the steam admitted to a cold engine preparatory to starting up, or (as happens all too commonly) its presence may be due to the simple fact that the steam main was not properly drained.

Before starting the engine drain the steam main thoroughly in every part. Then open the drain cocks on all the cylinders (and preferably the indicator cocks also), and if water runs out of the drain cocks wait until it has ceased to flow. Then, leaving the drain cocks still open, start the throttle valve a mere trifle (or, in technical language, "crack" it a little), and allow steam to enter the engine slowly, but without the production of pressure), so that the cylinder will gradually become heated up to the working temperature. This must be done, of course, when the engine is in such a position that at least one of the admission valves is open. If the engine is of the compound or multiple expansion type, all the cylinders should be warmed in the same way by opening the pass-over valves. If the cylinders are provided with steam jackets these should also be filled with steam, as the heating of the cylinder will thereby be greatly facilitated; and in plants in which excessive peak loads may occur, or in which there is likelihood of a heavy call for power on short notice, the jackets should be kept filled with steam at all times, so that the engine may be ready to start without the least delay. Attend carefully to the draining of the steam jackets. Vacuum jackets are now being tried out in connection with reciprocating engines, the principle involved being the same as that upon which the familiar vacuum bottle depends. These vacuum jackets are supposed to diminish the loss of heat by radiation to such an extent that the cylinders remain quite hot for a number of hours after the engine has stopped.

When the cylinders have become thoroughly warmed the engine may be started turning over slowly, but the drain cocks should be left open until all danger of the collection of water in the steam-chest and cylinders is past. Under usual conditions this means that the drains should not be closed until the engine has been running at least five or ten minutes. It is advisable to "fiddle" the engine (or cause it to rock back and forth slightly) before turning it over, if it is of the reversible type, or if, on an en-

gine of the Corliss type, the carrier or reach-rod is detachable from the wrist-plate.

Before removing a cylinder head the workmen should make sure that the throttle and exhaust valves are both closed, and that the drains are open, and they should also try the indicator cocks to prove that no pressure remains in the cylinder.

PIPE RAIL GUARD FOR ENGINE CRANK.

See that all moving parts of the engine are kept thoroughly lubricated, and use the right kind of lubricant in each place. Positive force-feed automatic lubricators are recommended for pins and other similar parts, not only because they insure good lubrication, but also because they are more economical in the end, although they are higher in first cost. All lubricating devices should be examined frequently to see that they are properly adjusted, and that the oil flows freely and in suitable quantity.

All parts of the engine should be kept in good adjustment, and all nuts and keys should be kept tight. If knocks or other unusual or abnormal noises are noted, locate them immediately, ascertain the cause, and apply the proper remedy.

Slippery floors in engine-rooms frequently cause falls, and a slip-proof surface of rubber, or other approved non-slip material, should therefore be provided wherever slipping would be attended by special danger, and (preferably) also on the most frequented parts of the floor.

Employees from other departments of the plant should not be permitted to loiter in engine-rooms, nor even to enter them except as their duties may require them to do so. No person, other than those responsible for the operation of the engines, should be permitted to manipulate any valves, nor even to touch any of the mechanism, nor to approach any moving part, except under the direction and supervision of the chief engineer or of some other person in authority.

If the foregoing suggestions are followed, the number of accidents in engine rooms will certainly be materially reduced.

FUEL SAVED BY SCIENTIFIC FEED-WATER REGULATION

Here are some interesting "before and after" feed-water temperature charts that were sent to us by the Northern Equipment Co., Erie, Pa., manufacturers of the well-known Copes boiler feed regulator.

Fig. 1 shows how the feed-water temperature fluctuated before a regulator was installed. The average temperature by actual measurement and computation was only 177 deg. Fahr.

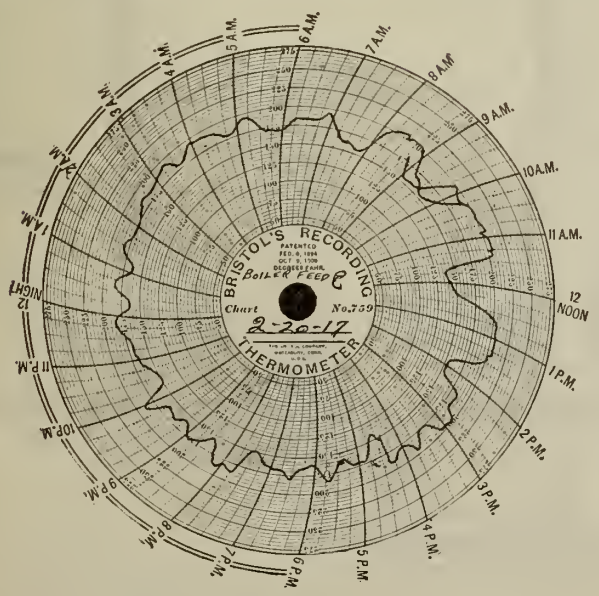
Fig. 2 shows a vast improvement. There is practically no fluctuation in the temperature now that the regulator has been installed, and it is maintained uniformly high, the average temperature being 210 deg. Fahr. A correction in this instance had to be made on account of the recorder reading 12 deg. high.

The average increase in feed-water temperature due to the regulator is therefore (210—177) = 33 deg. Fahr. Since it is customarily reckoned that 11 deg. difference in feed-water temperature is sufficient to save 1 per cent. of the fuel, it is easy to figure that the Copes regulators in this installation are saving 3 per cent. of the annual fuel cost.

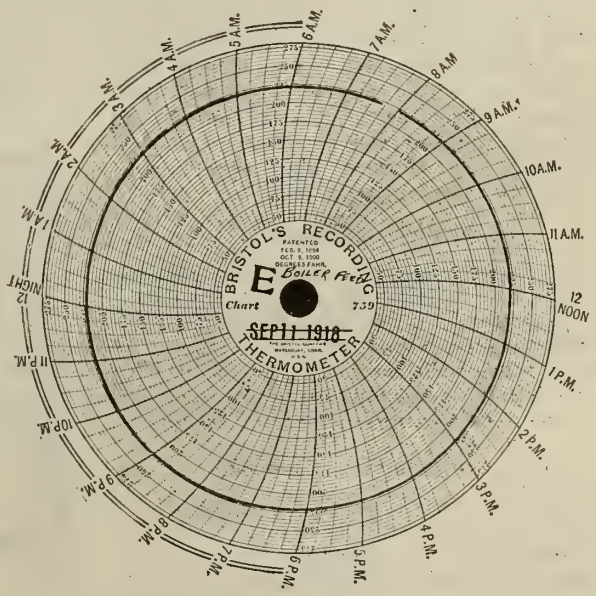
No steam escapes from the heater now that the regulator is installed. Before installation, steam constantly escaped, because with improper regulation the full amount of heat in the exhaust was not utilized. This saving of steam is accomplished by having part of the exhaust steam supplied to the heater controlled by a temperature regulator. The bulb of this regulator is installed in the heater vent and not in the heater outlet as is the usual case. With this arrangement, when any steam begins escaping through the heater vent, the steam supply valve closes quickly.

It has been calculated on the above 3 per cent. basis that these regulators pay for themselves every 15 days, due alone to this saving.

In addition it is pointed out by the manufacturers that with scientific regulation there is an increase in boiler efficiency, an increase in boiler capacity, a saving in wear and tear on pumps, and after relieving the water tender of this undesirable mechanical duty he can be given more pay in an occupation around the plant that requires brain power rather than mere muscle. The modern tendency is toward complete automatic operation everywhere, with human beings serving in a supervisory capacity only. Machinery, machinery, and more machinery, has made the 8-hour day possible, and may eventually reduce it to 6 hours, 4 hours, and even less.



BEFORE FITTING REGULATOR.



AFTER FITTING REGULATOR.

Railway Converter Substations---Part II

The Author Gives Some Useful Information Concerning the Class of Equipment to be Used and Its Arrangement in the Substation Building.

By C. F. LLOYD, Manager Substation Section, Westinghouse Electric and Mfg. Co., Pittsburgh

Regulation and Compounding

Compound wound converters are recommended for railway work, primarily because their regulation is superior and parallel operation is more readily effected than with shunt wound machines. The regulation of a compound converter depends upon three factors, namely: Series Field, Reactance and Ohmic Drop between the source of power and the converter. Compounding is not obtained directly by change in series field as in a D.C. generator, but by changing the machine power factor, which causes any reactance volts behind the machine to be added to or subtracted from the voltage actually applied to the converter collector. The D.C. voltage from no load to full load will be raised, neglecting the drop in the converter due to load, in the same percentage as the voltage is increased at the collector. The A.C. ohmic drop between the source of power and the converter is directly opposed to compounding and should it amount to the same percentage as the percentage increase, then a practically constant voltage will result. The standard method of compounding converters is to adjust the machine shunt field to a valve such that when fully loaded with the series field in circuit, it will be operating at approximately unit power factor. The applied voltage to the collector rings, therefore, at light loads, with the lagging power factor, is reduced as the reactance volts subtract from the generator volts, while at full load unity power factor, the current is in phase with the impressed voltage and the impressed volts are almost equal to the generator volts.

It is practically impossible to correctly determine the values necessary to figure the regulation that will obtain in individual cases, consequently, converter regulation cannot be predicted with any degree of accuracy. Standard Westinghouse Converters are designed with a reasonably heavy series field and their transformers with 15 per cent. inherent reactance, which is the maximum reactance consistent with good practice. Such a combination will give approximately constant voltage from no load to full load, providing the voltage is practically constant at the high tension side of the transformers.

The best results are obtained with slightly dropping voltage characteristics at substations. This means that the converter should be under-compounded in amount depending upon local conditions. Invariably it is good practice to shunt the converter series field to obtain a drop in excess of that which may be due to A.C. line drop. This adjustment allows better distribution of load between substations and, in consequence, better results are obtained when cars become blocked for some abnormal reason.

Parallel Operations

To parallel rotary converters successfully, both the new and the old machines may have to be adjusted to obtain the best results, even though the new equipment is a duplicate of the old. There, however, will be no difficulty in making the proper adjustments, assuming the design of the new apparatus is proper.

Transformers' Standards

Standard transformers for railway converters are listed only in the oil insulated, self-cooled type for converter capacities of 2,000 k.w. and below. Other types and transformers for larger converters are not listed, but can be supplied when required. The following table shows standard listed transformer ratings:

Standard O.I.S.C. Transformer Ratings

Rating. Com. K.W.	Rating. Trans. 1-phase.	Rating. Trans. 3-phase.	V. 2200 Cycle.	V. 6600 Cycle.	V. 11000 Cycle.	V. 13200 Cycle.	V. 16500 Cycle.	V. 22000 Cycle.	V. 33000 Cycle.
300	100	300	60-25	60-25	60-25	60-25	60-25	60-25	60-25
500	167	500	60-25	60-25	60-25	60-25	60-25	60-25	60-25
750	250	750	60	60	60	60	60	60	60
1000	333	...	60-25	60-25	60-25	60-25	60-25	60-25	60-25
1500	500	...	60-25	60-25	60-25	60-25	60-25	60-25	60-25
2000	667	...	60-25	60-25	60-25	60-25	60-25	60-25	60-25

Taps and Terminals

Standard transformers are provided with high tension full capacity taps to take care of a total variation of 10 per cent. in the line voltage. In capacities up to 200 Kva. inclusive, taps are provided for 5 per cent. and 10 per cent. voltage below normal. In capacities above 200 Kva., taps are provided for voltages 2½, 5, 7½ and 10 per cent. below normal. The low tension winding has no taps other than those for obtaining suitable reduced voltage for starting. All low tension leads are brought through the case. All connections available on the high tension are brought up to the terminal board and only such leads as are required for external connections are brought through the case. When different high tension connections are required, they can be made at the terminal board inside the transformer case. There may be isolated cases requiring special high tension tap arrangement with a greater number than standard. This can usually be supplied but costs more and very often makes it impracticable to use 3 phase transformers, due to mechanical reasons. It is usually impracticable to put additional taps on the low tension winding on account of the heavy current and small number of turns.

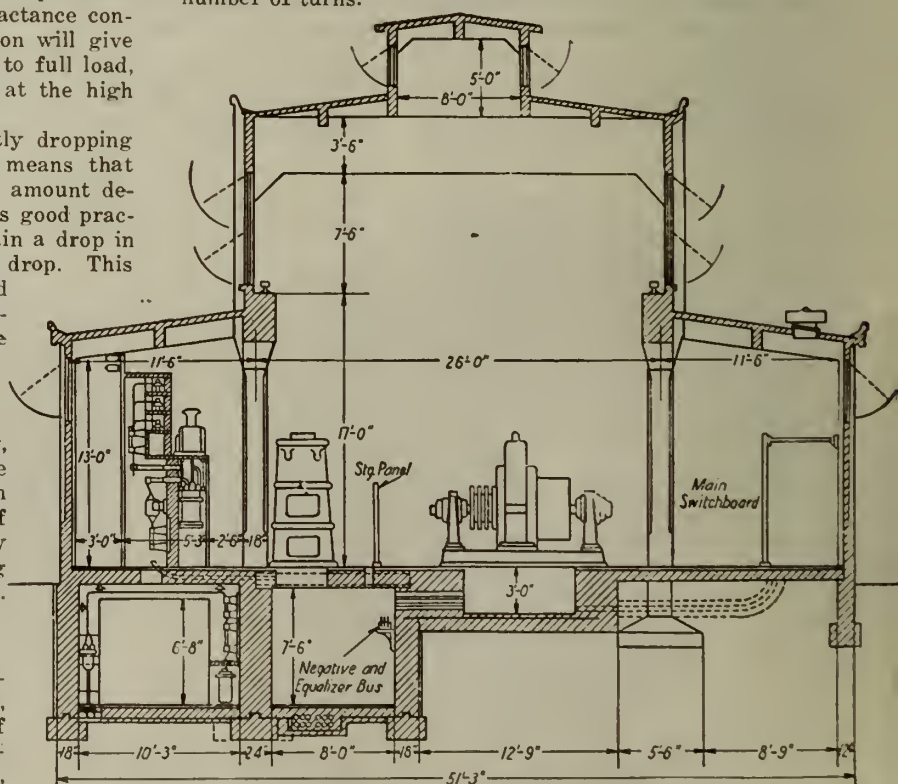


FIG. 11—UNITED RAILWAYS AND ELECTRIC CO. BELVEDERE SUB-STATION. 600 V.D.C., 13200 V. 25 CYCLE A.C. ELEVATION.

Reactance

Standard transformers are designed with 15 per cent. inherent reactance for compounding purposes. This arrangement is not only less expensive, but requires less space, reduces wiring, etc., over the older practice of supplying transformers of normal reactance with external reactance coils.

protection against insulator breakage. For underground work, multiple conductor cable with double weather-proof covering, is recommended. Where space is very limited, it may become desirable to install high tension bus, circuit breakers, etc., in cell structures, in order to equal the safety factor to be obtained where sufficient space is available. This form of construction is more common in

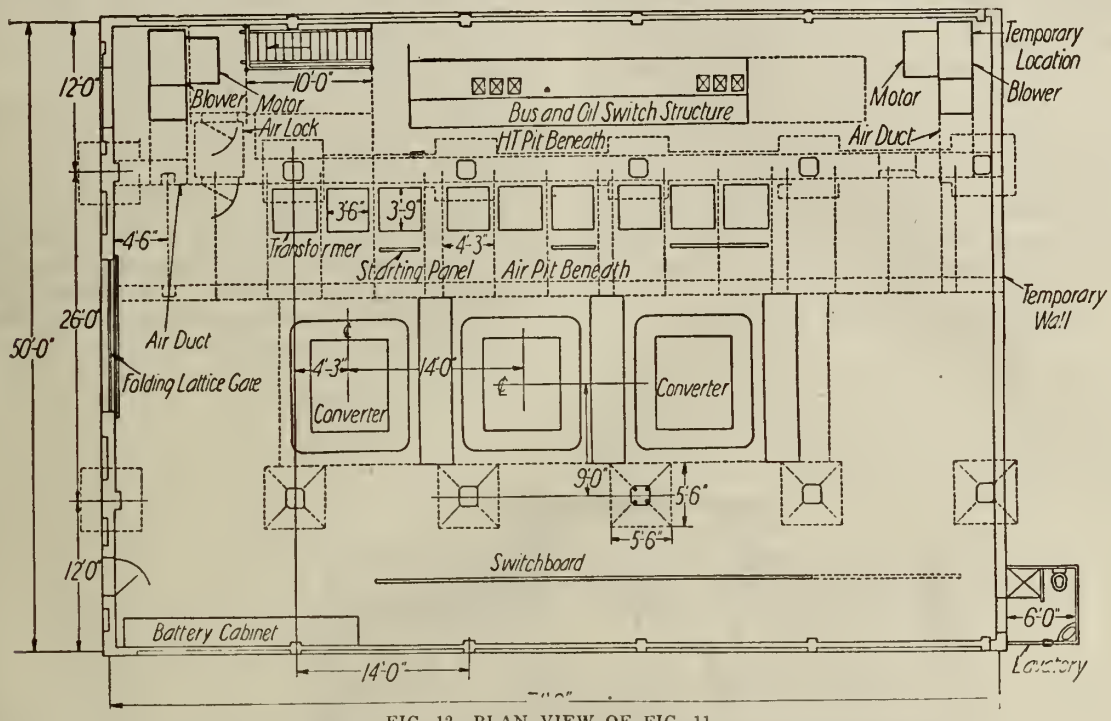


FIG. 12—PLAN VIEW OF FIG. 11.

Miscellaneous Station Equipment High Tension Wiring

Whether incoming lines are overhead or underground, it is good practice to install disconnecting switches for isolating the oil circuit breakers. Overhead lines can be brought in through roof or wall bushings or carried on suitable insulators through openings in the substation wall. Underground lines should be brought in through suitable potheads.

All high tension wiring should be well out of reach of attendants or visitors. For voltages of 22,000 to 66,000 volts, the use of solid bare copper wire, not less than No. 1 B. & S. gauge carried on suitable insulators, is good practice. Copper tubing makes a better appearance, but is more expensive. For voltages of 2,200 to 15,000 volts, the use of single conductor flame-proof copper wire, insulated with varnished cambric for full working potential, carried on suitable insulators, is good practice. Insulation is used on this class of overhead wiring, as protection against the loss of life, although it also affords additional

larger substations, fed by high tension lines of 22,000 volts and below, located in congested districts.

Low Tension Wiring

For A.C. or D.C. voltages up to 1,500 volts, the use of standard single conductor cable, insulated with varnished cambric, is recommended. Rubber covered cable is satisfactory. The cable should have a flame-proof covering, or double weather-proof covering, depending upon whether the wiring is exposed or in conduit. Care should be taken to drain all cable ducts to a pit, as it is unsafe to assume that a cable is dry, unless it is drained in this

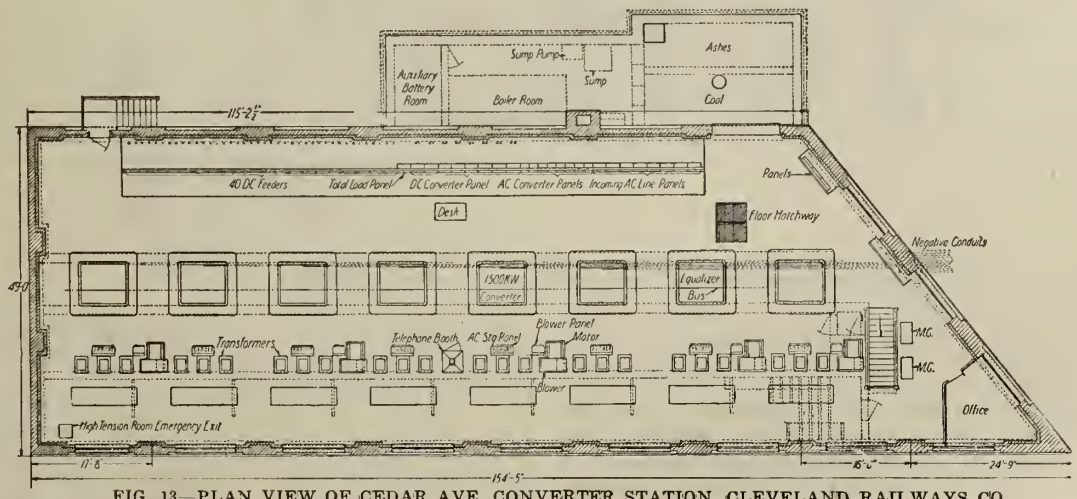


FIG. 13—PLAN VIEW OF CEDAR AVE. CONVERTER STATION, CLEVELAND RAILWAYS CO.

manner. There should be no danger of a break-down of cable in conduit, unless it is covered with water for some time.

Lightning Arresters

Continuity in service in railway work is vitally important. For this reason, and due to the comparatively high initial cost, the best protective devices should be

used. To obtain this protection, electrolytic arresters with choke coils should be installed. Lines should be protected as follows:

1. Incoming high tension lines.
2. Outgoing high tension lines.
3. Outgoing D.C. feeders.

The lightning arrester should be installed between the station apparatus and the line, with suitable choke coils connected between the station apparatus and the lightning arrester. For high tension voltages in excess of 10,000 volts, the arresters can often be installed outdoors to advantage, from an arrangement standpoint. It is undesirable to use outdoor arresters below this voltage, as the horn gaps must be placed so close to take advantage of the freedom of discharge of the electrolytic element, that they are liable to be short circuited by rain. Besides serving to prevent the arrester from being continuously subjected to normal line voltage, the horn gaps also act as disconnecting switches, when inspection or repairs are necessary.

D.C. aluminum arresters should be installed on each outgoing feed. Where installations do not warrant the use of electrolytic lightning arresters, other types may be used to advantage.

D.C. aluminum arresters have, in some cases, been used connected directly across the converter armature on the D. C. side inside the series field, for the purpose of minimizing flash-overs. Whether this practice is of sufficient value to warrant the installation apparently must yet be determined.

Compressed Air

The substation should be provided with an air compressor for cleaning the machines, high tension insulators, etc. The pressure should be from 40 to 60 pounds, and the set should have a capacity of 15 to 20 cu. ft. per minute. The compressor should be mounted with storage tank on a truck, or stationary, with a few air pipes to various points where compressed air is required.

Crane

Where the installation warrants, a crane of suitable capacity should be installed, to facilitate erection and repairs in cases of emergency. Cranes of ten tons capacity or smaller can usually be hand operated to advantage, as they are not in use frequently enough to warrant the expense of electric drive.

Where no crane is installed, roof beams can usually be located, suitable for supporting a chain fall of sufficient capacity to facilitate handling of the apparatus.

Substation Building

When drawing up plans for a substation building, full consideration should be given the following design factors:

1. The arrangement of the apparatus should be made to economize space, and reduce to a minimum the quantity of low tension cables required. On the other hand, sufficient space must be allowed around the apparatus to prevent interchange of radiated heat, for efficiently cleaning and for making repairs.

2. Careful study of the ventilation problem must be made, as it is just as important in this class of building as in an office building. Good ventilation but very slightly increases the cost of the building and materially increases the life and output of the apparatus. It increases the efficiency of the transforming and converting apparatus, since copper losses are reduced at lower temperatures and often conditions are such that the load factor can be improved. It also improves the efficiency and alertness of the operators.

The ideal system of ventilation is to take the air in at

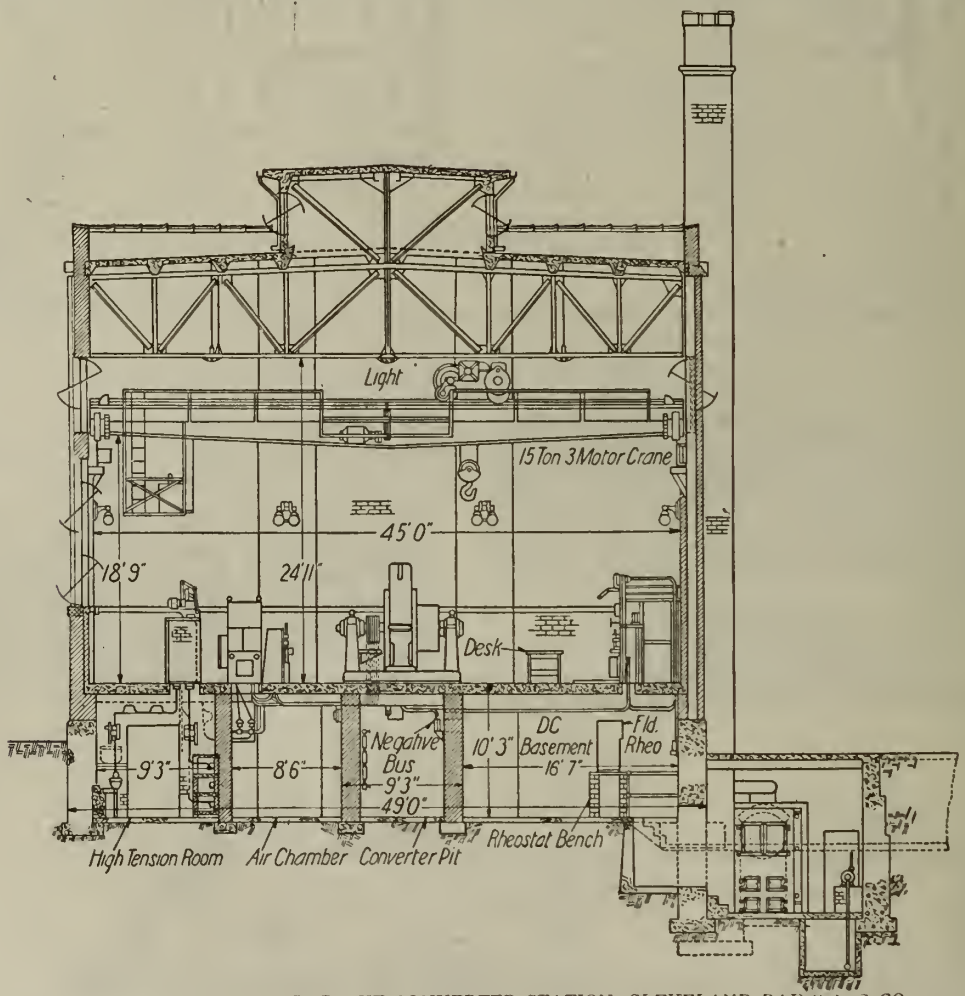


FIG. 14—CROSS SECTION CEDAR AVE CONVERTER STATION, CLEVELAND RAILWAYS CO.

the base of the machines or transformers and allow it to pass out through the roof by means of monitor construction or metal ventilators. The velocity of the warm air rising from the apparatus depends upon the difference in temperature between the incoming and the outgoing air and the height of the openings for the exit of the air above the floor. Consequently, the height of the exit openings, must be considered, although usually the required head-room will brace these openings sufficiently higher to use this ventilating scheme efficiently. Unlike the old window method of ventilation, this scheme is possible during all kinds of weather.

3. Noise from the machines, especially where substations are located in resident districts, is a point for consideration and it may become so great as to become a decided nuisance, rendering it possible for neighbors to obtain injunctions, causing a substation shut-down. The method of using open windows and doors for ventilation, is not only objectionable in many localities due to the deposit of dust blown in on the rotating apparatus, but due to noise. The ventilation scheme recommended above is particularly recommended from the noise standpoint.

4. While the window area should not be excessive, the building should be well lighted by day, in all parts to facilitate repairs so that all corners, pits, etc., can be readily observed and thereby kept clean. The use of ribbed glass is very desirable, as it eliminates the glare of the sun, making it easier to read instruments, gauges, etc. Artificial illumination should approach the natural lighting, as very often repairs have to be made at night. It should preferably be obtained by the use of lamps in large units with suitable diffusers. In 600-volt substations, a cluster of small lamps can be substituted, thereby avoiding the use of a special lighting transformer. This same arrangement can be used for 1,200 or 1,500-volt substations, but except in rare cases, it is probably better to use a separate lighting transformer. The arrangement of the lights should be made with particular reference to the easy reading of switchboard meters, transformer and machine bearing oil gauges, thermometers, etc.

5. The building should be constructed throughout on a fire-proof basis, with every arrangement practicable to protect one piece of apparatus from another and to protect all from external fire communications. In some cases, it may be desirable on account of insurance rates, or for a greater insurance to continuous operation, to increase the cost of the substation building by the cost of a fire wall to isolate the transformers and oil switches from the converters and switchboard.

6. Every provision should be made for a possible extension of the substation even though it appears that no future extensions will be necessary at the time the design is made. This refers to a symmetrical arrangement of the apparatus on the unit system and the proper construction of roof framing to make such extensions feasible.

7. The building should be simple and substantial with just sufficient paneling on the exterior to relieve the monotony of a plain wall. An attractive building can be built at the same cost as an unattractive and poorly designed one if sufficient attention is given to this point.

Indoor vs. Semi-outdoor Substations

Except in rare cases there is little saving in resorting to the semi-outdoor substation. Where a semi-outdoor installation is contemplated it is wise to investigate the relative cost, as the indoor substation presents advantages assuming approximately equal initial cost.

A cubic inch of coal pulverized so that 95 per cent. will pass through a 100-mesh screen will contain over two hundred million particles, none of which will be greater than one one-hundreth inch cube, and a larger percentage will be less than one six-hundreth of an inch cube.

A simple cable conductor has been in use for some time past, in Germany and other European countries. It consists merely of a flat metallic tube in which a series of notches are made with a special tool, after the two ends of the cable to be joined are properly inserted. The contact is said to be perfect, and the grip is such that the cable breaks before the connector gives away.

Montreal has a street cleaning device which sweeps the dirt to one side of the thoroughfare, where it is taken up by suction into a machine following up. Another feature of the road-sweeping scheme, is that sprinklers in front of each machine lay down the dust. Proving that ingenuity and machinery in unison make a wonderful combination.

Noise has no terrors for the new Magnavox anti-noise transmitter, which was used on all the airplanes of the United States Navy. This device was patented nearly two years ago, but only recently released for commercial purposes. No helmet is necessary for the listener, but still the voice is distinct whether one or one hundred miles away. E. S. Prideman, and P. L. Jensen are the inventors of this interesting telephone aid.

Nearly all animals are said to be better swimmers than man, and to take to the water naturally. The rhinoceros and hippopotamus are wonderful swimmers and divers, while the Indian elephant crosses great rivers with heavy loads. The elk keeps its head above water and crosses directly from bank to bank to avoid turning. The reindeer, on the other hand, turns as often as it likes, keeping its head only a little above the water. But of all swimmers, of all climes, the best, though not the swiftest, is the polar bear, which passes half its time in the water, swimming and diving.

The Eiffel Tower, the tallest structure in the world, was erected by Alexander Eiffel, a French engineer, for the exposition of 1889 at Paris. It stands in the Champ de Mars, and is 984 feet high (429 feet higher than the Washington Monument). The base is a square of 112 yards, from each corner of which rise the four curving supports of interlaced iron-work. At a height of 590 feet these merge into a single shaft. There are three platforms at various heights, to which the ascent is made by elevators or staircases—1,927 steps in all. The total cost was over $1,000,000, of which the State contributed about $300,000. In 1909 the Tower became the property of the City of Paris.

Valued for its weather-resisting qualities, galvanized iron or steel has long been produced by dipping sheets of the metal into molten zinc, which deposits itself as a coating of small crystals or spangles. Occasionally, however, sheets have been produced with large spangles which, it was found, improved both the appearance and the non-corrosive qualities of the product, and hence increased the price it would bring. So one plant has raised the value of its output by treating high-grade molten steel with an alloy containing titanium before rolling it into sheets and subjecting it to the zinc bath. It is claimed that 75 per cent. of the treated sheets emerge from the bath with the large spangles desired.

Out of the war shortage of tin has come a new and successful substitute for babbitt as a bearing metal. It is composed almost wholly of lead, hardened by an electrical process. Its high manufacturing cost is more than compensated for by the low market price of lead compared with tin. The new metal shows a tensile strength of 13,000 lbs., the figure for genuine babbitt being 11,000; and an elastic limit of 11,525 lb. as against 10,000 for babbitt. Its friction factor is very low. With a shaft running at 400 r.p.m. and a load of 1,000 lb. per sq. in., 150° was the highest temperature reached by the bearing.

Across 11 miles of rough country near Pittsburgh, Pa., is being constructed what is probably the largest gas line in the world. It will have a maximum diameter of 40 in., enabling it to convey 70,000,000 cu. ft. of gas daily from a by-product coke plant to three steel mills.

Saving Coal in Steam Power Plants

The Following is a Reprint of Engineering Bulletin No. 2, Prepared by the United States Fuel Administration in Collaboration With the Bureau of Mines

Isolated Plant Versus Central Station Power

If the available power purchased or privately generated is obtained purely from a hydro-electric service its use will, of course, save fuel over any steam-power proposition. If, however, in a steam plant all the exhaust steam were sufficiently utilized the boilers would still have to be operated at about 90 per cent.[1] of their former output to supply the heating steam (even if at low pressure) if the engines were shut down, and the saving in coal would be only 10 per cent. instead of 100 per cent.

B. If the purchased power is produced in a central steam plant capable of delivering a kilowatt hour for, say, 2½ pounds of coal, then its use will waste or save in comparison with a private steam plant, as follows:

B-1. If all the exhaust steam from any design of private plant is absorbed by heating and process work, no central power station[2] of condensing operation can ever be designed to compete with it in the matter of coal consumption.

If the engines in this private plant were all removed it would still require 90 per cent. as much coal as formerly to make low-pressure steam for heating, and outside current at 2½ pounds per kilowatt hour would still have to be purchased.

If the private plant had been using 8 pounds of coal per kilowatt hour it would save eight-tenths of a pound of coal, to replace which it would buy current costing 2½ pounds. Thus, for each pound saved in the private plant 3⅛ pounds are burned in the central station. This example represents the extreme case in favor of the private plant.

B-2. If the same private plant operating noncondensing wastes all of its exhaust steam, coal will be wasted in the ratio of 8 to 2½ per kilowatt used. Coal will be saved by substituting purchased power. This example represents the extreme case in favor of the central station current, and the ratio is 8 to 2½ or 3.2 to 1.

To sum up cases B-1 and B-2, the use of exhaust steam is the determining factor. Where it is all used the small private plant generates its energy as a by-product of its heating. The engine or turbine acts as a pressure reducing valve between the boiler and the heating system, and abstracts a small percentage (3 to 12 per cent.) of heat from the steam. Therefore shutting down the engine will save only this small fraction of the total coal. For most cases of this kind it is safe to say the engine absorbs less than 10 per cent. of the heat or fuel. As a matter of fact, many cases could be quoted where no saving of coal occurs when the engines are shut down[3].

[1]Exhaust steam contains, within a few per cent., as much heat as direct steam. Thus an engine or turbine with steam consumption of 20 pounds and 60 pounds per indicated horsepower hour will discharge in their exhaust about 88 to 96 per cent. of the heat of the steam admitted at their throttles respectively. In the examples given 90 per cent. is assumed.

[2]Operating condensing in accordance with standard practice. If a central plant were designed to furnish exhaust steam to its customers it could then compete on a coal basis with the private plant. This is the sound theory of the "city block" or "district" system of power and heating.

[3]There are sound technical explanations for these cases, but it is aside from present purposes to enter into a detailed discussion.

[4]The proportion of exhaust required for heating represents almost the same proportion of coal which will have to be burned for direct steam heating if the engine is replaced by purchased power.

[5]Equal coal consumption obtains when the proportion of total coal required for heating alone equals one minus the fraction obtained by the ratio of the kilowatt hour coal consumptions of the isolated plant to the central plant figured from the purchaser's switchboard. Example: With purchased current at 4 pounds of coal and private power at 7 pounds, an equal coal consumption with either system will obtain when the proportion of coal required for heating is 1 minus 4/7 = 3/7 of the total coal.

Hence for purposes of approximate calculation the power is a pure by-product of the heating. But assuming 10 per cent. of the heat of the steam to be taken by the engine, then only 10 per cent. of the coal consumption will be saved if the heating is done by direct steam. Eight pounds of coal per kilowatt hour, the figure assumed, is based upon an extravagantly wasteful boiler plant, but even under these conditions the small private plant using all its exhaust would save coal over central station current for power ratio of 3⅛ to 1.

If on the other hand no exhaust steam is used in the same private plant, the saving in favor of the central station power is in the ratio of the coal used per kilowatt hour for the two cases, or with the figures assumed, 8 to 2½, that is 3.2 to 1.

It is evident that in a noncondensing private plant, as the use for exhaust steam decreases a certain point will be reached where the same coal consumption would obtain by the generation of power by either type of plant. A still further reduction in the utilization of exhaust would then throw the balance in favor of central station power.

This critical point of equal total coal consumption depends upon the coal consumed per kilowatt hour in the private plant and the central plant, respectively. Thus if the central station has a coal rate of 3 pounds per kilowatt hour and the private plant 6 pounds, the critical point is reached when 1 minus 3/6=1/2 of the exhaust or coal is needed for[4] heating, and the same total coal will be consumed whether the power is purchased of the engine operated. If less than one-half of the exhaust is used, the purchased current will effect a saving; if more than one-half of the exhaust is used, running the engine in the private plant will save coal.

Take another case and assume that current can be supplied at the purchaser's switchboard for 2 pounds of coal, and that the small plant produces it for 5 pounds. Then, if 1 minus 2-5 = 3-5 of the coal or exhaust is needed for heating no change in total coal consumption will occur if current is purchased, the engines shut down and boilers operated for heating only[5].

If the coal per kilowatt hour for outside current is less than the same figure for the private plant, the most coal will be conserved by carrying just enough load to furnish exhaust for the heating and buying the surplus power. Thus the small plant obtains a part of its power as a by-product of its heating and buys the balance for the least total coal consumption. This method saves more coal than shutting down the small plant entirely, even when a saving would be thus effected. There are many cases where at night or during non-heating months where an important coal saving can be made by buying the power which is in excess of that required to furnish exhaust for heating.

Still another situation is met when the private plant is of modern design and operates solely for generation of power. Such cases would be determined purely on a comparison of the coal consumed per kilowatt hour. Central station power is produced at consumers' switchboard from a minimum of about 1¾ pounds of coal in the largest and most modern plants up to 3 pounds, 4 pounds, 5 pounds, and upward in less efficient stations.

In moderately large private plants of good design a kilowatt hour is produced for a little over 2 pounds, while less efficient and smaller plants consume up to 10 pounds and over. In this whole problem it is necessary to regard coal as the basis of economy and not money as heretofore. Central station interests and private consumers should patriotically endeavor to meet each other half way in sacrificing by reduced rates or increased expense when important economies in coal are at stake.

PART II

After due consideration has been given to the question brought out in the previous discussion and if it has been determined that the plant is justified in continuing to operate, attention must be given to those points having a bearing on economical operation. No transformation of energy can take place without appreciable loss, and every effort should be made to keep the various losses down to a minimum. Diagram A shows a typical distribution of heat in a medium-sized hand-fired plant.

Stopping Fuel Waste

Beginning at the grates upon which the fuel bed rests, see that the air spaces are properly proportioned to avoid loss of combustible material into the ash pit. This will depend on the kind of coal used. Study the fuel with this point in mind. Five per cent. is not an unusual loss from this cause.

The amount of grate surface is important, as it determines the rate of consumption. Ratios of grate area to boiler heating surface will vary from 1:35 to 1:60, depending on the characteristics of the coal and whether hand fired or stoker fired. For power purposes in hand-fired plants do not permit the rate of combustion to fall below 15 pounds of coal per square foot of grate surface per hour, or go above 28 pounds with bituminous coal. With stokers the rate may be as high as the design of plant and the draft will permit. With the fine-steam sizes of anthracite the rate of comparison should not be less than 10 pounds.

With settings tight to prevent infiltration of air, heating surface clean, radiation losses reduced by proper covering, piping and steam mains lagged, engine valves tight and properly set, all condensation returned to the feed-water heater a good start will have been made in fuel conservation.

Human Element Important

However, merely placing the plant in good physical condition will not suffice. Conditions change from day to day, from hour to hour, even from moment to moment. These changes must be interpreted, and the degree of intelligence with which they are interpreted marks the degree of success which will be realized in fuel saving.

A good plant poorly operated will show low efficiency, while a poor plant skillfully operated will sometimes show a relatively high efficiency. Therefore,

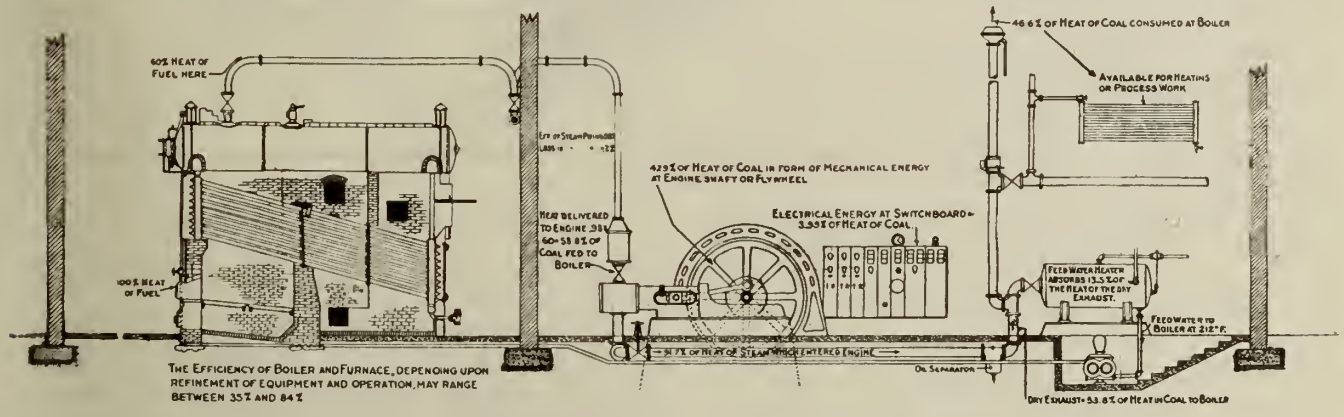
Ultimate efficiency = E × H

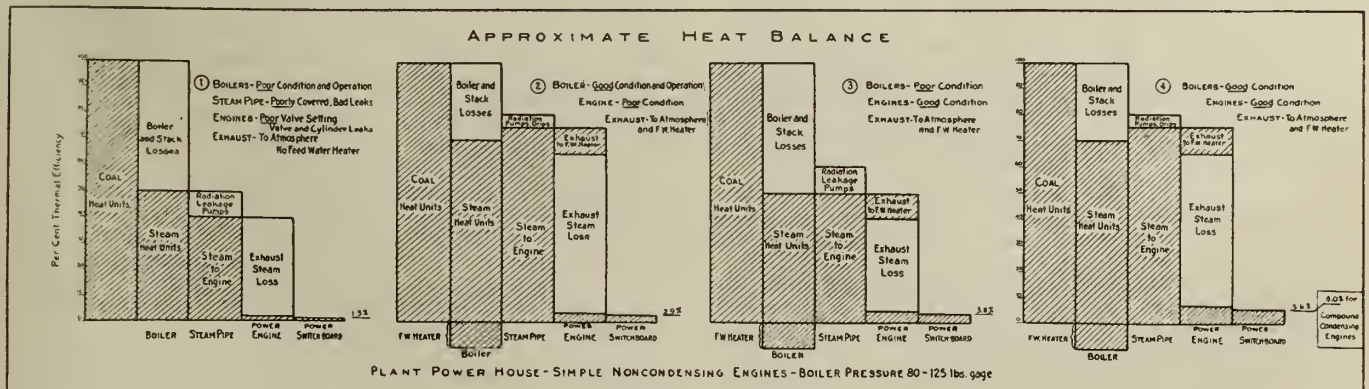
Where E = Equipment

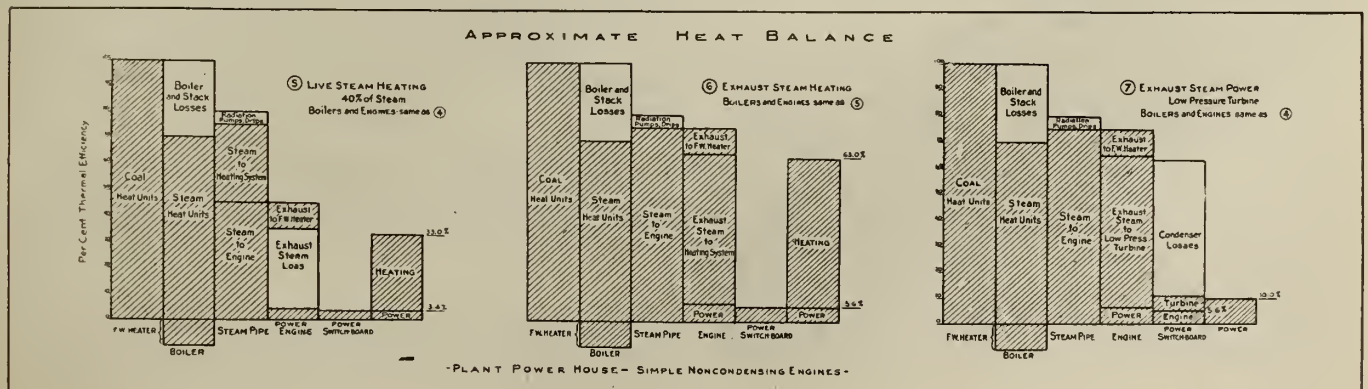
and H = Human element.

Check Operation Closely

Find out what the boilers are doing. Provide facilities for weighing the coal; for measuring the feed water; for checking up on combustion; for determining draft; for taking temperature readings at important points. To appreciate the significance of the above items it is desirable to become familiar with the literature of power-plant operation. Read Bulletin No. 1 of the United States Fuel Administration on Boiler and Furnace Testing, Technical


60% HEAT OF FUEL HERE
100% HEAT OF FUEL
HEAT DELIVERED TO ENGINE 39% 60-58.8% OF COAL FED TO BOILER
42.9% OF HEAT OF COAL IN FORM OF MECHANICAL ENERGY AT ENGINE SHAFT OR FLYWHEEL
ELECTRICAL ENERGY AT SWITCHBOARD 3.93% OF HEAT OF COAL
46.6% OF HEAT OF COAL CONSUMED AT BOILER
AVAILABLE FOR HEATING OR PROCESS WORK
FEED WATER HEATER ABSORBS 13.5% OF THE HEAT OF THE DRY EXHAUST.
FEEDWATER TO BOILER AT 212° F.
DRY EXHAUST - 53.8% OF HEAT IN COAL TO BOILER
THE EFFICIENCY OF BOILER AND FURNACE, DEPENDING UPON REFINEMENT OF EQUIPMENT AND OPERATION, MAY RANGE BETWEEN 35% AND 84%


APPROXIMATE HEAT BALANCE
Per Cent Thermal Efficiency
① BOILERS - Poor Condition and Operation
STEAM PIPE - Poorly Covered, Bad Leaks
ENGINES - Poor Valve Setting
Valve and Cylinder Leaks
EXHAUST - To Atmosphere
No Feed Water Heater
② BOILER - Good Condition and Operation
ENGINE - Poor Condition
EXHAUST - To Atmosphere and F.W. Heater
③ BOILERS - Poor Condition
ENGINES - Good Condition
EXHAUST - To Atmosphere and F.W. Heater
④ BOILERS - Good Condition
ENGINES - Good Condition
EXHAUST - To Atmosphere and F.W. Heater
COAL
Heat Units
Boiler and Stack Losses
Steam Heat Units
Radiation Leakage Pumps
Steam to Engine
Exhaust Steam Loss
Exhaust to F.W. Heater
BOILER
STEAM PIPE
POWER ENGINE
POWER SWITCHBOARD
F.W. HEATER
6.0% for Compound Condensing Engines
PLANT POWER HOUSE - SIMPLE NONCONDENSING ENGINES - BOILER PRESSURE 80 - 125 lbs. gage



Paper No. 80, and various other publications of the Bureau of Mines. In small and moderate sized plants, hand fired, a boiler efficiency of 60 and 70 can be expected, while in medium-sized stoker-fired plants 70 to 75 per cent. should be realized. In any given plant determine what efficiency should be expected, considering load and equipment, and keep the plant up to mark set.

Principal Losses

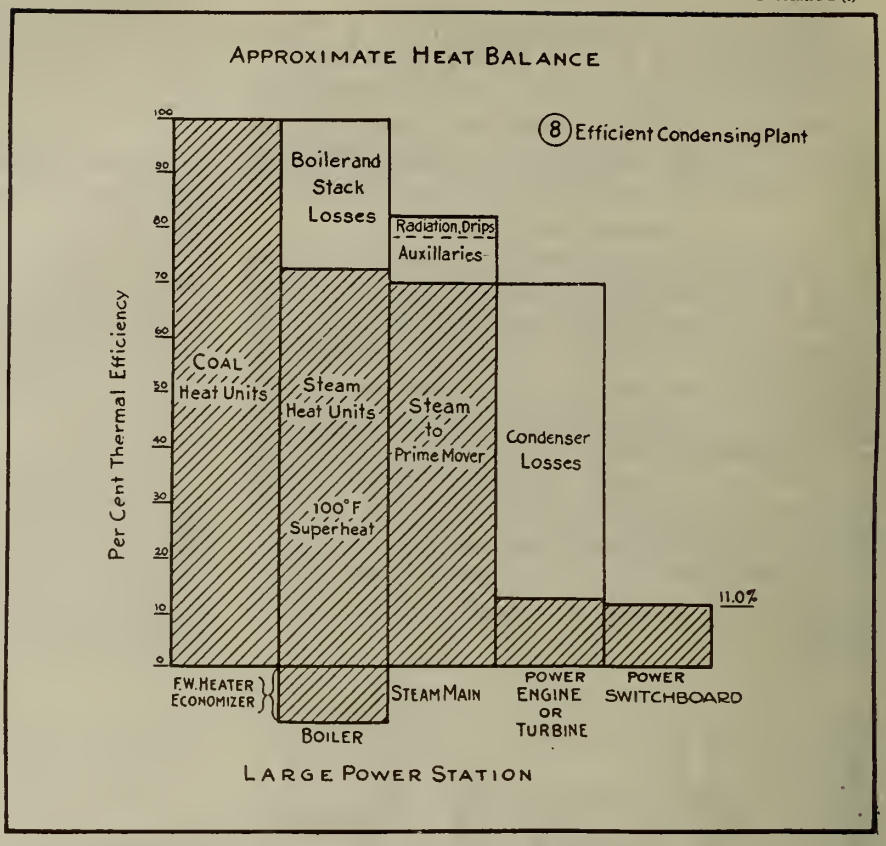
The chief losses in boiler-plant operation are:

1. Cause, dirty boiler, loss up to 25 per cent., remedy, clean boiler. 2. Leaky setting, loss up to 15 per cent., remedy, tight setting. 3. Poor firing, loss up to 40 per cent., remedy, good firing.

1. A boiler may be dirty on the inside or outside or both. Dirt on the inside is due to scale formation and can be corrected by cleaning the boiler and then giving consideration to the character of the feed water and its proper treatment. See Engineering Bulletin No. 3 of United States Fuel Administration.

Outside cleaning must receive careful attention. A slight accumulation of soot deposited in a few hours' run will result in a great loss of efficiency. Someone must be delegated to follow up this matter of soot and see that the cleaning is done thoroughly, frequently and regularly.

DIAGRAM B (c)



2. Air leaks reduce efficiency. The ordinary brickwork setting develops cracks and crevices which allow a considerable amount of air to enter the setting, lowering the temperature of the gases of combustion. The porous character of the brick itself is such that an appreciable leakage takes place through the walls.

The remedy is to point up the brickwork with plastic fireproof mixture and paint or cover the setting with a coat of air-tight material.

3. Bad firing includes allowing holes to develop in fuel bed; carrying an uneven fire; carrying too thin a fire; carrying too thick a fire; stirring fire, thus forming clinkers; and improper manipulation of dampers. It is here that the human equation becomes of most importance. Attention concentrated on what takes place from day to day in front of the boilers will pay greater returns for the time spent than in any other part of the plant.

Power Plant Records

The importance of keeping a systematic record of operations can not be overestimated. In this way affairs in the power plant are lifted from the realm of guesswork to certainty. While the system adopted for the ordinary plant may be very simple, the records should be arranged for convenient reference so that comparisons of results with past performance may be made. Thus it is possible to note the effect of changes in equipment or methods and improvements in economy or the reverse may be at once detected.

Engine Room

After the steam has been delivered to the engine, care should be taken to see that it is utilized to best advantage. Where all the steam is needed, the economy or rate of the engine itself is not of particular consequence; that is, a simple slide-valve engine using steam at the rate of 40 or 50 pounds per horsepower may be the most desirable type to use. This all depends on circumstances. As the demand for exhaust steam decreases, the importance of economy in the engine increases. Should there be periods during which all of the exhaust is not used, the maximum economy of the engine during these periods is of utmost importance. At such times the most economical generating unit should be selected and one of a size that will be economically loaded with the amount of power developed.

Use of Exhaust Principal Factor

A portion of the exhaust should be used for heating the feed water to the highest temperature practicable; not less than 200° in any event.

Exhaust mains should be pitched in the direction of flow, drained and trapped, and the condensation returned to the heater. Use no live steam where the work can be done with exhaust. To get the most efficient transfer of heat the radiating surface of coils and other heating elements should be properly disposed to promote circulation of the heat-absorbing medium, whether air, water, or other liquids. Large increase in efficiency or capacity can sometimes be made in old systems by a little attention to this feature.

In the case of stills, evaporators, or triple effects in which deposits of suspended or residue matter is liable to form, periodical cleaning of the coils is essential.

Venting radiators and steam lines of air should receive careful attention. See Engineering Bulletin, No. 6, on Saving Fuel in Heating Systems. For large systems vacuum returns are recommended. Direct radiation should be checked up with special respect to location in order that heat loss through exposed walls and windows shall be taken care of efficiently.

A study of the accompanying heat balance diagram will serve to indicate the small portion of the heat developed by the fuel which is used in generating power.

Do not, therefore, assume that the steam after passing through the engine is a waste product. It will represent a large percentage of the heat delivered by the boiler. Save it wherever possible. It is the principal product of the plant. The power is the by-product.

A WOMAN conductor on a New Jersey street car was kind to an old man and got $6,000 in his will. The only trouble with this is that most old men with $6,000 have about 60,000 places to put it.

U.S. shoemakers say that each immigrant who returns home to Europe takes eight pairs of shoes with him. The Yankees are in danger of losing their soles in this way.

Cheese Factory Boiler Explodes at Joyceville

Little Village Near Kingston is Scene of Disastrous Explosion—Boiler Ruptures Along Longitudinal Seam, Which Was Badly Corroded—No Inspection Had Been Made on This Boiler Since Installation

T. H. FENNER, Associate Editor Canadian Machinery

THE question of the adequate and regular inspection of steam boilers is once more brought to the public mind in a way that defies evasion. Once again a boiler in an industrial plant has exploded without a minute's warning, leaving in its trail a wrecked building, and worse still, destroying two human lives. Both the victims were young men, with many years of life in front of them under ordinary circumstances.

The boiler in question was in use at the cheese factory of Thomas Anglin, of Joyceville, and was of the horizontal return tubular type, about 38 inches diameter. It was similar to most of the cheese factory boilers, of which there are no less than one thousand and forty, known and listed in the Factory Inspection Department. There are probably many more than this in use, for it is a difficult matter to keep track of these boilers. Under the Factory Act, steam boilers in use on farms, or for general agricultural purposes, are exempt from inspection. Cheese factory boilers were at one time also exempted, but for some years past they have been brought within the law.

The original thickness of the plate was ¼ inch, and the boiler was made up of two sheets, the longitudinal seam being single riveted. We have no particulars of the pitch, but with a joint of this kind the percentage of strength to the solid is approximately 50 to 54. On this assumption the resistance of the shell to internal bursting force would be, with a factor safety of 5, about 70 lbs. if made of steel. This, if the boiler was in good condition, which it was not.

Some interesting statements were made at the coroners' inquest relative to the operation of the boiler. It had been installed in 1915, having previously been in operation for some time. The owner was supposed to have notified the Steam Boiler Department at that time, but presumably was not aware of this. It was not until two years after that he received a circular from the Factory Inspection Department, notifying him that an inspection was necessary. He then called in a local firm, who made a repair by patching the boiler. The repair people undertook to notify the Inspection Department, and apparently did so. The inspection was not made for reasons given later in this article. The owner thereupon let things slide, evidently believing it was no affair of his. He continued using the boiler, and finding that the safety valve opened at about 40 lbs. pressure, hung some more weights on the lever, to bring the pressure up to 80 lbs. It was stated that the boiler actually blew off at 100 lbs. per square inch. At the time of the explosion, the pressure was stated by Edward Gallery, the cheesemaker, to be between 80 and 100 lbs.

This man was presumably the operator of the boiler. He had received some instruction in boiler operation while taking his course for cheesemaking. He was not aware that any inspection was necessary, and stated that he never heard of inspections being made in other cheese factories.

Here we have the two men most interested in the boiler, one the owner and one the operator. The owner knew that the boiler should be inspected, but, when the inspection did not materialize, took no steps to find out why. The other man had no idea that the boiler needed inspection, and cheerfully went on operating without the slightest conception of the danger he was running. When the catastrophe took place, it was two men who were not even employed at the factory who were killed. There is an instance of fate's irony.

The provincial inspector, who made an examination of the remains of the boiler after the accident, found evidence of deep corrosion on the seam where the rupture took place. The plate was grooved until a bare one-sixteenth of an inch thick. He stated that the boiler was poorly built, and when new would have been good for only 54 lbs. per square inch. If it had been inspected by him he would have condemned it, or allowed only 15 lbs. per square inch.

Two weights were found which had been on the safety valve lever. Had they been at the end of the lever it would have required a steam pressure of 200 lbs. per square inch to raise the valve. The steam gauge, never having been tested, may have been considerably out, and probably was.

Here is a case where, had the inspection been made, the accident would have been prevented. The reason given for not making the inspection is a shortage of inspectors, there being only six for the whole province of Ontario. In the case of cheese factory boilers, the difficulty of inspection is enhanced by the out-of-the-way localities they are usually placed in. This makes the inspection a matter of a whole day in some cases, and when the number of boilers are considered, it is quite to be understood that some of them are missed. There are many owners of boilers who take no interest in the safety of their property, either through ignorance, or a desire to save the fees. There is a great need of a means to enforce the laws already in existence. In this connection a good plan has been suggested. It is that instead of having the inspectors all atttached o the central office, the province should be divided into districts, with a resident inspector in each. This inspector would know the district and everybody in it, and the possibility of a boiler being operated without inspection would be reduced to a minimum.

It would also prevent a thing that frequently happens now. A man has a boiler on his farm which comes under the agricultural classification and is, therefore, exempt from taxation. He takes up cheese manufacturing, or starts a sawmill, and the boiler is then, of course, in commercial use, and liable to inspection. If the owner himself does not notify the Factory Department of the change, it is quite probable that under the existing conditions he may operate it for one or two years before anything is known about it. Resident inspectors would know of a case of this sort immediately.

The Case of the Farmer's Boiler

This brings us to another consideration. Why should any steam boiler be exempt from inspection merely because it is not used for commercial purposes? A farmer who uses a threshing engine, or steam tractor, is not compelled to have it inspected.

The viewpoint of the Legislature is presumably that a man using a boiler on his own land for what may be reckoned as purely domestic purposes, should not be bothered with inconvenience of Government supervision.

Speaking generally, the less the Government interferes with private enterprise, the better; but here is a case where it is in the interest of the man himself to interfere. The law puts effective checks in the way of the purchaser of poison, even if only to kill vermin, or a dog who has had his day. It should do the same with such a highly dangerous instrument as a steam boiler.

There is a very wide spread fallacy among small steam users that because a boiler is comparatively small and operating at low pressure it can't do much damage anyway. They are partly right. A 30 inch diameter boiler operating at 100 lbs. pressure is not so dangerous as a 60 inch boiler operating at 50 lbs. pressure, but it is dangerous enough. The explosive force of a boiler lies not in the pressure it carries, but in the heat energy contained in the water. The greater the weight of water, the greater the damage that will be done. This

Continued on page 344

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Another Fatal Explosion

ONCE again the peaceful life of a little village has been violently interrupted, and sudden death and disaster descended without warning on the unsuspecting inhabitants.

The instrument of destruction this time was the small boiler in the cheese factory of Thomas Anglin, of Joyceville, a little village about twenty miles from Kingston. The boiler, which was being operated at a limit far beyond its safe working pressure, ruptured suddenly along a seam which was afterwards found to be corroded down to a thickness of only one-sixteenth of an inch.

Nobody in connection with the establishment knew anything about a boiler and the boiler had never been inspected since its installation four years ago. The boiler was not then a new one, and according to law, should have been inspected. Two years after installation a circular was received from the Factory Inspection Department, notifying the owner that inspection was necessary. This was his first inkling of anything of the kind. He called in a local firm who put a patch on the firesheet, and this firm, in accordance with the requirements of the law, notified the Boiler Inspection Department.

The chief boiler inspector replied, saying that he was willing to allow the boiler to be put in operation, and would instruct one of his inspectors to examine it on the first occasion he should visit the district. Two years elapsed, and the boiler exploded before that inspection took place.

The failure did not take place at the spot where the repair had been made, but at the longitudinal seam which was wasted away. An inspection would have discovered this wasting. The safety valve was loaded too high. An inspection would have determined the safe (if any) working pressure.

The reason advanced for non-inspection is that there are not enough men on the inspecting staff to do the work. Surely the Government of Ontario can afford to employ sufficient inspectors to protect life and property. There are considerably over one thousand cheese factory boilers in the province. How many of them are unsafe?

Buried Treasure Again

THE uncovering of lost treasure from the bed of the ocean has exerted a fascination over the minds of men from early times. From day to day new schemes for salvaging sunken vessels are sprung on an expectant world, to dazzle susceptible minds for a few brief moments and then fade away from sight and memory. Most of these schemes would be perfectly practicable if it were not for certain fixed and immutable laws of nature. One of the most important of these is that every 2.3 feet depth of water exerts a pressure of 1 lb. per square inch on the surface of any object immersed in it, the effect of this pressure being to set very definite limits at which diving operations can be conducted.

One of the latest of these schemes has been evolved by the United States Ship Salvage Participating Syndicate. They have borrowed the famous tank from the battlefield, and are going to ask it to become an amphibious animal, and conduct constructive work on the bottom of the sea, instead of destructive work on the surface of the land. The tank can be built with strength to withstand the pressure of the sea at whatever depth it is necessary to operate. It will be directed from above electrically, and in order that the operators can see just what it is up to, an instrument called a "subsea visionscope" has been invented. The idea is that the tank will be lowered to the bottom of the sea, carrying wire cables, the ends of which are brought up to the surface on each side of the sunken vessel. All being ready, the operator on the surface applies the current, at the same time keeping a watchful eye directed down the subsea visionscope. The tank immediately gets busy burrowing under the wreck thus passing the cables under her bottom. Air containers are attached to the ends of the cable and inflated, upon which the buoyancy of these air vessels raises the vessel from the bottom.

Could anything be simpler?

Here is a chance for those who are getting bored with the tameness of the mining market to get a little quick action. The syndicate is going to be capitalized at $5,000,000, in $1 shares, so there is really no reason why everyone should not get in.

Now that one cannot put a little bet on an "also ran," the romantic interest of these salvage operations should have an appeal all its own.

HAVE YOU LOTS OF FRIENDS?
By H. J.

If you have, then all is Jake, as the saying goes.

If you have not—then something is out of kilter.

Is this your trouble?

Are you inquisitive, and keep sticking your nose into other people's business?

Do you repeat all the gossip tales you hear of?

Did you ever haw! haw! at some religious belief you've heard suggested?

Do you carry a grouch around with you?

Have you ever knocked someone, simply because they possessed some quality you haven't got yourself?

Do you tell your troubles, and speak of your aches to every Tom, Dick and Harry that you meet?

Do you try to convince everybody that this old world is all built wrong, and that you've been lost in the shuffle?

If you have spilled any of the above remarks from time to time—no wonder your friends are few.

A considerable vein of pitchblende, from which radium is extracted, has been discovered near Buckfastleigh, in southern Devonshire, England. The ore yields over 26 per cent. of uranium oxide, and the lode will be developed immediately.

* * *

A very effective dust catcher for surface grinders consists of an iron bracket, to which is bolted a broad piece of sheet metal, with a water pan or trough built on at the bottom. A piece of heavy cloth, or burlap, is hung over the sheet-metal surface, long enough to reach down into the water trough. The burlap soaks up the water like a wick, and is always kept wet. Emery dust and small metal particles thrown against it are caught and kept from flying around the shop.

* * *

Wealthy tourists to St. Moritz, the world-famous Swiss winter and summer resort, may soon be able to make the trip from Zurich in one hour, instead of the seven or eight now required by the railroad. Capitalized at about $100,000, a company has been formed to back the 90-mile airplane line, and has already announced that service will be inaugurated during the year with tickets selling at about $100. Many will doubtless be willing to pay this price, if for nothing but the matchless view of mountains, lakes, and glaciers.

* * *

A newly developed steel that seems particularly desirable for dies, taps, and other cutting tools, changes its form so little during the hardening process that castings have the appearance of smooth forgings, and need almost no machining. The texture is uniform and close-grained, and castings may be subjected to high temperatures without scaling. Because of this heat-resisting property it is claimed that the walls of annealing boxes may be made much thinner with this material, and that the original shape and weight is retained through many more firings than when malleable or cast iron is used.

* * *

A novel kind of lock nut, which cannot be accidentally loosened on the bolt, but is readily removed with a wrench, has been designed by a woman inventor. A recess in the top of the nut is shaped at the bottom like a shallow spiral stairway. The nut is turned onto the bolt, and a short cotter pin is inserted through a slot in the bolt. Tightening the nut engages the pin with the notches or "stairs" of the recess, which position it holds until forcibly disengaged. With the cotter pin removed it acts as an ordinary nut.

* * *

MANY people spend a great deal of time wondering why the Government, or some other organization, does not go ahead and deal with the cold storage. We heard of one man who spent three days going around getting signatures to protest against storing eggs. The same amount of effort, together with a crock and some water-glass, would have given this well-purposed chap a cold storage plant of his own, and would have made the doings of the cold storage people a matter of indifference to him.

* * *

Pottery ware which is to be subjected to kiln fire is placed in rough clay boxes, called "seggars." Ordinarily made by hand, these articles can now be turned out by an electrically-driven press, which increases the capacity of a man and helper about tenfold. The operator places a piece of plastic clay in the mold, pushes it under the press, and moves the lever forward. The screw brings the top plunger down, and presses the seggar; after which the machine reverses itself and comes to a stop at the proper height. Pulling the mold back, the operator pushes out the seggar by means of the geared ejector.

* * *

Liquids and solids do not ordinarily mix, and the idea of combining coal and petroleum to make a new fuel sounds rather chimerical at first. Yet that very thing has been done, and successfully, by pulverizing the coal so finely that it forms a colloidal, or suspended, mixture with the oil. This compound passes freely through all regular oil pipes and burners, so that it can be used for power and heat without equipment change; and it generates a greater heat value than oil alone. Coal dust, passed through a 200-mesh screen, mixed with a little tar in the oil, leaves no deposit even after months. Use of the new fuel in place of fuel oil on sea and land would save millions of barrels of oil a year.

Tinkerin' John

HE was just a sort of a handy man as he canted around the plant, and everything got done the same with a kind of a skip and a hop. He did odd jobs and just filled in whenever a chap was off, with the gout or rheumatiz or such, or nursin' a graveyard cough.

But they'd never give him a steady job, this tinkerin' chap named John, for fear that somethin' he turn or do would have a chance to be wrong. So he puttered around at this and that, and he worked from bell to bell, but Tinkerin' John could never do a particular job real well.

Oh, Ive seen a heap of tinkerin' Johns; you meet them East and West, and they couldn't, to save their bloomin' hides, name the job they could do the best.

They can tinker at this and tinker at that, and they're handy to have around, and they always stay on the ladder quite near where it hits the ground. And when there's a chance to go higher a bit, where pay is both thick and long, they never turn to give a chance to this here tinkerin' John.

Oh, I've seen a heap of tinkerin' Johns; you meet them up brown, and do it better than any chap what's campin' in the town. It's great to see the hand of skill linked up with a mind that's keen; that can take any job that comes along, the fat as well as the lean—and can do the thing bang up each time with never a flaw to spoil—it's chaps like them that help to bring real honor to honest toil.

But tinkerin' John, he's always here, just fiddlin' his years away; a sort of a handy chap to have and never one hard to pay.

There's a bit of a sermon here for you—don't dodge nor pass it along—if you want to get to the top of the heap don't be just a tinkerin' John.—ARK.

INDUCTION MOTOR TROUBLE

By W. F. S.

A case of induction motor trouble, which offers some interesting features, has recently come to our attention. The particular motor was only of three horsepower, 25 cycle, 220 vol, three-phase type, and was connected to a shell conveyor inclined at an angle of about 30 deg. through chain drive. It was noticed that the motor stalled quite frequently owing to pieces of steel jamming in the delivery end of the elevator. When this happened the motor very accommodatingly ran backwards and picked up speed in the reverse direction. It was thought at first that the weight of the conveyor, loaded as it usually was with shell billets, was the cause of this reversal of direction, the weight being sufficient to run the motor backwards. This, however, proved to be incorrect, as the motor and conveyor remained stationary when the motor switch was opened and the conveyor loaded to capacity. In fact, a couple of huskies with crowbars were unable to move the equipment.

The motor proved so accommodating that it was decided to try its possibilities out still further, and the conveyor was arranged so that it would run in the forward direction a short distance and then jam. If the motor reversed and the conveyor ran backwards, it would again run freely for a short distance before jamming again. The motor lived up to expectations and a regular seesaw action resulted.

The solution for this peculiar motor action was found in the fact that one of the fuses was blown on the running side of the double throw switch used for starting and running, the starting side being connected in solid without fuses. The motor was started by means of three-phase current in the usual manner, but when the starting switch was thrown over to the running position only single-phase current was available for operating the motor. This served the purpose in a fairly satisfactory manner, but when the motor stalled, due to the conveyor jamming, it would ordinarily be unable to pick up and run in either direction. A three-phase motor will not start on a single-phase supply of itself, as no rotating field is produced, but only an alternating one, which is fixed in position. When, however, a three-phase motor, fed with a single-phase current, is given a slight rotation by any outside means, it will pick up speed and run in either direction, depending upon the impressed rotative effort. This rotation is accounted for by means of the rotating elliptic field set up by means of the action of the induced rotor current on the field magnetism.

When the conveyor jammed in either direction the elasticity of the conveyor itself and in the chain belt was sufficient to give the motor a slight rotation in the opposite direction, and this sufficed to give it all the start it needed.

One point should here be mentioned in the testing of fuses when applied to induction motor protection. The fuses should be tested out by means of lamps, or some other method with power off, as with the motor running both sides of it a dead fuse will be made alive, the one from the line and the other through the motor.

STORING AIR IN THE EARTH

A novel method of providing a receiver of unusually large capacity for compressed air was described by Mr. N. Knapp in the course of the discussion of a paper on natural gas storage, read before the American Institute of Mining and Metallurgical Engineers. Mr. Knapp required a supply of compressed air for working pumps used to raise oil from wells and for blowing out the oil from the wells directly. He connected up an old exhausted well to the air compressors, and for a period of seven years used the well as an air receiver. With this storage system, many times the capacity of the air compressor could be used for short intervals without any appreciable loss of air pressure, and when no air was being used there was no appreciable gain in pressure. Two two-stage compressors were used with approximately 200 horsepower gas engine capacity, running twenty-four hours per day. The original rock pressure of the depleted sand was 305 lb., and the open flow capacity of the well as a gasser was about 2,000,000 cubic feet per twenty-four hours. When the air was pumped into the well, the gas had been used down to a rock pressure of 115 lb., the production was small and the gas was wet and troublesome to use. In the course of a few months' use of the compressors, a rock pressure of 290 lb. of air was developed and there was no water trouble. The extent of the sand used for air storage was small, probably not over 20 or 25 acres, as shown by dry holes and exhausted wells. The thickness of the porous gas sand probably did not exceed 7 ft. The occasional gas sands of this region, Mr. Knapp imagines, were like isolated hillocks of sand resting on the salt-water sand that underlaid the whole country. The depth to the gas sand was about 800 ft., and it underlaid the oil sand.

BOILER EXPLODES AT JOYCEVILLE

Continued from page 341

Joyceville boiler was of the kind usually reckoned by the farmer class to be without possibilities of danger. The accident clearly shows what a small boiler can do if it explodes.

The Remedy

The remedy is so obvious that it hardly needs suggesting. It is the plain duty of the Government to put its inspection departments on a basis that will enable them to keep track of every steam boiler in the province. Where there is danger to life, petty economies should not be considered. Five or six inspectors for a province the size of Ontario are hopelessly inadequate, and it is to be earnestly hoped that steps will be taken before any more fatalities occur

* * * *

Mixing dry colors in ready mixed paint with the ordinary paddle to get the desired shade is a decidedly tedious job and unless thoroughly mixed will be streaked and spotted when applied with a brush. A much quicker method of accomplishing the mixing is to use an egg beater, which also eliminates the skin and other foreign matter from the liquid.

* * *

The British Government has decided to offer a prize of $10,000 for a process of making a mixture of dehydrated coal tar with mineral petroleum oils suitable for Admiralty use as fuel oil. This will be awarded to the first competitor submitting a successful process which must be capable of ready and economical application without undue absorption of material and labor.

* * *

The metal layers of an engine that come in contact with one another rub off small articles of matter that combine with the lubricant used and form a dirty and sticky mess. The olein contained in the lubricant will in course of time form an acid, known as oleic acid, which has a deleterious effect on the metal parts that it touches, causing progressive corrosion. But luckily, it is only when its oleic-acid content exceeds one-quarter of one per cent. that an oil becomes unfit for lubricating purposes.

* * *

Celluloid articles can rarely be restored to their original whiteness if they have been thoroughly discolored throughout, but if merely superficially discolored, wipe them with a woollen rag wet with absolute alcohol and ether mixed in equal proportions. This dissolves and removes a minute layer of the surface being cleansed and lays bare a new surface. To restore the polish rub briskly with a woollen cloth and finish with silk or chamois. A bit of jeweler's rouge will greatly facilitate matters.

* * *

Regulations have now been laid before the British Columbia Legislature in which there is to be the provision that every winding rope shall be given a bath in hot oil before being installed; that every winding rope shall be recapped at intervals of not more than six months; and that no winding rope which has been in use for more than two years, or which has been spliced, shall be used for raising or lowering persons. No cable is to be used for more than two years for raising or lowering persons. In this country the Royal Commission on Mines in 1909 recommended that winding ropes should be allowed to be used for three years and six months. To prevent crystallization of chains it will be provided in the new B. C. regulations that all cage chains in general use shall be annealed once at least in every six months, and detaching hooks shall be cleansed and refitted once in every three months.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

47. What is the object of the safety valve?

48. How should a safety valve be connected to a boiler?

49. How are safety valves, in practice, adjusted for a given steam pressure?

50. What is the object of a gauge-cock?

51. What is the purpose of water alarms and fusible plugs?

52. What is the object of running boiler feed-pumps at a slow speed?

53. What is combustion?

54. What is the principal element in the composition of all fuels?

55. How many pounds of water at 212 deg. can be evaporated into steam at the same temperature by a pound of coal of the following composition: Carbon, 74 per cent.; hydrogen, 8 per cent.; oxygen, 5 per cent., and ash, 13 per cent.?

55. In what way will the presence of sulphur in steel affect the latter?

56. What joint in a cylindrical boiler is subjected to the greater stress?

57. What is the bursting pressure of a seamless steel tube 12 in. in diam., 3-16 in. thick, and having a tensile strength of 64,000 pounds per sq. in.

58. What is the working pressure allowable on a boiler shell 60 in. in diam. and 11-32 in. thick, if the material has a tensile strength of 60,000 pounds per sq. in. and the longitudinal joints have an efficiency of 87 per cent. The factor of safety is 5?

59. If 2½ in. stay-tubes are placed 10 in. centre to centre, what area will each tube support?

60. A flat boiler head is supported by end-to-end stays placed 12 in. centre to centre and having nuts on both sides of the head, which is ¾ in. thick. What working pressure is allowable?

61. With a steam pressure of 160 pounds per sq. in. what load is borne by each staybolt if the pitch is 7 in.?

62. To what distance beyond the top of the upper row of tubes may the head conservatively be estimated to be supported by the tubes?

63. For what reason is the furnace of a vertical boiler made of light plate and stayed?

Questions Answered

Question.—35. What surfaces, owing to their shape, require no bracing to resist an internal pressure?

Answer.—Surfaces that form, or are part of, a cylinder, cone, or sphere.

Question.—36. Classify the stays used in bracing boilers?

Answer.—Direct stays, diagonal stays, and girder stays.

Question.—37. How are crown bars usually constructed?

Answer.—Two flat bars of wrought iron or steel are riveted or welded to blocks at each end, spreading being prevented by distance pieces placed between and riveted to the bars.

Question.—38. What means are adopted to give warning when a screwed staybolt breaks?

Answer.—A telltale hole is provided.

Question.—39. State how the crown sheets of combustion chambers of marine boilers are generally braced?

Answer.—The crown sheet is usually braced by crown bars and crown-bar bolts.

Question.—40. How are the tube-sheets of high pressure boilers braced?

Answer.—By stay-tubes.

Question.—41. How are stay-tubes fastened to the tube-sheets?

Answer.—By threading their enlarged ends, screwing them into threaded holes in the tube-sheets, and beading over the ends. Sometimes stay-tubes are further secured by nuts on the outside of the tube-sheet.

Question.—42. What is an Adamson ring-joint?

Answer.—A joint formed in a built-up furnace flue by flanging the sections and riveting them together with a finished ring between them.

Question.—43. What good feature is embodied in corrugated furnace flues?

Answer. — The corrugations permit free expansion and contraction.

Question.—44. Explain the purpose of boiler tubes; state by what process they are made and how they are designed.

Answer.—They are used for giving a large heating surface. Boiler tubes are made by lap welding or by the seamless drawing process and are designated by their outside diameters.

Question.—45. What process of manufacture produces the best steel boiler tubes?

Answer.—The seamless cold-drawing process.

Question.—46. State the purpose of a combustion chamber?

Answer.—It forms a space that provides for a thorough mixture of air with unconsumed gases of combustion, whereby complete combustion is aided.

HARDNESS AND WEAR

The Editor:—In your issue of May 20th, 1919, we find an article "Hardness and Wear" in which reference is made to abrasion of cast iron slide valves, seats, etc. As we are particularly interested in lubrication problems that are out of the beaten track, this article has made considerable impression upon us. However, recommendation for relieving this state of affairs is contained in a report of the committee on Superheated Locomotives of the American Railroad Association. They say:

"On the railroads using slide valves no change was made in the oiling or lubricating devices when bronze valves were used, but where the original cast iron valves were used some trouble with cutting the seats was experienced. The application of an additional system of graphite lubrication stopped the trouble."

The reasons behind this are not very hard to see, as the fine flake graphite fills up all the small pores, not only in the valve, but in the seat as well and then the movement is really one of one graphite surface over the other. In addition the very low co-efficient of friction of the graphited surfaces makes a very easy moving valve and one that will neither stick nor squeal.

We believe that the necessity of breaking the cast iron skin will be entirely overcome by the feeding of small quantities of fine flake graphite to the parts affected.

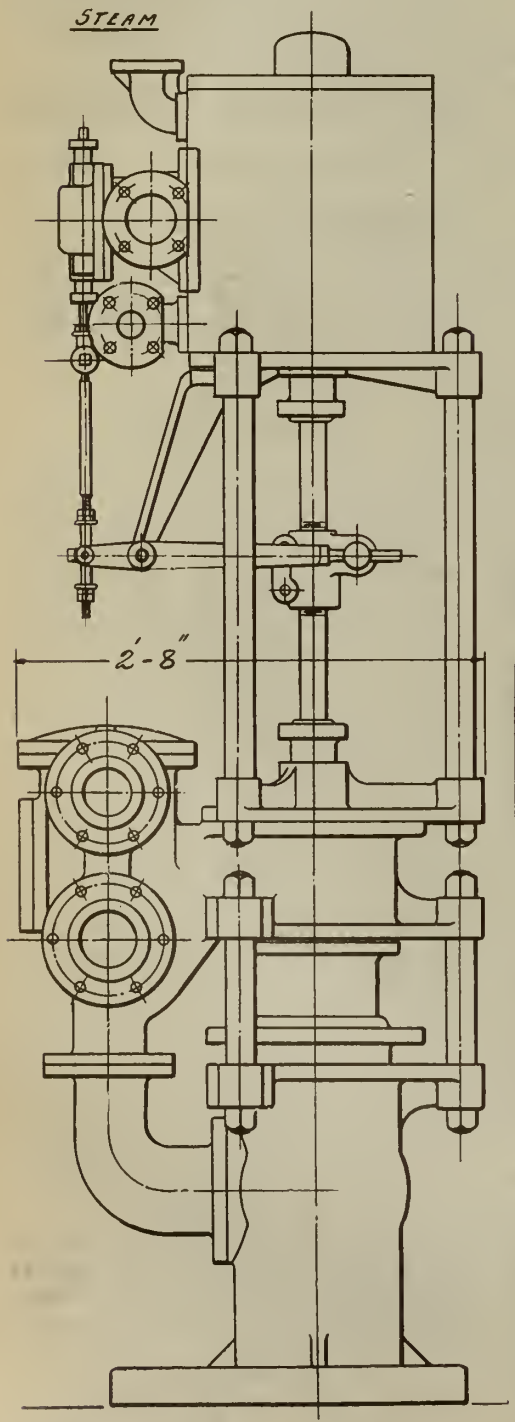
Very truly yours,
Joseph Dixon,
Crucible Company.

THE TOD-ATTWOOD RAM PUMP

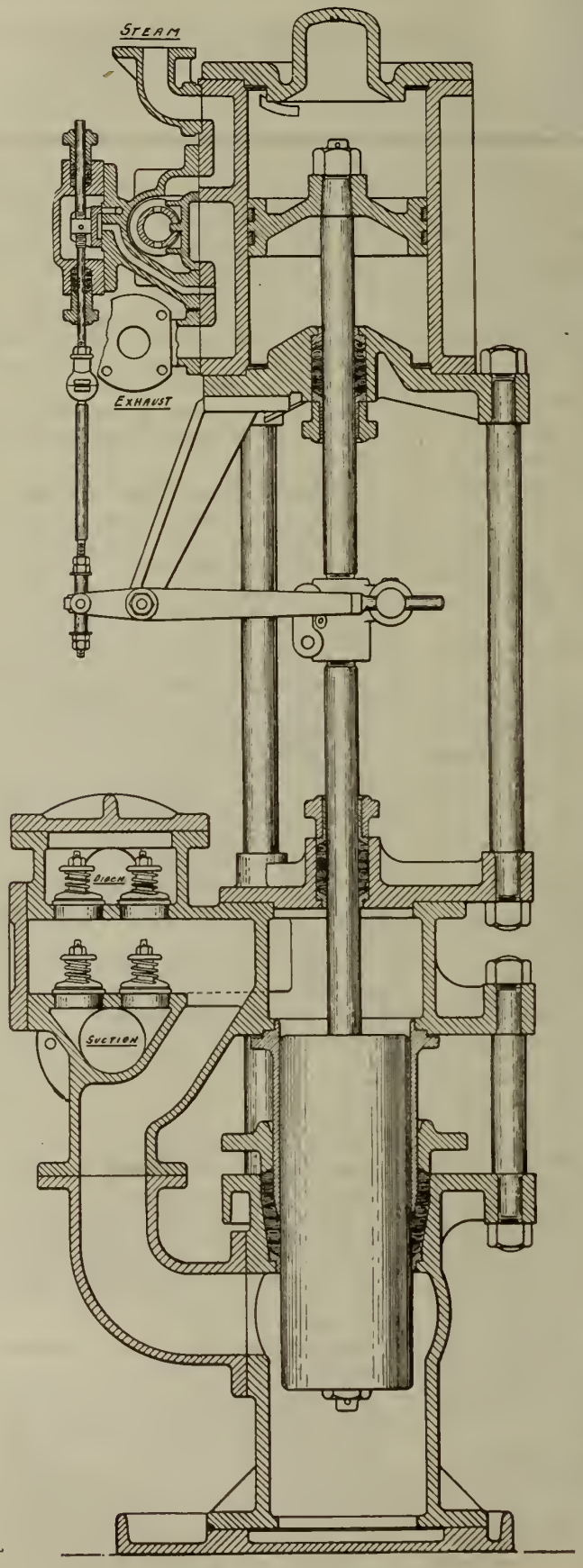
The vital part of a steam power plant is the boiler feed pump, and especially a marine steam plant, where the pump presents the only means of feeding the boiler. One of the latest developments in marine feed pump design is furnished by the Tod-Attwood vertical simplex pump, a description of which is given here.

A glance at the accompanying sectional elevation will at once reveal several departures from conventional design, all of which tend to make a smooth working and easily accessible pump.

The pump here described is the 11-inch by 8-inch by 12-inch size, which is designed to supply 1,250 h.p., at a piston speed of thirty feet per minute. This would require fifteen double strokes per minute, which is a very reasonable speed, conducive to long life. The steam piston is of the conical, or marine type, with two Ramsbottom rings. The valve arrangement for admitting steam is a combination of slide and piston valve, the slide valve being operated from a lever on the pump rod, and the motion of the slide giving steam to either end of the piston valve, which controls the admission to the cylinder. Unlike the majority of this style of valve, it is devoid of complications, the whole range of operations being taken care of by three main ports. The main valve chest is bolted on to the steam cylinder, and the slide valve chest is bolted on to the main chest, making access to either as convenient as possible. The ports in the cylinder bore are cut in such a manner that the piston automatically cushions itself at the end of the stroke, and so well has this feature been designed, that the suction connection can be broken with the pump under full working pressure, without any knocking at either end of the stroke. This is a remarkable claim, but it has been proved to the satisfaction of Lloyd's representatives.



OUTSIDE VIEW SHOWING CONNECTIONS



SECTION SHOWING CONSTRUCTION OF PUMP

At the water end of the pump, ample provision has been made to give easy access to suction and discharge valves. A hand hole door is provided on the suction valve box, and there is ample clearance between the top of valve studs and the discharge valve seats to enable a man to pass his hand through comfortably.

The ram is of gunmetal, as also is the cylinder liner, and the liner is arranged so as to be easily removable. There is only one packing gland which is arranged with ample working clearance round it, and the ram being water borne at all times, the wear on both liner and ram is but slight. The lower part of the chamber is made separate from the upper part, so that in the event of a break in either there is no need of a complete new water end. The steam end is supported on three rigid stanchions secured by nuts each end. All glands are bushed with gunmetal

Continued on page 30

Removing and Replacing Ceiling Motor Armatures

A Handy Rigging Which Enabled Heavy Armatures to be Handled With a Minimum of Labor and Time—Two Pair of Chain Blocks and Small Buggy the Means

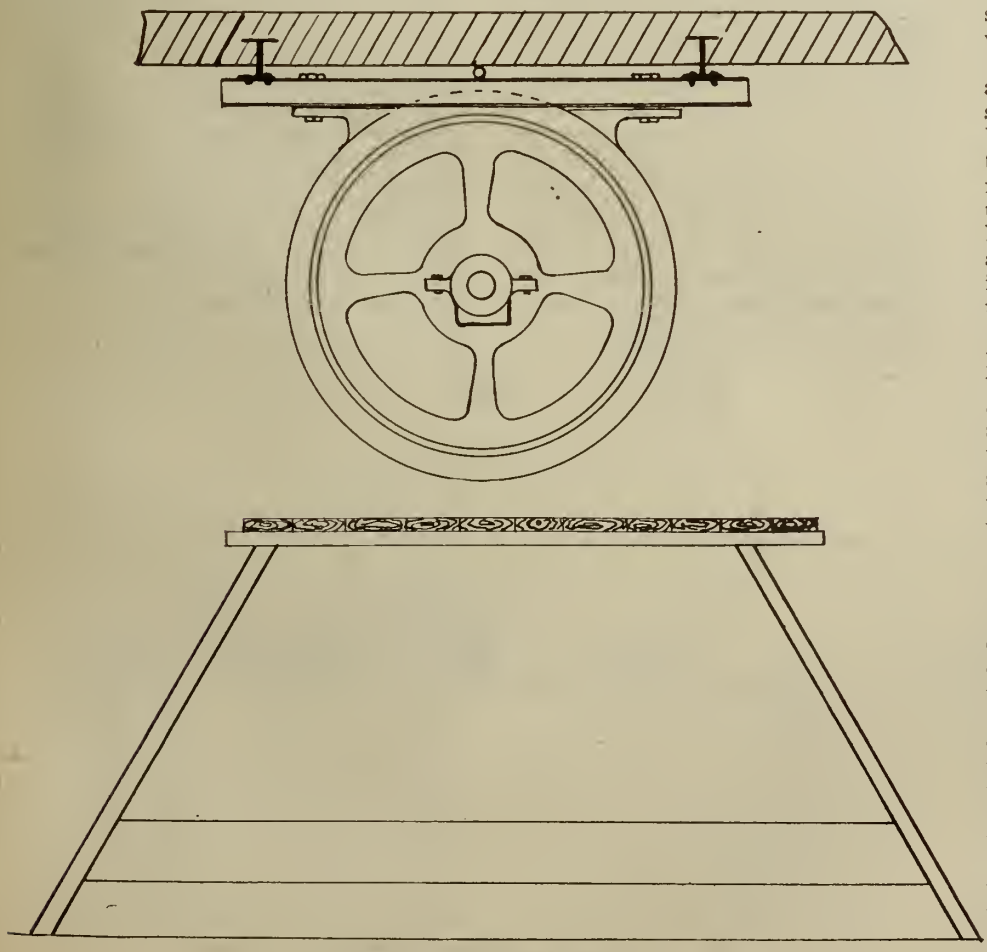
By T. H. FENNER, Associate Editor

IN manufacturing plants where the motors are suspended from the ceilings it is often necessary to remove an armature for repair and replace it by a spare one. The ease with which this work can be done depends on the familiarity of the millwright's crew with the job, and the gear available.

Direct-current motors of medium speeds and power have armatures weighing up to twelve hundred pounds, and require careful handling if they are to be moved without damage to men or property. This is especially the case where they are suspended from ten to fifteen feet in the air.

In one plant the writer has in mind a very good system had been evolved for doing this kind of work speedily and safely. The ceiling motors were about forty-five in number, running all the way from 1½ h.p. to 75 h.p., but the majority were 35 and 75 h.p.

Spare armatures were kept, and the rule was to remove an armature whenever it gave signs of becoming troublesome and replacing it with a spare. Sometimes of course an armature would burn out through various causes during the working hours. This would mean a certain number of machines being stopped, and in this case speedy replacement was a necessity.



SIDE VIEW OF THE MOTOR.

The motors were fastened to channel irons, which were in turn fastened to the I beams of the concrete floor above. These beams were made heavier than the ordinary floor beams in view of the extra weight. The line shaft was direct coupled to the motor shaft in most cases, and in some instances, where one motor drove two adjacent departments, each end of the motor shaft drove a line shaft. This of course made more work when an armature was to be removed.

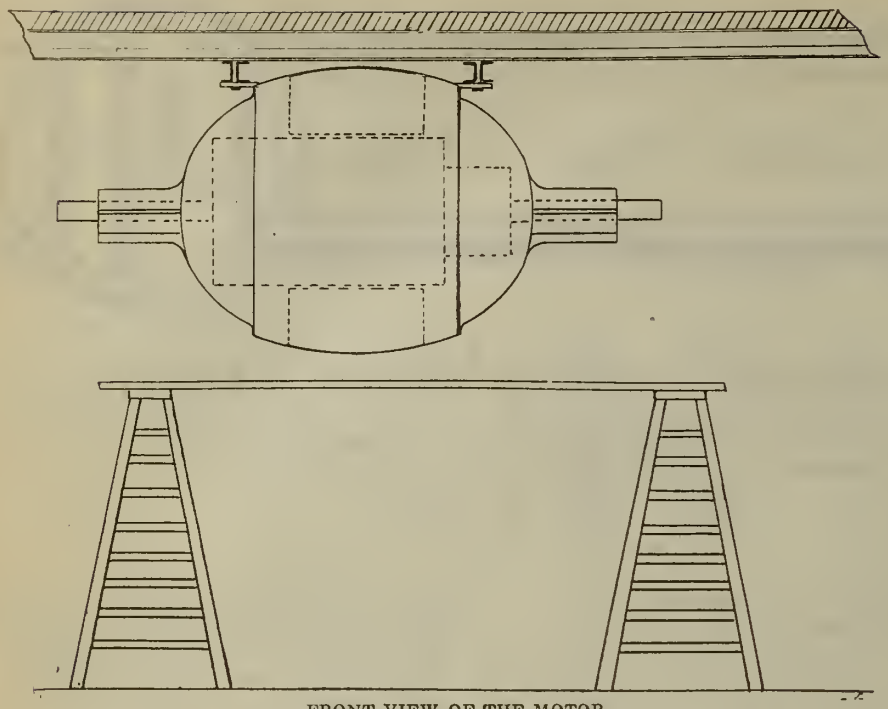
The hangers for the line shafts were about fifteen feet apart, the length of shafting being about seventeen feet. Where a heavy pulley was installed between the motor coupling and the first regular hanger, extra hangers would be used to take the weight of pulley and belt pull. The hangers were of the self-aligning type, and were bolted to three-inch wooden stringers, which were in turn fastened to the floor I beams.

In the millwright's store was kept a pair of strong, high trestles and enough two and three-inch planking to make a strong working platform. A supply of square blocking was also on hand and was kept for this particular work. A strong four-wheeled truck for moving the armatures from and to their place was also kept here.

The Method of Procedure.

The best way to describe the method employed is to follow the course of events from the time of receiving word of a burn-out till the repair is made and the motor running again.

The first step would of course be an examination by the electrician, and he would decide whether he could effect temporary repairs, or if the armature would have to be removed. If this was the case work would start immediately. While the electrician and his helper would disconnect the leads and remove the brushes from the commutator, the millwright's gang would hustle over their trestles, chain blocks, slings, etc.



FRONT VIEW OF THE MOTOR.

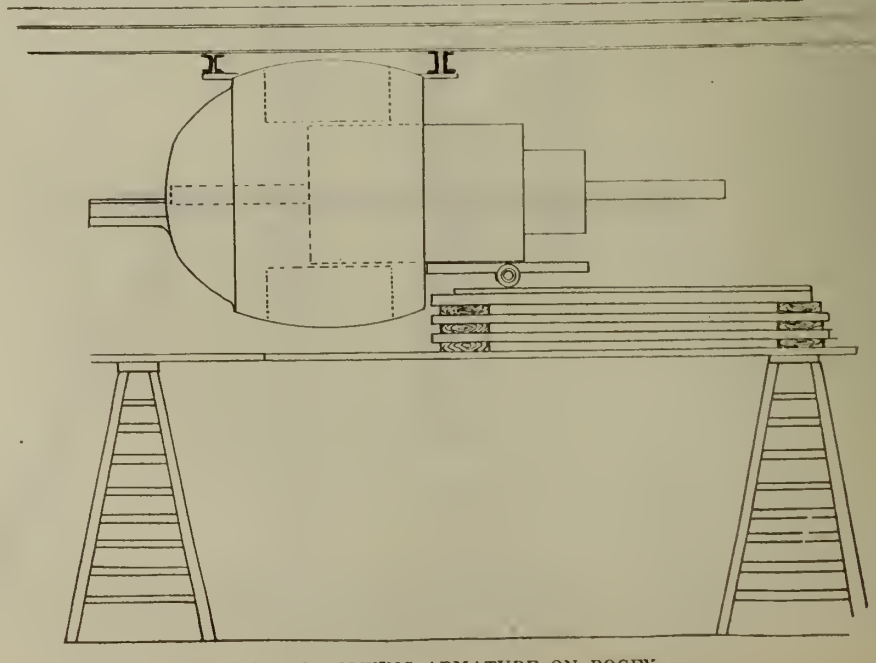
The first actual dismantling would be the removal of the length of shaft immediately adjoining the motor shaft. If there were no pulleys on this length the caps of the bearings would be removed and the length slid back over the hangers far enough to leave room for the armature to come back. If fitted with pulleys these would have to be removed first, though in some cases it would be feasible to lower the whole length of shaft, with hangers and pulleys intact. The shaft out of the way, the next step would be to remove the end housing. This was done by hitching the ½-ton chain blocks to a stringer placed on the ceiling and before slacking the cap bolts holding the housing, taking the weight of the armature on the chain block. The bolts are then taken out and the housing pulled back, the blocks being slacked out till the weight of the armature comes on the field magnets. The blocks are then hitched to the housing and the platform is opened up by removing two or three planks, and the housing lowered to the ground.

On the channel iron to which the motor is fastened, a length of shafting has been left for the purpose of holding the chain blocks. Two pairs of blocks are used, one at each end of the armature. The hook of the chain block at the end opposite to the commutator is passed down through the openings in the housing but is not used till the shaft is just leaving the bearing. It may not be needed at all, but it saves time to hang it up ready before moving the armature. The armature is moved out by the block at the commutator end by leading the block out of the perpendicular so that when tightened up it tends to straighten out, pulling the armature out with it.

By the time that the other end of the armature shaft is ready to leave the bearing another very useful little arrangement is brought into play. This is a small bogey mounted on two wheels at the centre and made with its platform curved to a radius approximately close to that of an armature. Blocking is made up on the working platform till the bogey can be set in just underneath the armature. If the armature is far enough out of the frame to rest on the bogey without tipping, the back pair of blocks will not be needed. Usually, however, the back chain block is tightened up sufficiently to prevent the armature dropping when the shaft comes out of the back bearing. Holding the weight on the two pair of blocks, the armature is worked out until it is fairly over the bogey, and then lowered. This done, the bogey is pulled back on the blocking till the armature is clear of the motor frame altogether. The use of this little carriage saves a great deal of time which would be otherwise used in making fluts and changing blocks. The next step is to lower the armature on to the working platform, which is done by taking a turn on each end of the shaft with the chain blocks and then removing the blocking. This gives more head room and the yoke for lifting can be put on. This is made up of a piece of 3-in. I beam with an eye in the centre for hooking on the blocks. Two pieces of ¾-in. round iron are screwed at each end and bent to a V shape, with the lower end widened out. These fit over the shaft of the armature, the screwed ends passing through the lower flange of the I beam and fastened with nuts. The 1-ton blocks can now be used for lowering. The weight is taken on the blocks, the platform opened up and the armature is lowered on to a truck moved in ready to receive it. This truck is then moved out and the spare armature moved in on its truck. The yoke is taken from the old armature and placed on the new, and it is heaved up. The platform is then replaced and the armature lowered on to it while the yoke is removed. The chain blocks are once more hitched at each end of the shaft, the armature raised up and the blocking put in again with the carriage on top. Working the armature into the frame is probably the most awkward part of the job as the shaft has to be entered fairly into the far end bearing and the oil rings held up carefully till the shaft has passed. The two pair of blocks are used when the carriage has reached its limit.

The armature replaced, the remaining parts of the work do not take long. If all goes well with connecting up the shafting, and couplings can be trued up reasonably quickly, three hours will see the completion of the whole job. This, to remove an armature weighing perhaps 1,000 pounds, and replace it with another, move and replace shafting, and rig platform and gear, is good work.

The number of men engaged on this work was usually five for the heavier motors. Of course handling the smaller ones was only a light job, and two to three men were sufficient.



VIEW SHOWING ARMATURE ON BOGEY.

A PNEUMATICALLY OPERATED CONDUIT AND PIPE BENDER

By THOMAS A. CORBETT

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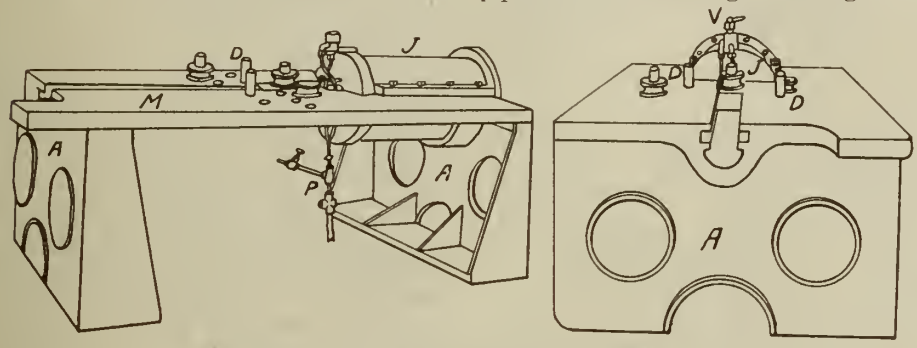
A Pneumatically-Operated Pressure Bender (Fig. 1) designed and used by the Wabash Shops at Decatur, Illinois, has proven in as a most useful machine. In any industrial plant or large contractor's shop where much conduit or pipe is bent a tool of this character will soon pay for itself by virtue of the economies in time and material which it effects. Saving in time results because the machine forms bends more quickly than they can be bent manually. Furthermore, one man can operate the pneumatic bender, whereas two may be required for bending by hand tubes of the larger diameters. Economy in material results because, after the rolls have once been set, the bends produced by the machine are of a uniform contour which cannot be reproduced with hand bending. Hence, little or no material is lost through spoilage. The Southern Pacific Railroad Company has a pneumatic conduit bender in its shops at West Alameda, Calif., and the Westinghouse Electric & Manufacturing Company has one in its East Pittsburg Works. Both of these machines are used for bending conduit electric car and locomotive wiring and for wiring around the plants. There are two duplicates of that illustrated, in the Wabash Shops. Doubtless a number of others, designed and constructed in the plants where they are operating, are in use.



FIGS. 1 AND 2.—ASSEMBLY OF BENDER.

The piece of conduit to be bent is placed on the bending table, M, so that it lies across the T-slot (Fig. 2) in the grooves of two of the rolls. Then the operator, by throwing the throttle of the air control valve, V, admits air to the rear end of the air cylinder, J. This forces the third grooved roll, carried on the crosshead of the piston rod, against the conduit. Thereby the tube is bent to the desired contour. The pipe having been bent sufficiently, the throttle of the control valve is reversed, which returns the piston to its extreme position where it is ready for another operation. It requires only about one half minute—the time consumed by the piston in moving the length of its stroke—to make a bend with the machine.

Rolls of Various External Diameters and Having Grooves of Different Sizes are Provided for tubes of different diameters and for forming bends of different radii. In Figs. 3 to 6, inclusive, are indicated the mechanical details. The extension of the top plate at X and X (Fig. 3) is to provide for the clamping on of pipe vises for threading the fitting. The piston rod, H, (Fig. 4) is held in the piston head, L (Fig. 5) by being screwed in against a shoulder, which is not shown in the details. The end of the piston rod is then headed over. Cylinder rings of leather are used on the piston head, as shown at III in Figure 5. Steel-wire spreaders hold these leathers out against the sides of the cylinder. The ¾-in air supply pipes from the control valve, V, enter each of the cylinder heads. The air pressure used is 100 lb. per sq. in. In the stuffing box in the cylinder, J, for which the gland of Fig. 6 is used, Garlock round packing is employed.

Note that pins, D and G (Fig. 4) of two diameters are employed for the accommodation of the two sizes of stationary rolls. The lower ends of these pins are tapered to fit correspondingly tapered holes shown in the top plate in Fig. 3. The V block, B, held by the clamp C (detail in Fig. 4 and shown in position in Fig. 3) is used for holding a length of conduit for straightening or for bending. A movable roll held on the crosshead pin E is forced up against the pipe, thus gripping it in the V-block of B.

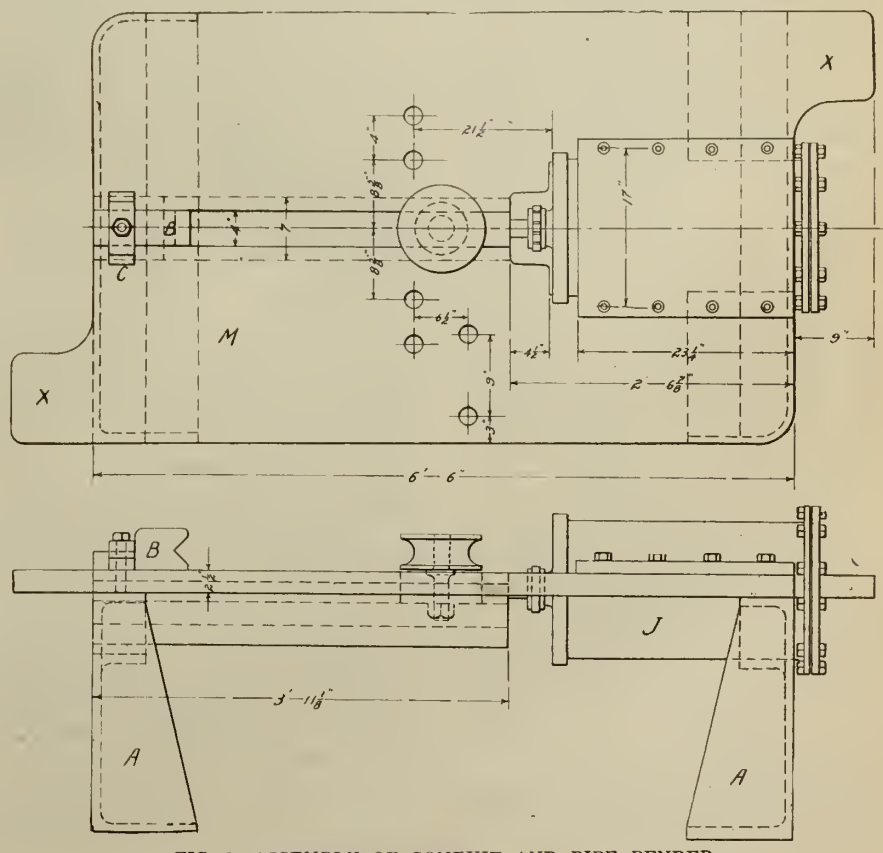


FIG. 3—ASSEMBLY OF CONDUIT AND PIPE BENDER.

FASTENING ANCHOR BOLTS

By Hal B. Beecher

Some very interesting information is given in the letter by Terrell Croft on page 291 of POWER HOUSE of July 5. What he states in reference to a foundation bolt being set in cement 30 times its diameter may be quite true, nevertheless I would advise builders of foundations to stick to the old safe plan and place some kind of a hold-back on the end. A right angle bend on the end will answer. No thread, nut, washer or plate is necessary as it is a practical impossibility to pull such a bent bolt out of a set cement foundation.

If, in following out Mr. Croft's idea, a very small amount of oil might be left on the bolt, this would be fatal to the effective adhesion of the cement to the rod, or the rod or bolt might be slightly rusty, which might be as bad as the oil; another point in placing foundation bolts is this: Whenever possible the bolts should have an outside casing at least

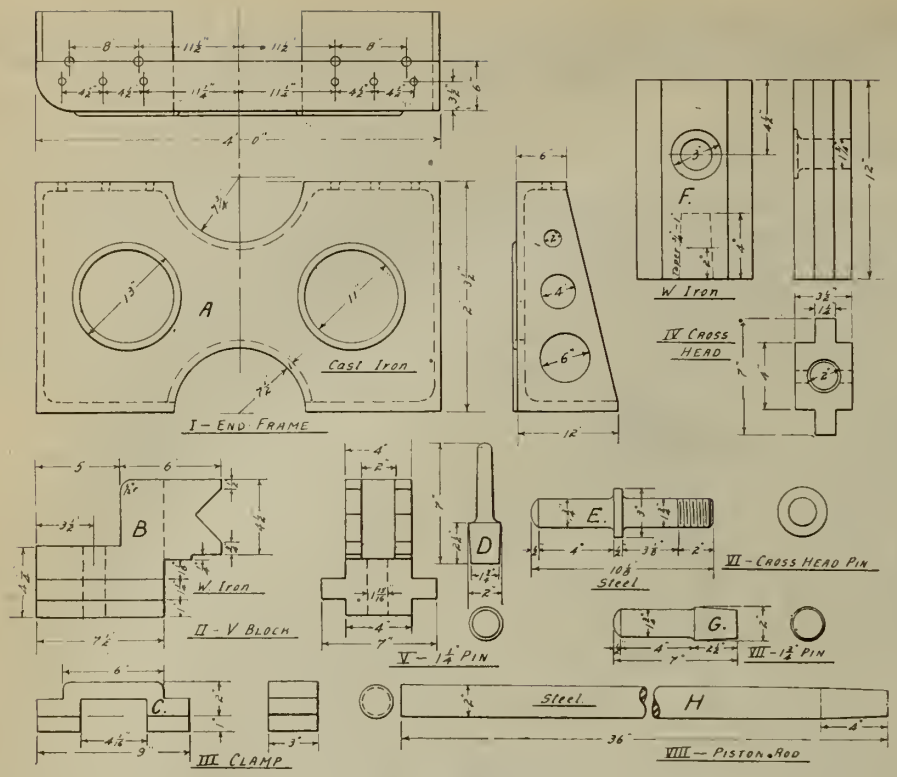
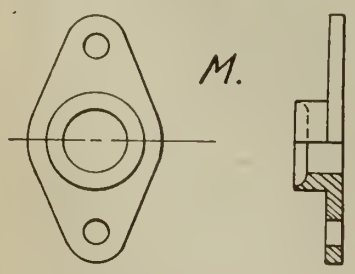


FIG. 4—DETAILS.

double the diameters of the bolt, such as a piece of iron pipe, and a fairly large piece of iron plate at the bottom. A thick nut should be used on the bottom of the bolt, the thread on the rod being such that it makes a snug but not tight fit into the nut. With such a layout it is possible at any time to remove the bolt or bolts if it is necessary to move the machine for repairs, or other reason. With the bolts removed the machine can be moved on low rollers with ease. With heavy machines with high bases this point is worth considering as the cement will have set around the nuts holding them in place; it is an easy matter to replace the bolts. In some cases a recess is formed below



GLAND DETAIL.

the bolt head so that by removing the top nut the bolt can be lowered until the top of the bolt is level with the top of the foundation; when this plan is used a small hole is drilled and threaded on top of the bolt so that a small rod can be screwed into the bolt to lift it up when the machine is in place. Much more might be written on this subject but one thing I wish to repeat: do not adopt Mr. Croft's plan, for it looks to me that a headless bolt set in cement might possibly be loosened into its bed if the bolts were subject to sharp and constant vibrations, which would have the same effect all through the bolt. I imagine I could loosen such a bolt so that it could be pulled out without breaking, by tapping or striking said bolt for some time close to the cement, using a hammer or other tool.

ANTI-FREEZE FOR THE RADIATORS

A friend was telling me that a few pounds of chloride of magnesium added to the water in a house heating system will prevent the water in the pipes, radiators and boiler from freezing, should the fire go out or the house be left idle, and that the chloride will do no injury to the pipes. I thought I would pass this information along, as it is a mighty fine thing to know, if it is true. This mixture should also make a good anti-freeze liquid for auto radiators.

By J. E. M.

Editor's Note: Calcium chloride lime is well known as a refrigerating medium. Certain anti-freeze compounds on the market for motor radiators have as their basis nothing more nor less than calcium chloride.

THE TOD-ATWOOD RAM PUMP

Continued from page 346

bushings, and the workmanship throughout is of the best. The pump has earned the seal of approval of Lloyd's surveyors here, and is at present under examination by the Bureau Veritas. The pump is manufactured by the G. H. Tod Co., Ltd., Toronto, who also manufacture a line of stationary pumps embodying some of the features of the pump described. The overall dimensions of the pump shown are 7 feet 9 inches high by 2 feet 8 inches wide. The floor space is 24 inches by 32 inches.

Electric current is available to most people, but it is not always apparent whether it is direct or alternating, 110 or 220 volts. A new pocket instrument, 4 inches long, 2 inches high, and 1½ inches wide, has a dial at each end in which the letters "A. C." or "D. C." appear, as the case may be, when the flexible cords are connected to the circuit. The voltage is indicated in the same manner. Provision is made for connecting to any kind of terminal, a plug being provided into which the posts on the wire-ends fit, for lamp-socket testing.

* * *

Word comes from the north-east coast of England of a vessel that has been designed to meet the need of an unsinkable ship. To accomplish this end the bridge of the ship is made watertight, and is made large enough to accommodate all the people and valuables on board. It is not made integral with the ship, but is attached thereto with easily-detached fastenings, and in the event of the hull being mined or torpedoed, the bridge will have enough buoyancy to float and sustain the weight of the immersed hull. The crew and passengers can remain in the bridge until taken off or towed into safety. If the hull through very bad weather becomes a danger to the bridge it can be released and allowed to sink, leaving the bridge afloat.

* * *

Stamping, drawing, and general press work on cupro-nickel can be accomplished as easily as with brass, according to the "Metal Industry." The metal can be more drastically treated, and stands greater reduction than brass, although more power is required than for working most alloys. Annealing cupro-nickel articles between operations is not advisable, chiefly on account of the great tendency toward fire-cracking and the production of excessive scale, which is very difficult to remove, and which, unless entirely eliminated, will ruin punches and dies.

* * *

Zinc water pipes which come in contact with mortar containing gypsum become in a relatively short time corroded and eaten through. Where the surface is wetted and quickly dried a protective coating of zinc oxide is formed, but where the contact with running rainwater is prolonged, such as in the case of roofing plates and gutters, energetic action must be reckoned with. According to "Building News," the most active agent of destruction is sulphate of lime. Zinc is energetically attacked by mortar containing gypsum sand, but only feebly by mortar containing limestone sand alone, or with an addition of gypsum. Lead, on the other hand, is energetically attacked by limestone alone and with an addition of gypsum, but only feebly by gypsum sand mortar. Both metals are strongly attacked by pure cement, but the destructive action is lessened by the addition of sand. Hence zinc should be put in contact only with limestone—carbonate—mortar, and lead only with gypsum—sulphate.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 70	66 94
3½ in	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8 in.	193 00	244 00
9 in.	222 00	281 00
10 in.	266 00	366 00
10½ in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$2	20
Leather in sides 1	75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly 0	34
Solder, guaranteed 0	39
Babbitt metals ..... 18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums..... 6	75
White lead, pure, cwt..... 17	80
Red dry lead, 100-lb. kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D," per lb. 0	03
Rosin "G," per lb. 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon.... 1	80
Whiting, plain, per 100 lbs.. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....	$42 50	$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper .....$	22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided .....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila....	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

To Build Mammoth Plant

The Lunkenheimer Company, Cincinnati, Ohio, manufacturers of valves and engineering appliances, has announced its intention to greatly increase and improve its manufacturing facilities by building a complete new plant. The site selected for the undertaking comprises about seventy acres of land in Carthage, a suburb of the city of Cincinnati, directly on the Toledo Division of the Baltimore and Ohio Southwestern Railroad. The location selected is not far distant from the centre of the city, is in the heart of one of the manufacturing sections of the city, where labor is plentiful and facilities for the handling of incoming and outgoing freight is ideal.

Buildings will be of the one, two, three storey types, of steel and concrete construction, and there will be provided all modern devices for the manufacture, handling, and transportation of raw materials, part finished and finished products. The undertaking will represent an outlay of approximately $2,000,000.

The welfare of the employees has been given special consideration. A piece of land about eight acres, lying directly opposite the land upon which the main plant is to be located, has been reserved as a recreation centre, upon which will be erected an assembly hall, club rooms, base ball grounds, tennis courts, swimming pool, etc. Upon this site will also be erected a dining room capable of accommodating one thousand employees at one time.

Arrangements are being made so that there will be no interruption to the business of the company while the building operations are in progress, nor while the task of moving into the new plant is under way.

"We Welcome Fair Competition" is the title of a circular just issued by the Portable Machinery Co., Passaic, N.J., manufacturers of the Scoop Conveyor. It briefly describes how one concern has copied and is trying to market an imitation of the Scoop Conveyor. As there is suit now pending for infringement of rights, the circular warns possible customers of portable conveyors against purchasing the imitation.

The Combustion Engineering Corporation, New York, have issued a new catalogue on their "Grieve Grates." This publication shows in an interesting manner, both as to text and cuts, the detail and operation of the grate.

The Vulcan Soot Cleaner Co., Du Bois, Pa., have issued a publication entitled: "Six Vital Features of Vulcan Superiority." As indicated in the title the various excellent features of design of this soot cleaner are dealt with in a thorough manner.

S. F. Bowser & Company, Inc., Fort Wayne, Ind., have issued two new publications on "Systems for Oil Economy and Efficiency," and "Handsome Returns to Yourself." These pamphlets deal with the economies to be secured in providing proper methods of handling oil in industrial processes and for lubrication.

Newfoundland Imports Free. — The last restrictions on imports into Newfoundland have now been removed, by flour being restored to pre-war conditions.

Substation Expands.—The Toronto Hydro-Electric Commission has purchased the property at 27 and 29 Nelson Street, for the purpose of extending the substation at Duncan Street.

Saw Mill Burns.—The saw mill of Mr. Musclow, situated at Musclow, North Hastings, was completely destroyed by fire recently. The loss is a total one and is not covered by insurance.

Algoma Steel to Extend—The Algoma Steel Co. will spend several hundred thousand dollars in making extensions to their mills, to enable them to manufacture structural steel up to 32 inches.

English Firm For Hamilton.—The firm of Perrits & Spencer, Bury, England, will build a factory in Hamilton at an approximate cost of $600,000. W. J. Westaway has been appointed engineer for the building.

New Smelting Plant.—The forthcoming industrial congress at Calgary will consider the establishment of a smelting plant near that city, the new process of smelting by electricity to be employed. Considerable interest is being displayed already.

New Industry for Hamilton. — The Carr Fastener Company of Boston, Mass., are to open a factory in Hamilton. This firm are said to be the largest manufacturers of fasteners in the world. The Hamilton branch will be known as the Canadian Carr Fastener Company, and will be probably capitalized at $250,000. Two and one-half acres of land on Gage avenue have been purchased.

Municipal Power for Port. Colborne.—Port Colborne decided by a vote of 141 majority to purchase the distribution system of the Ontario Power Company in Port Colborne.

The Andian National Corporation, Ltd., has been incorporated with a capital stock of $1,000,000 in 10,000 shares of $100 each. The object of the company will be to search for minerals, oil, gas, etc. The head office of the company will be in Ottawa.

Corporal William A. Nugent, who served during the war in Company I, 21st Engineers, has returned from France and resumed his duties with the Independent Pneumatic Tool Co. as traveling representative. He has been assigned to his old territory in Indiana.

The proposed extension of the water supplies to Moose Jaw, Sask., Con., will entail laying a pipe line about 70 miles long. The pipe will be of wood and 24 in. in diameter. The relative costs of wood, steel, and cast iron pipe for the work are in the proportion of 2.3, 5.7 and 10.5.

Electrifying Montreal Harbor.—The Montreal Harbor Commissioners have awarded contracts for material required in the electrification of the railways on the wharves. Work will be started as soon as material is available. A generator set will have to be installed, the rails bonded and poles and wires erected.

Heavy Shot at Chippewa.—A dynamite charge that cost between $4,000 and $5,000 took place at Chippewa recently. The amount of dynamite used in the blast was in the neighborhood of ten tons. It was used in opening up a large section of rock in the forebay of the new development canal above Queenston.

A Fortune in Oil.—Mr. Kenneth Johnston, a former Sarnian, but now of Buffalo, is the inventor of a lubricating grease, which has been taken up by one of the largest oil companies in the United States. The sum paid to Mr. Johnson for his invention is said to be $600,000. He is a veteran of the South African war.

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The Nova Scotia Government is to create a hydro-electric commission similar to that in Ontario. Two bills, one to authorize the development of water power and the other to lay down regulations covering water and water courses, have been introduced in the Provincial Legislature.

The Battery Engineering and Supply Co., Ltd., with head offices in Ottawa, has been incorporated with a capital stock of $50,000, divided into 500 shares of $100 each. The company will manufacture all kinds of electrical appliances and automobile engines.

The Continental Storage Battery Co., Ltd., has been incorporated with a capital stock of $50,000, divided into 500 shares of $100 each, the head office being in Ottawa. The object of the company will be to make and sell batteries, and deal in automobiles and supplies generally.

Going Ahead.—The R. McDougall Co., Ltd., Galt, were not seriously inconvenienced by the fire which took place in their plant recently. The machine shop and foundry were uninjured, and the patterns that were burned or injured have been largely replaced. Their deliveries on their usual lines have not been interfered with.

To Relieve Congestion.—The British authorities, in an endeavor to relieve the congestion at the leading shipping ports, are introducing a new rule. All heavy cargoes consigned through ports where congestion is being experienced to destinations that can be more easily served through other ports will be transferred to coastwise steamers at once.

Contract Let.—The General Motors of Canada, Ltd., has awarded the general contract for a factory at Oshawa, Ont., to cost $1,000,000 to the Canadian Stewart Co., foot of Cherry street, Toronto. It will consist of an assembling building, four stories, 40 x 80 ft., of reinforced concrete; shipping building, 80 x 200 ft.; storage building, four stories, 80 x 800 ft.; enameling building, 80 x 300 ft., three stories.

New Cyanide Plant for Canada.—The Cassel Cyanide Company, Ltd., of Glasgow, Scotland, are about to incorporate a Canadian branch of their company. This is on the recommendation of their manager, Mr. Neill, after making one of his periodical tours of Canada and Mexico. He was very favorably impressed with the mineral resources of Northern Ontario and the industrial possibilities of the country generally. The board of the Canadian company will have three members from the Glasgow board, and Mr. Neill will divide his time between the Canadian firm and the parent company.

Increasing Yard Area.—The large farm of A. Weaver, on the Niagara River frontier, nine miles from the International Bridge, has been secured by a party of Toronto realty dealers. It is understood that the ground will be used for extending the yard holdings of the Canadian Niagara Bridge Company.

Veteran Contractors.—A firm of contractors has recently been formed in Vancouver, the members of which have seen service in France on railway work. They have taken a contract for one and a half miles on the Copper Mountain Railroad near Princeton. They will, as far as possible, employ none but returned men, and the wages paid will be up to the prevailing standard. To those men who stay on the work till completion a percentage of the profits will be given.

To Try New Boilers.—In order to try out the Spencer heating boilers equipped with self-feeding furnaces, which have been successful in Hamilton schools, the Board of Education of Toronto departed from their usual rule of accepting the lowest tender. The difference in the bids was as follows: Tubular boilers, $12,300; brickwork, $6,100. Spencer boilers, $15,500; brickwork, $7,375. The installation in Toronto will be in Howard Park School.

Newmarket Boiler Explosion.—At the inquest into the boiler explosion which caused the death of five persons recently in Newmarket, evidence was given to the effect that the water used in supplying the boiler was high in sodium carbonate. The analysis of the water coincided with that of the water in other districts where the embrittlement of plates by the action of sodium hydroxide has occurred. The water is from an artesian well on the premises. The town supply and the Office Specialty Supply Co. supply were found to be free from sodium carbonate.

Sells Buffalo Plant.—The Russell Motor Car Company has sold its Buffalo plant, which was an important subsidiary during its operations on war contracts. It is said that the sale is an advantageous one, realizing more than the company put into it. It is reported that the company is having a successful year, and will close its fiscal year on July 31, with a good record, though somewhat less earnings than in the bumper period before the close of the war.

Mr. W. B. Roberts, who has just returned from England, where he held the rank of Lieut. Commander (Engr.) in the Royal Navy, has been appointed chief inspector for Saskatchewan and Alberta, for the General Accident Insurance Co., boiler department. Mr. Roberts, before going overseas, represented the company in that territory for about two years. He was connected with the Manchester Steam Users' Association for a period of five years, where his opportunities to obtain expert knowledge of boiler questions was unlimited. Besides his naval experience, he was in the mercantile marine for some years, and holds the extra first-class certificate of the British B. of T. He should be a great acquisition to the engineering fraternity of the prairie provinces.

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20-24 K.W. direct connected 4-cylinder 80 V. complete.

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Canadian War Inventions.—There is a department at Argyll House, London, which has been instituted to deal with Canadian war inventions. A large number of devices have been submitted, of which a fair proportion were found to be of practical utility. Chief among these may be mentioned the following: Improvement to gas masks, of which about three million were manufactured, by Lieut. C. Rosling, C.E.; Lewis magazine loader and improvements to Colt machine gun, invented by Major H. R. Northover, M.C.O.B.E., both of which were used, and a bomb dropper invented by Lieut. Col. W. F. Kemp, D.S.O. The inventions cover appliances all the way from a combination turf cutter and conveyer to an auxiliary field kitchen.

The Cost of Coal.—The wild rumors that coal will jump in price as much as $5 to $6 a ton, and a famine develop during the winter, are discounted by Canadian coal dealers, who have been looking into the situation in the States. There will be a shortage, it is thought, and probably a small rise in prices, but nothing like the rise that has been freely prophesied. If people get panicky and all rush to buy coal at the one time there will be a fictitious situation created which will tend to elevate prices. Many of the Italian laborers are returning to Italy, which is creating a shortage of labor, naturally affecting the output. There will be enough coal available to face a normal winter is the consensus of opinion.

The Alien Getting Even.—The many aliens of supposedly Austrian nationality, but really Slavs and Croats, who have been working in the anthracite mines, are getting out of the country as fast as they can. Forty-two thousand have already gone, and as fast as steamer space becomes available, more are going. These men, who were far from being in sympathy with Austria during the war, resented the attitude displayed by many Canadians to them, and as a result of their being so anxious to get back to their own countries, there is a grave danger of many of the people who vilified them being cold this winter. The production from the mines, where central Canada gets her anthracite coal was, up till the end of June, only 38,000,000 tons, ten millions less than for the corresponding period of 1918.

The Coal Situation in B. C.—Sir Robert Borden sent a telegram to the mayor of Sydney Mines, which was read at a labor meeting recently. The Premier stated that the Canadian National Railways were taking more coal from Nova Scotia this year than last, and had divided their orders between sixteen different mines. He pointed out the handicap that Nova Scotia was under owing to the shortage of ship tonnage. He stated that the Canadian National now had a stock of coal on hand good for seventeen weeks and were adding to their stock daily. Mr. R. H. Butts denounced the leaders of the United Mine Workers locally as demagogues and agitators. Mr. McLachlan, addressing the meeting, was not disposed to accept the Premier's explanation and thought that much of the present unrest was due to the Government's attitude towards labor. He thought that United States coal should be shut out of Canada altogether.

New Company Starts.—Statement was issued at Toronto City Hall, that the Nukol Company had taken a lease of the property formerly occupied by Toronto Shipbuilding Company. The lease, which was issued by the Harbor Commissioners, is for 21 years. It occupies some 2½ to 3 acres. The company is importing machinery from Belgium, and will start operations in making Nukol as soon as it is installed.

The Jeffrey Manufacturing Company, Jeffrey, Columbus, Ohio, have issued catalogue number 210 on the Jeffrey Pivoted Bucket Carrier, well illustrated with engravings and forming an unusually complete treatise on the subject of conveying. In addition to the many illustrations showing typical installations, line drawings are given which show practically all the dimensions necessary for the complete installation of this type of mechanical conveyer.

INCORPORATIONS

The Canada Stoker Co., Ltd., has been incorporated with a capital stock of $40,000, divided into 400 shares of $100 each, the head office to be in Galt, Ont. The company will carry on a general business.

The Phoenix Construction Co. has been incorporated with a capital stock $100,000 in 1,000 shares of $100 each, and head offices in Montreal. The company will carry on business as manufacturers of metal products, etc.

The London Clay Products Ltd. has been incorporated with a capital stock of of $50,000 in 500 shares of $100 each, the head offices to be in London. The company will manufacture all kinds of sewage pipe, tile, etc.

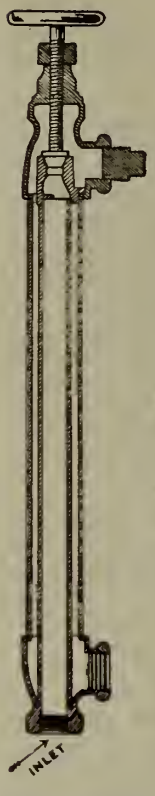
The Armstrong Cork and Insulation Co. have issued two booklets on "Nonpareil Corkboard Insulation for Cold Storage Rooms" and "Saving 63 Per Cent. of the Drinking Water Expense." As indicated by the titles these publications deal with the important subject of economy in refrigeration.

Lead poisoning is being investigated these days, because of its widespread existence in various industries. The Working Conditions Service, Department of Labor, has prepared, as a guide to industrial physicians, a schedule for the physical examination of lead workers, in which provision has been made for covering not only the typical manifestations of lead poisoning but also for bringing out the previous history of the worker, to determine whether hazards in other industries may have had an adverse effect upon the health. This schedule has been forwarded to districts in which lead poisoning in the pottery industry has appeared.

The LONG

PATENT

STEAM TRAP



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Most simple and effective Steam Trap you can install in your plant. **Has only one Moveable part.**

The Long Trap is open at the start and cannot become air bound. Never freezes. Works against 1 and 200 pounds pressure. Can be installed in any position.

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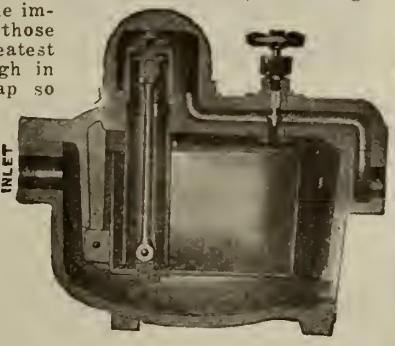

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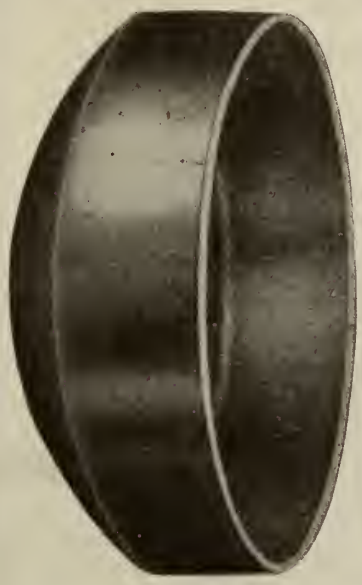

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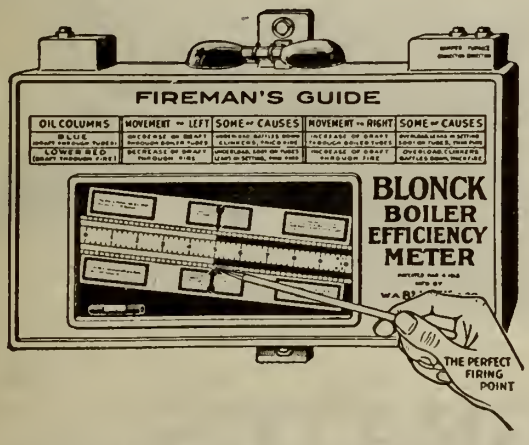

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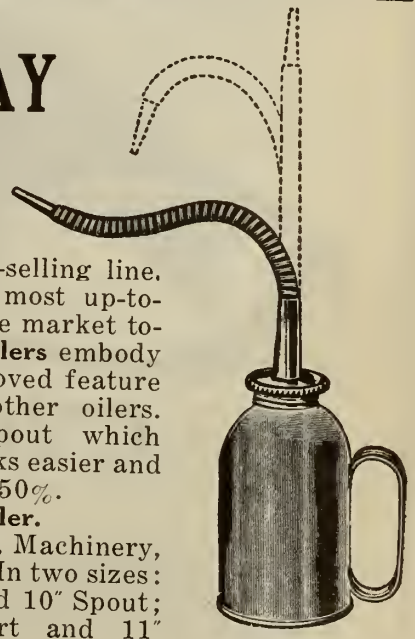

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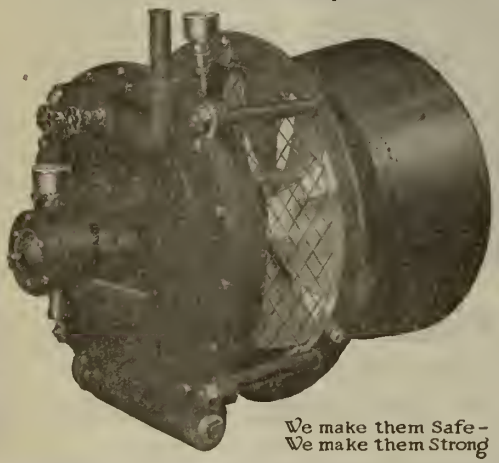

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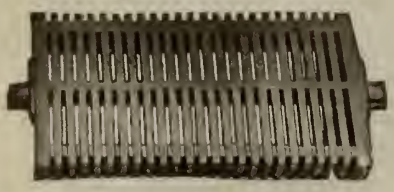

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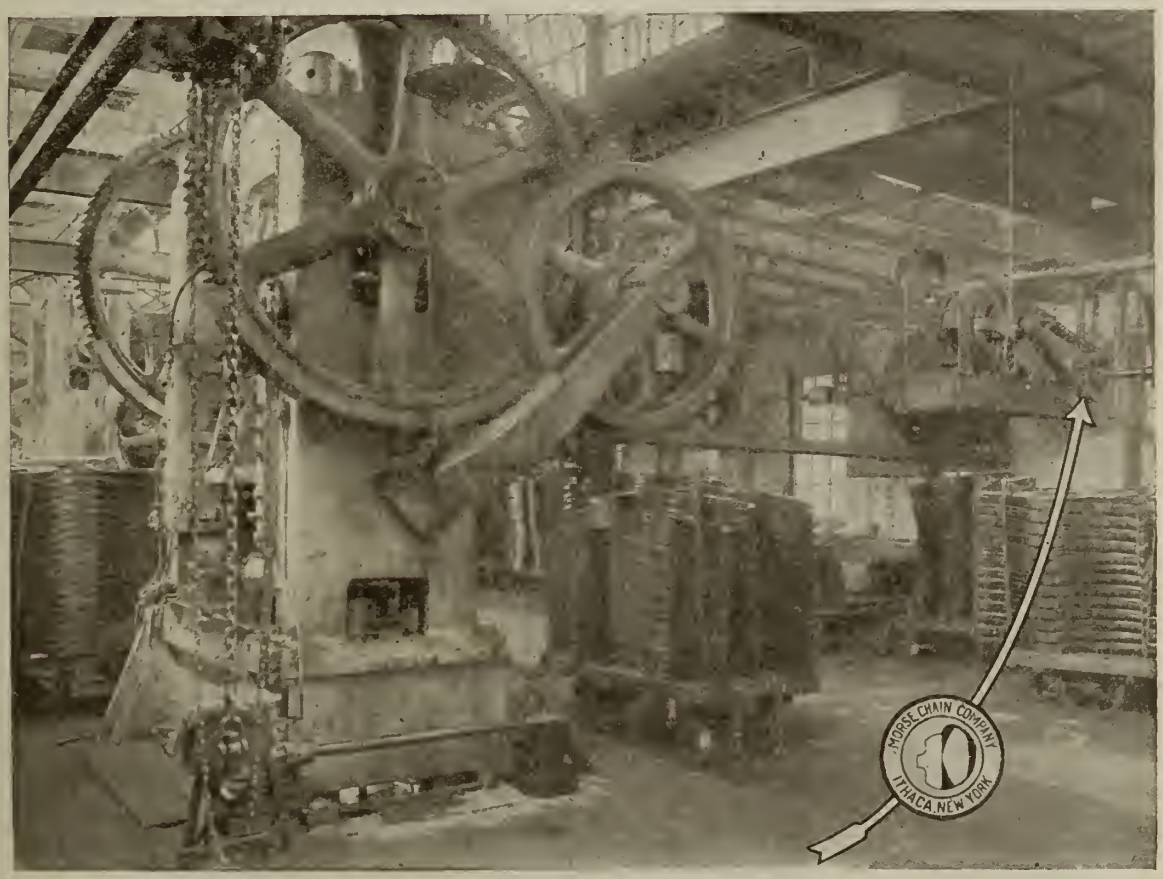

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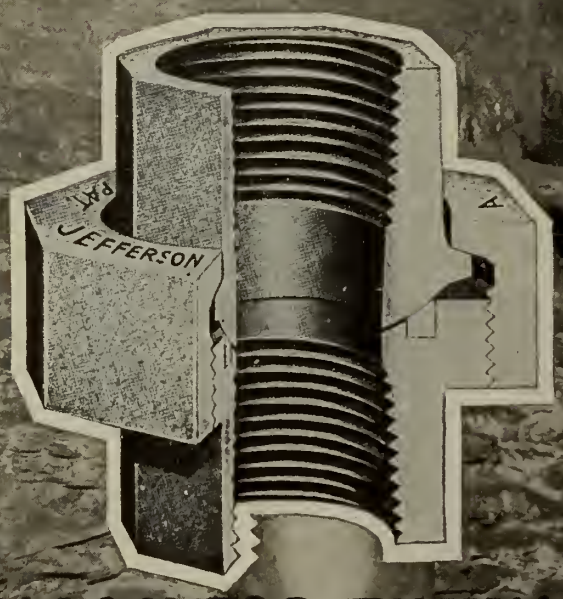

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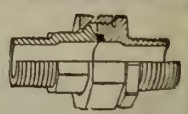
Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.

Union Elbow, all female. Takes the place of a straight union, nipple and an elbow. Also made male and female.



All Male Union. Saves two pipe joints between two female threaded parts.

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LINK-BELT Locomotive Cranes are rendering highly efficient service in leading industries throughout Canada.

They are handling ore at foundries. Handling steel at fabricating plants. Handling small parts with electric magnets at factories. Handling coal and ashes at power plants. Handling steel in ship yards—in fact wherever heavy parts or assembled products are to be handled economically and with dispatch, there you'll find Link-Belt Locomotive Cranes on the job.

And in each case you'll find them rendering a highly satisfactory service. For back of Link-Belt Cranes is a great engineering organization. Each crane is of the highest standard throughout—the same high standard which has long characterized Link-Belt products and made the name Link-Belt a guarantee of quality and efficiency.

Send for our Crane Book No. 370. Gives complete details.

CANADIAN LINK-BELT COMPANY
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220

We Also Make

- ☐ Elevators and Conveyors
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Standard Weight

These fittings are of good design and weight, and are suitable for steam working pressures up to 125 lbs., or water working pressures to 175 lbs.

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Straight Tee

All sizes, ¾″ to 6″ inclusive, carried in stock.

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CAST IRON SCREW FITTINGS

Straight Elbow

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250 pounds working pressure.
All sizes, ¾″ to 6″ inclusive.

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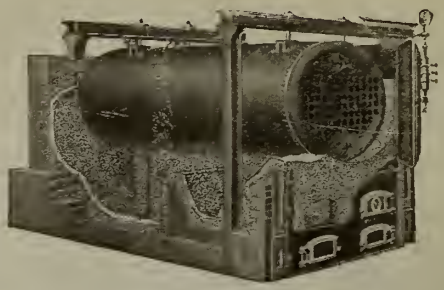

A SOLID ONE-PIECE, JOINTLESS LEAKLESS LINING

Your Boiler Furnace Linings--How Often Do You Repair Them?

During the year how many times must you cut out your boilers to completely reline the furnaces?

Of course the life of a boiler furnace lining depends a whole lot on the service, but have you ever considered what it would mean in dollars and cents if you could reduce that number of repairs or renewals?

And it can be reduced at least 3 to 1 under ordinary load conditions.

It's the one-piece, monolithic boiler furnace lining made of Betson's Plastic Fire Brick that makes this possible. What's more—a Betson lining becomes harder and stronger with service.

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Our illustrated booklet tells how anyone can make a durable furnace lining. Just ask for it.

International Chemical Co.
44 Lombard Street
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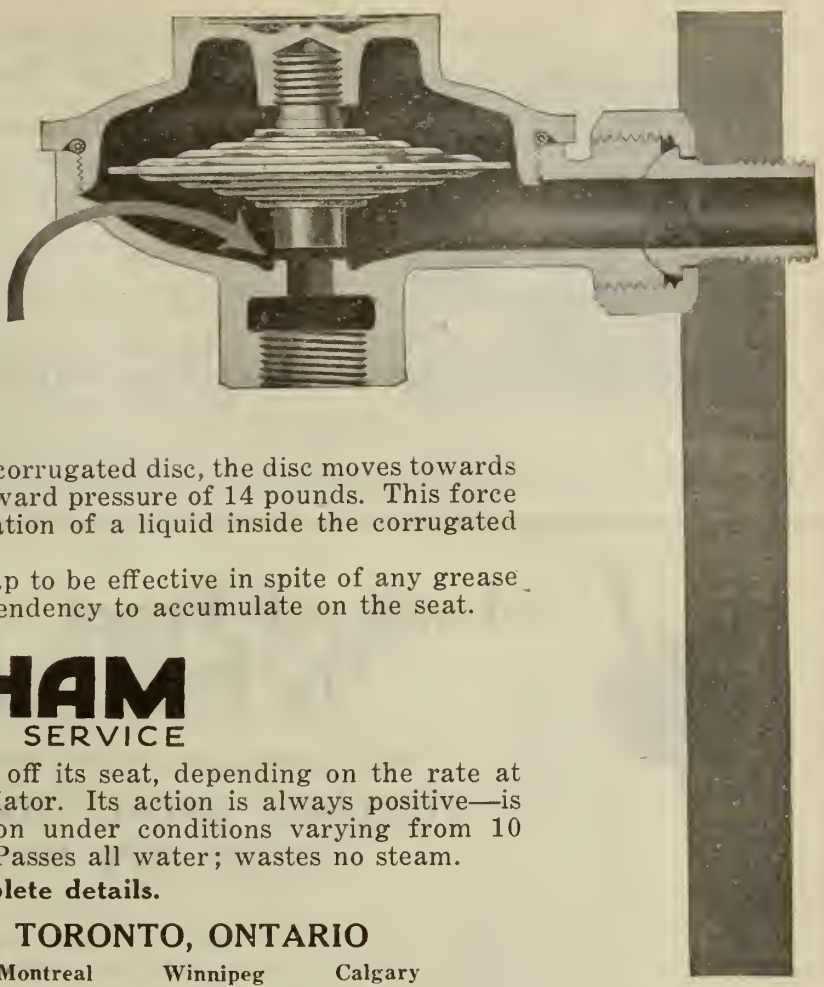
31

14 Lbs. Pressure downward



AS soon as steam strikes the sensitive corrugated disc, the disc moves towards its seat and exerts a maximum downward pressure of 14 pounds. This force is exerted uniformly by the vaporization of a liquid inside the corrugated disc.

This downward pressure causes the trap to be effective in spite of any grease and foreign matter which might have a tendency to accumulate on the seat.

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In action, the disc is alternately on and off its seat, depending on the rate at which the steam is condensed in the radiator. Its action is always positive—is never sluggish—and can be depended on under conditions varying from 10 pound pressure to 15 inches of vacuum. Passes all water; wastes no steam.

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Any Capacity *Any Pressure*

Distinctive Features that Add to the Efficiency of Norwalk Compressors

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In the Norwalk the valve, valve stem and head are forged in one piece. This eliminates the serious difficulty frequently encountered when stems are screwed in or when a nut and a "jam nut" or split pin are used.

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Pioneer Builders of Compressors

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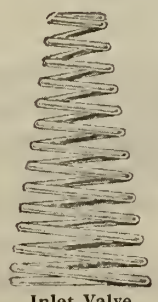
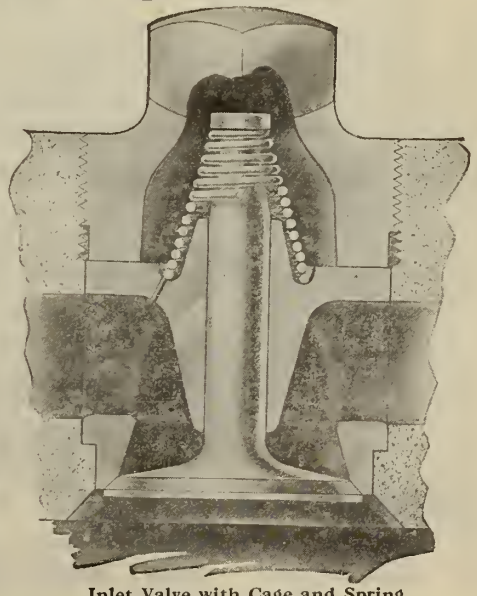


Inlet Valve Spring.



Inlet Valve with Cage and Spring. Note Integral Valve Design.

Showing ease with which Plibrico is laid in place.

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There's proved and certified strength in every

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Each and every Flat Link Chain is "proof-tested" to two-thirds of its listed catalog strength in a standard tension machine. To each chain so tested is attached the Gray Leaden Seal, illustrated above, and every Flat Link Chain leaving our works *must* bear this seal—the Proof of Quality—as evidence that it has passed our standardized "proof-tests."

Look for this Mark of Proof for it is Proof of Quality—it guarantees uninterrupted, severe service as well as safety to the operator. Williams' "Vulcan" Chain Pipe Wrenches are the *only* Wrenches which offer this certified assurance.

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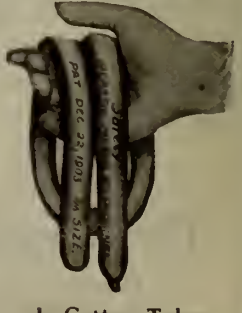

In Cotton Tubes

Settling the Packing Question

More experimenting has been done with packing than with any other power plant supply—and most of it has been done at the expense of the users. The packing question has been such an ever present problem with most engineers that they have been willing to try almost anything that promised relief. And it is easy to make packing — *of a sort.* Consequently there are dozens of brands — good, bad and indifferent. We do not claim that

VULCABESTON
RED FIBRE SHEET PACKING

is the *only* good packing. But we do claim—and stand ready to prove—that Vulcabeston is the equal of any packing made, at any price, and that it has one most important advantage: Where other packings are satisfactory for one or two kinds of service *only*, Vulcabeston is equally good for *all* kinds of service. It is the universal packing. That is why Vulcabeston settles the packing question once and for all.

The Johns-Pratt Co.
HARTFORD, CONN.
U. S. A.

TRADE MARK
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REG IN US PAT OFFICE
RED FIBRE
STEAM
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AMMONIA
SHEET PACKING
MFD EXCLUSIVELY BY The Johns Pratt Co. HARTFORD CONN U.S.A.

19-7

VULCABESTON

The Secret of the Strikes

Most Canadians are asking "What is the cause of the 'Great Unrest' "? Is it the fault of labor—or of capital?—or is it the result of German propaganda? Do you know of the real reason for the labor disturbances in Canada, and elsewhere? Are YOU thoroughly familiar with the ins-and-outs of the plans which threaten a world-wide "tie-up?" This is something that should be understood by every Canadian. And every Canadian should read "The Secret of the Strikes," by Lieut.-Colonel J. B. Maclean in the August issue of MacLean's Magazine. It is brimful of startling and authoritative information regarding this great problem. Read it carefully. It starts on page 33, August MacLean's.

"The Lecturer At Large"

Stephen Leacock is one of the continent's greatest humorists. "The Lecturer at Large" is one of the best humorous sketches that he has written. It is made up of what he terms "a few painful reminiscences of the platform" in the course of his lecturing up and down Canada. Get your family around you and read the sketch aloud—it's a rare treat.

Other Big Features

"A Party in the Making." By J. K. Munro. Illustrated by William Casey. An article on the political situation, giving a great deal of inside information with reference to recent developments at Ottawa.

"Solving the Problem of the Arctic." By Vilhjalmur Stefansson. The fifth instalment of his story of the five years' explorations that he conducted for the Dominion of Canada.

"The Unspoiled Country." By Harold C. Lowrey. A descriptive article of a part of Canada which is little known to Canadians generally, Temagami.

"Petite Simunde." By Arthur Beverley Baxter. Illustrated by E. J. Dinsmore. A charming romance of the war. The author will be remembered favorably for his "Mr. Craighouse of New York, Satirist."

"The Seven Blue Doves." By W. A. Fraser. Illustrated by Charles L. Wrenn. The fifth of the Bulldog Carney series and in some respects the best. It is a mystery story.

"His Majesty's Well-Beloved." By Baroness Orczy. Illustrated by C. F. Peters. The second instalment of this splendid romantic novel of the colorful era of Charles II.

The Month's Vital Question

Turn to page 34, August MACLEAN'S, and you will find timely and interesting information regarding the High Cost of Living—a problem of large proportions.

The Review of Reviews

Here are a few of the articles chosen as the best published during the past month in all magazines:—Britain Winning Supremacy of the Air; Has Japan Two Governments?; Kaiser Employed Famous Beauties; The New Triple Alliance; Mammoth Animals in Alberta.

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2 and 3 Phase—25 Cycles.

Generator. K.W.	Volts.	R.P.M.	Engine. Cylinder Dimensions.
250	220	214	15 x 22 x 17″
350	600		
450	550	125	24 x 40 x 36″
1000	240	107	24 x 48 x 42″

2 and 3 Phase—60 Cycles.

Generator. K.W.	Volts.	R.P.M.	Engine. Cylinder Dimensions.
25	440	1200	8 x 8″
50	2200	300	11 x 19 x 11″
75	220	277	12 x 14″
100½	240	277	14 x 14″
125	220	225	14½ x 18″

Generator. K.W.	Volts.	R.P.M.	Engine. Cylinder Dimensions.
125	240	200	12 x 21″
150	220	225	10 x 20 x 18″
150	2300	225	14 x 22 x 16″
200	2300	200	
300	480	150	14 x 28 x 30″
300	2300	150	18 x 30 x 22″
325	2300	120	24 x 36″
325	2300	150	18 x 36 x 24″
400	600	150	24″
450	2300	100	22 x 42 x 48″
500	480	120	20 x 40 x 36″
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Also 30 Turbo Units of various sizes. 35 D.C. Units.

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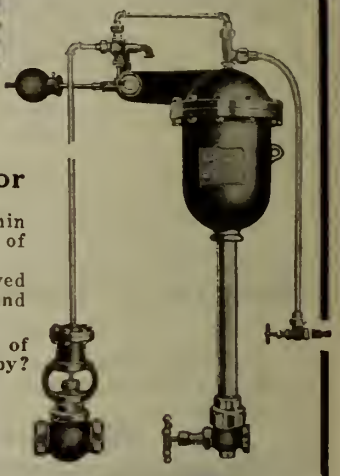

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The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.
Years of service test has proved it the utmost in reliability and efficiency.
Catalogue presents many points of interest. May we send you a copy?

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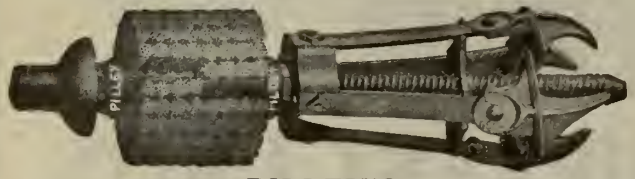
The Simplest and Best Cleaner on the market is



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Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
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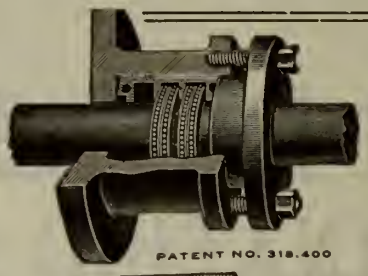

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" " 602,328
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" " 776,194
" " 791,300
" " 805,669

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HOLMES' Metallic Packing Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

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FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

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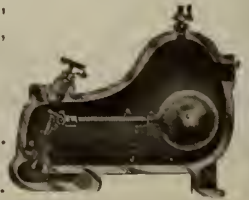

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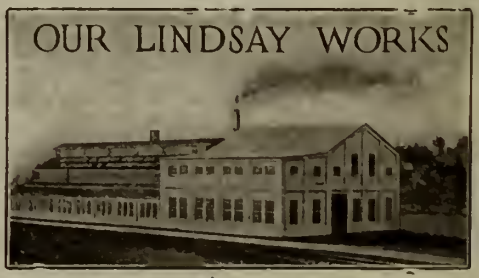

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NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

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Special Castings *Forgings*
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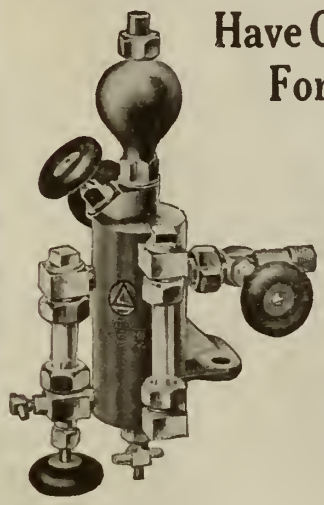


Have Given Satisfaction For Forty Years.

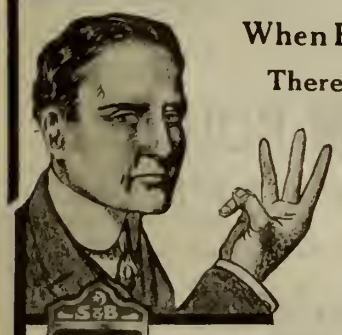
Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.



When Buying Thermometers

There's Just Three Things to Remember—

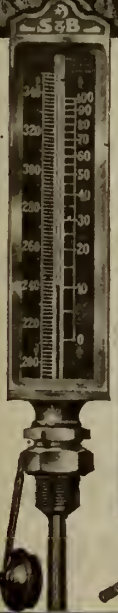
First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers



And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H.-200 to-day.

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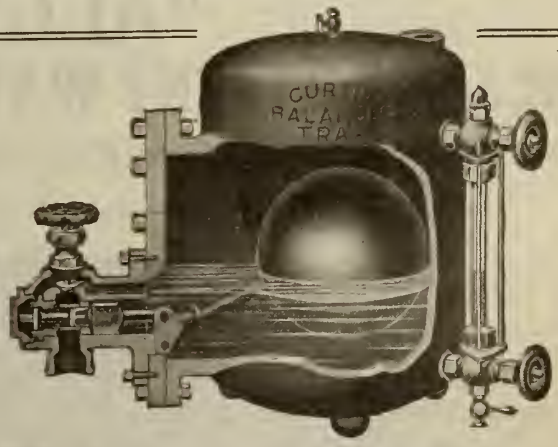
Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

CURTIS Engineering Specialties



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2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

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Diamond Soot Blowers, because efficiency of operation is the keynote of our production policies. Every piece of equipment in our boiler room was chosen on the basis of highest return on invested capital, character and scope of service considered.

"Among the specific reasons which led us to choose Diamonds are—design and constructional superiority —notable fuel and labor-saving ability—increase in overall efficiency, steaming capacity and flexibility of boiler plant."

Thus speaks the Power and Construction Engineer of one of the largest industrial plants in Canada.

If you operate a boiler plant of any size, from 100 H.P. up, and these reasons appeal to you, write for Bulletin 177.

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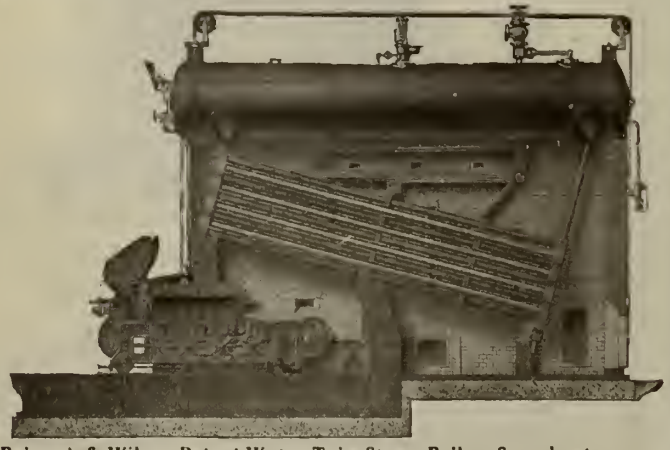
Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



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and **ELECTRIC CRANES**

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TORONTO OFFICE, TRADERS BANK BUILDING

POWER HOUSE BUYERS' DIRECTORY

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AIR COCKS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

AIR VALVES
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

ALLOYS, BRASS AND COPPER
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

AMMETERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.

AMMONIA VALVES AND FITTINGS
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa

AMMONIA TANKS
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
Canadian Fairbanks-Morse Co., Ltd. Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd. Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

ASBESTOS PACKED COCKS
Pratt & Cady Co., Inc., Hartford, Conn.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co. Montreal.

BALLCOCKS
Jas. Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto, Ont.

BEARINGS
Wilson Mfg. Co., J. C., Belleville.

BEARINGS, BRASS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.

BELT CEMENT
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
D. K. MacLaren, Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
Waterous Engine Works Co., Brantford, Ont.
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, BALATA
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

BELTING, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

BELTING, CONVEYOR
Can. Consol. Rubber Co., Ltd., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

BELTING, LEATHER
Bond Engineering Works, Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can Consol. Rubber Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.
Federal Engineering Co., Toronto, Ont.

BIBS, COMPRESSION
Empire Mfg. Co., Ltd., London, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
E. J. Philip & Sons, Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FANS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, FORCED DRAFT
Coppus Eng. & Equipt. Co., Worcester, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.

BLOWERS, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER BAFFLE WALLS
Jointless Fire Brick Co., Chicago, Ill.

BLOWERS, TURBINES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

BOILER COVERING
Beveridge Paper Co., Montreal, Que.

BOILER COMPOUNDS
Beveridge Paper Co., Montreal, Que.
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Metlskin Mfg. Co., Rochester, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

BOILER FRONTS
Victoria Foundry Co, Ltd., Ottawa.

BOILER SKIMMERS
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Coppus Eng. & Equipment Co., Worcester, Mass.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

BOILER FITTINGS
Empire Mfg. Co., Ltd., London, Ont.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mason Regulator & Engineering Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Empire Mfg. Co., Ltd., London, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.
Metlskin Co., Inc., Rochester, N.Y.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Mason Regulator & Engineering Co., Montreal.
Yarnall-Waring Co., Philadelphia, Pa.

BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates Refractories, Limited, Montreal.
Jointless Fire Brick Co., Chicago, Ill.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
MacGovern & Co., Inc., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd. Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity, T., & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BUCKETS, ELEVATOR
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CAR LOADERS AND UNLOADERS
Portable Machinery Co., Inc., Passaic, N.J.

CAST IRON FITTINGS
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

CASTINGS, ALLOY
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co, Brantford, Ont.
Wilson Mfg. Co., J. C., Belleville.

CELLAR DRAINERS
Morrison Brass Mfg. Co., James Toronto, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT HARDNER & WATERPROOFER
Beveridge Paper Co., Montreal, Que.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.

CEMENT HANDLING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.
CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd. Montreal
Canadian Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford, Ont.
CEMENT, INSULATING, REFRACTORY
Green's Economiser, Ltd., Toronto.
CHAINS, AGRICULTURAL
Morse Chain Co., Ithica, N.Y.
CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.
CHAINS, BICYCLE
Morse Chain Co., Ithica, N.Y.
CHAINS, BLOCK
Morse Chain Co., Ithica, N.Y.
CHAIN DRIVES
Can. Link-Belt Co., Toronto, Ont.
Coventry Chain Co., Coventry, England.
Jeffrey Mfg. Co., Montreal, Canada,
Morse Chain Co., Ithaca, N.Y.
CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
CHAIN, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
CHAINS, POWER TRANSMISSION
Morse Chain Co., Ithica, N.Y.
CHAINS, SILENT
Morse Chain Co., Ithica, N.Y
CHAINS, SPROCKET WHEEL
Morse Chain Co, Ithica, N.Y.
CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., N[illegible]ford, Mass
CHIMNEYS, RADIAL BRICK
Green's Economiser, Ltd., Toronto, Ont.
CHIMNEYS, STEEL
Babcock & Wilcox, Ltd. Montreal
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
CIRCULATING SYSTEMS (LUBRICATING OIL)
S. F. Bowser Co., Ltd., Toronto, Ont
CLAMPS, PIPE-JOINT
Yarnall-Waring Co., Philadelphia, Pa.
CHUTES, COAL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.
CLEANERS, BOILER TUBE
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto,
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Frank Gilman, Birmingham, Eng.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.
CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
CLOSETS
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford, Ont.
COAL
Dom. Coal Co., Montreal
COAL AND ASH CONVEYORS
Babcock & Wilcox, Ltd. Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.
COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Can. Link-Belt Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md
COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal
MacGovern & Co., Inc., Montreal, Que.
Royles, Ltd., Irlam, Manchester, England.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.
CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Roving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford
CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
CONSULTING ENGINEERS
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.
CONDUITS
Can. H. W. Johns-Manville Co., Toronto, Ont.
CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
CONDENSER AND SMOKESTACK PAINTS
Beveridge Paper Co., Montreal, Que.
CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.
CONTRACTORS' STRUCTURAL STEEL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
CONVEYOR MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
CONVEYORS, PORTABLE
Portable Machinery Co., Inc., Passaic, N.J.
CONVEYORS, BELT
Portable Machinery Co., Inc., Passaic, N.J.
COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.
COPPER TUBE
Empire Mfg. Co., Ltd., London, Ont.
CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
COTTON HOSE
Garlock Packing Co., Hamilton, Ont.
COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
COUPLINGS
Roving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.
COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.
COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.
CRANES, ALL KINDS
Canadian Allis-Chalmers, Ltd., Toronto.
Babcock & Wilcox, Ltd. Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Roving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton.
CRANES, LOCOMOTIVE
Can. Link-Belt Co., Toronto, Ont.
CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal.
Roving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.
CRANK AND CROSSHEAD PIN OILERS
Lunkenheimer Co., Cincinnati, O.
CRANK SHAFTS
J. H. Williams & Co., Brooklyn, N.Y.
CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.
CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Canada.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
CURB PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
CYLINDER OIL
E. H. Kellogg & Co. New York.
DAMPER REGULATORS
Defender Automatic Regulator Co., St. Louis, Mo.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas Morrison Brass Mfg. Co., Toronto.
DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.
DISTILLING APPARATUS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.
DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
DRAFT APPARATUS SYSTEMS, MECHANICAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
DRAFT RECORDERS
Jas W. Hays Corp., Michigan City, Ind.
Defender Automatic Regulator Co., St. Louis, Mo.
DRAFT GAUGES
Sanford Riley Stoker Co., Worcester, Mass.
Defender Antomatic Regulator Co., St. Louis, Mo.
DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithica, N.Y.
DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.
DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
DRY CLEANING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont
DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
EFFICIENCY ENGINEERING
MacKinnon, Holmes & Co., Sherbrooke, Que.
ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
EJECTORS AND SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Torooto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadiao Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.
ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
ELEVATORS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.
ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.
ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.
ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.
ENAMELWARE FITTINGS, IRON PIPE
Empire Mfg. Co., Ltd., London, Ont.
ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.
ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.
ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St Catharines, Ont
Waterous Engine Works Co., Brantford.
ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.
ENGINES, GAS AND GASOLINE
Roving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton.
ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N.Y.
ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR DRIVES
Sterling Engine Co., Buffalo, N.Y.
ENGINES, STEAM
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Those valves in that out-of-the-way corner, how quickly could you close them if necessity demanded? Would you have to hunt for a step ladder, or climb over obstructions? With a Babbitt Safety Sprocket Wheel and Guide it is as easy to close the most out-of-the-way valve as those closed by your hand. No climbing, no delay. Danger to property and workers is thus minimized.

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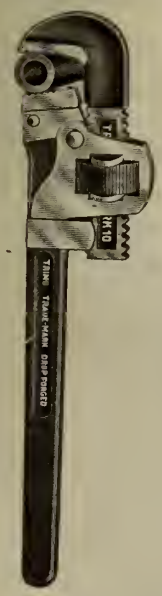
The Wrench of 25% Greater Efficiency

TRIMO PIPE WRENCH



Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

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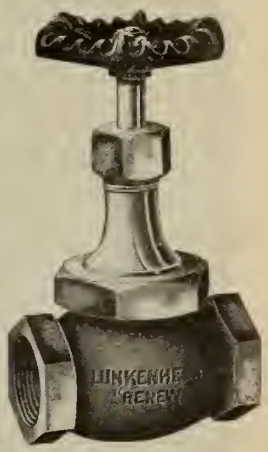

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And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

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METLSKIN is neither "Compound" nor "Cure-all."

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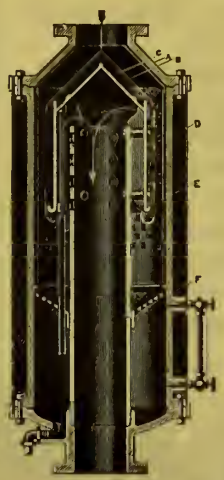
A SEPARATOR



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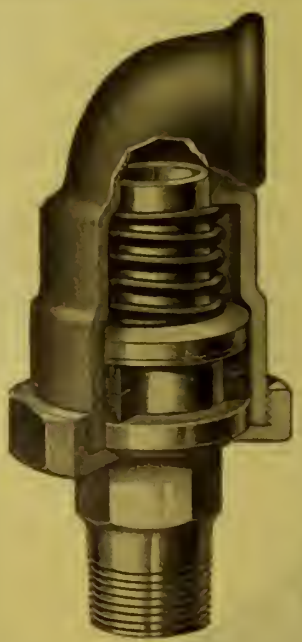

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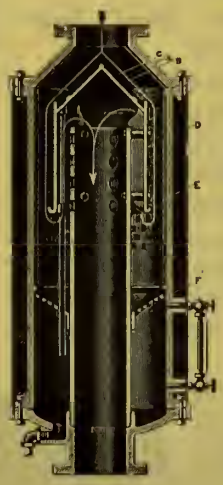

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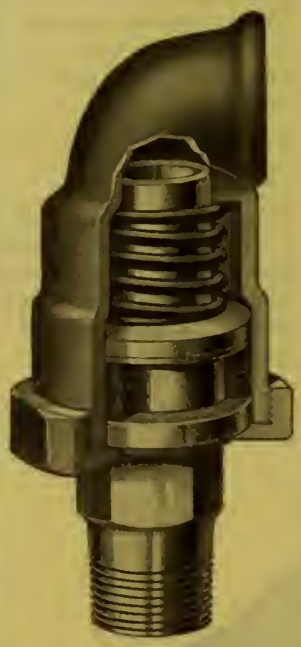

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SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

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FAIRBANKS-MORSE
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"from hook to hook a line of Steel"—provide the strongest, quickest and easiest means of hoisting, no matter what kind of plant you operate.

The parts are few and simple, they have the greatest overload capacity, the chain is tested to two and a half times its capacity, the gears centre around one main shaft.

In short, the Yale is the most practical of all hoists.

No matter what kind of loads you have to handle—no matter what difficulties there are to be overcome, the Yale meets the contingency. Before you equip your plant, or replace old equipment, investigate the Yale.

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Scale in Your Boilers

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

METLSKIN CO., Inc.

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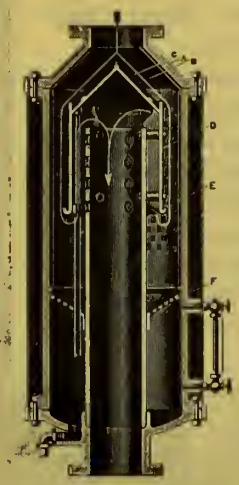
III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

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General Sales Agents:

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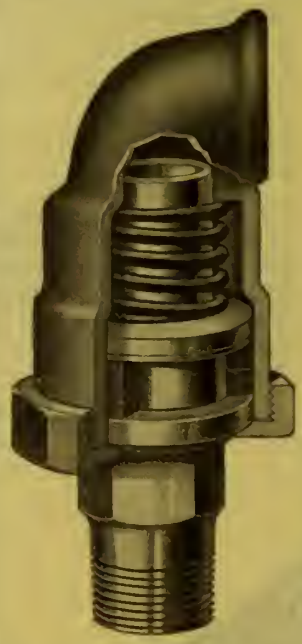

Tuxeda
SWING JOINTS

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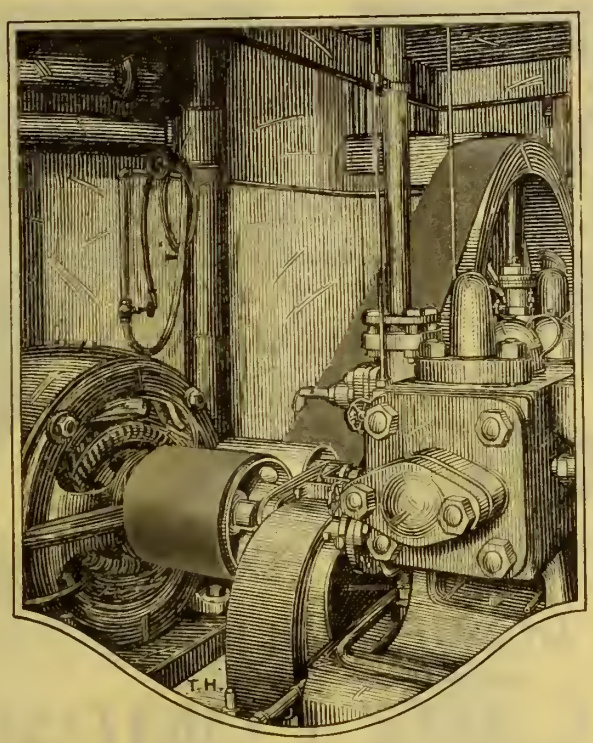
FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Do you know that the centrifugal force in belts at high speed reduces their driving power until at about 9600 R. P. M. a belt is incapable of transmitting power? All such factors are taken into account by our Engineering Department when they design standardized belt drives. Consult them about your problem.



This is a 12-inch Spartan Double Belt, operating a 50 horse-power Gas Compressor. Its cost to date is ½c per horse-power per week. When this belt had been in use 18 months, the engineer wrote us that it had given double the length of service of belts previously used. This has now been in use over four years and is still going strong.

TOP NOTCH

There is another case where top-notch efficiency and economy have been obtained by simply installing the right belt for the work to be done.

For many years Spartan Belting has been dominating the hard drives that destroy other belts. That experience ranks it as top notch in leather, in tannage and in workmanship. It is unusually pliable, wonderfully elastic, it is the greatest of pulley grippers and without an equal for high speed, overload drives or where unfavorable conditions exist.

Spartan well exemplifies the three principles back of Graton & Knight Standardized Series Leather Belt: First, they are made of the right material—leather. Second, they are tanned in our own tannery specifically for belting use, thus assuring the right kind of leather. Third, they are graded into a Standardized Series—a belt for each class of power transmission requirements—standardized in manufacture and standardized for the work to be done.

Certain articles can be tested in a short time—not so belting. It takes years to test out the correctness of principles applied in power transmission. The result of 60 years test of experience is that Graton & Knight Standardized Series Belting, the highest in grade, is also the most widely sold. That is a significant combination: highest quality—largest sale.

Many of the best belted plants ask us to specify the belting for every drive. Try the plan yourself. Then, when buying, call for "Graton & Knight—— Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for book on Standardization as applied to Belting

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STRENGTH—GOODNESS—QUALITY
WATER

Many miles of boiler feed lines carrying water at a temperature of approximately 210 deg. F. have never leaked because the flanges were packed with DURABLA gasket material. Equally satisfactory service is being given by DURABLA on lines where the temperature of the water is 40 deg. F. DURABLA does not pulp and this fact has convinced others that it is a standard for all water service.

Put DURABLA in the next water joints you make and it will prove this fact to you. It is guaranteed to make a tight joint.

DURABLA gasket material is also guaranteed for oil, air, steam, ammonia, gasoline and acids.

One Standard Material for All Gasket Work. Sold on a Service Basis.

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DURABLA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Cost of Packing a Small Valve

Do you know what constitutes the cost of packing a globe valve?

It's not the small amount of packing required, but the labor of applying it. To reduce the cost of packing the many small valves about your plant select a packing that is made of first grade materials and has the reputation of giving long, satisfactory service, and so reduce the labor cost, which is really the controlling item of expense.

If your engineer has something more important to do than packing small valves provide him with "Palmetto" twist packing.

IT MEANS REAL ECONOMY

Any size valve packed from one spool by unstranding.

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Sole Manufacturers
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Let us send you a sample spool to test for quality.

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FAIRBANKS-MORSE
EVERYTHING MECHANICAL

The Floating Head Allows for Unequal Expansion of Hot and Cold Tubes

There can't be trouble from expansion or contraction strains, because of this Alberger Multi-Head free from the cast iron shell of this

Alberger Heater

Nor can there be clogging of the tubes, for these Alberger tubes are corrugated pure copper. These corrugated tubes will remain scale-free longer than a heater with plain tubes, because the corrugations promote a scouring effect on the tubes.

Brass tubes are a source of expense, because they frequently split. But Alberger tubes are pure copper; they will neither split, bend nor buckle.

Keeps up with the heaviest hot water demands.

Because Alberger Heaters transmit 50% more heat than plain tube heaters of corresponding size. Alberger Heaters furnish hot water as fast as it can be drawn. You will use less fuel and need no storage tank with an Alberger Heater.

CATALOGUE EXPLAINS FULLY. WRITE FOR IT.

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BUFFALO, N.Y. Manufacturers of Alberger Multi-Head Heaters

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Voorhees Rub-Steel Valves

"The Valve with a backbone"

Are without an Equal for

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or Suctions on Paper Machines

Softest high-grade rubber as seating, supported by an inseparable **steel core.** Spring guides and brass bushed stud-holes as above, if desired, or plain faces.

Not a cheap valve, but positively smoothest in action and longest lasting.

This construction in Four Grades for **every** known pumping service.

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THE AMERICAN IDEAL STEAM TRAP

has an enviable record for removing condensation from steam lines.

Send for your copy of our new booklet—

"A Steam Trap Catechism with Specification Data,"

and plan to use the **American Ideal** as your standard.

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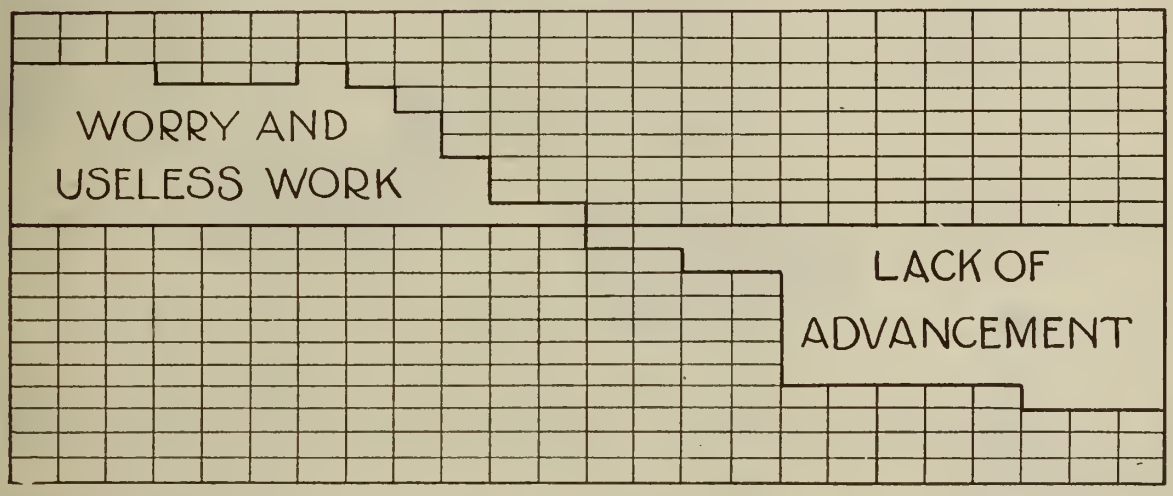
Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

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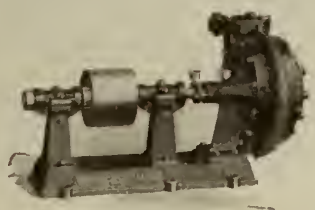
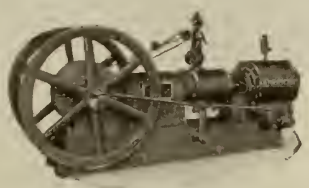
SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

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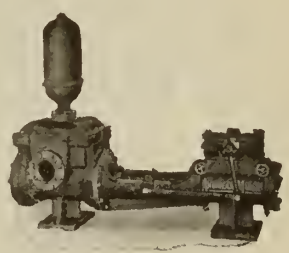
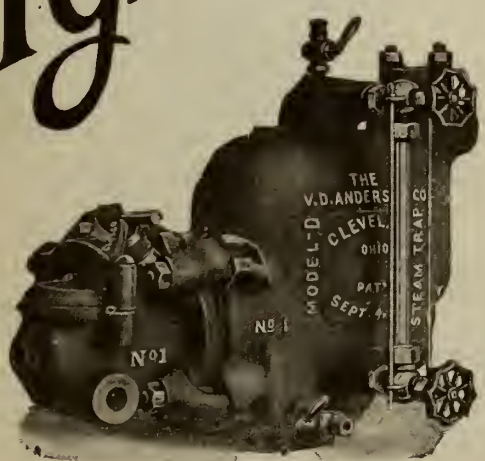


Stays Tight



The ANDERSON Model "D" Steam Trap

Just think of the satisfaction you have once this perfected trap is in your steam-room!

Tight from the day you put it in! Of that you can be sure.

It is operated by a counterbalanced Lake Superior Copper Float. Its large air valve is ever under deep water seal, and never will it wire draw.

Furthermore, every part is machined to solid gauge. Self-contained strainer and self-contained by-pass are Anderson features. Note the outside gauge glass. And the simple design! It gives you complete accessibility to every part.

Write for full particulars.

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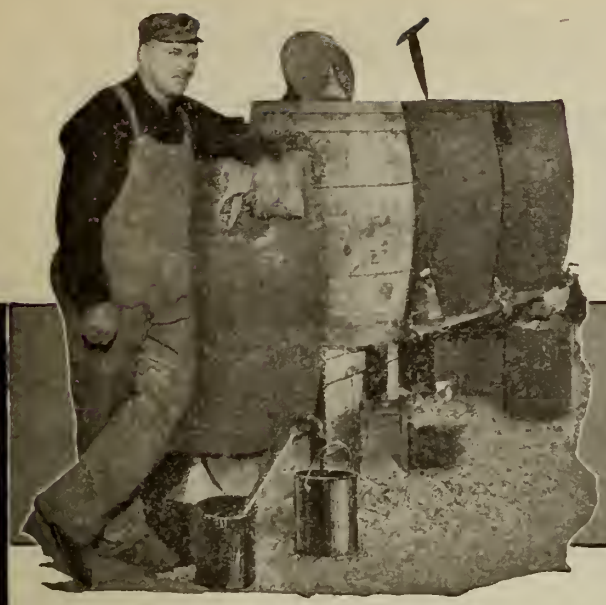

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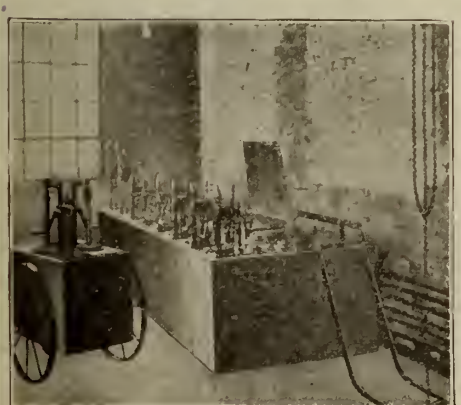
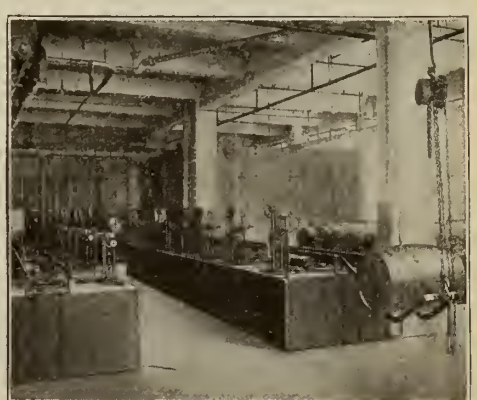


BOWSER Lubricating and Paint Oil Battery Installation with Portable Outfit for Lubricating Oil

Save the Oil



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Put your Oil storage problems up to the Bowser engineers. Let them make a survey of your plant, show you just what you may expect to save by the use of Bowser oil handling equipment. It costs you nothing and it should mean a saving for you. *Write us today for further information.*

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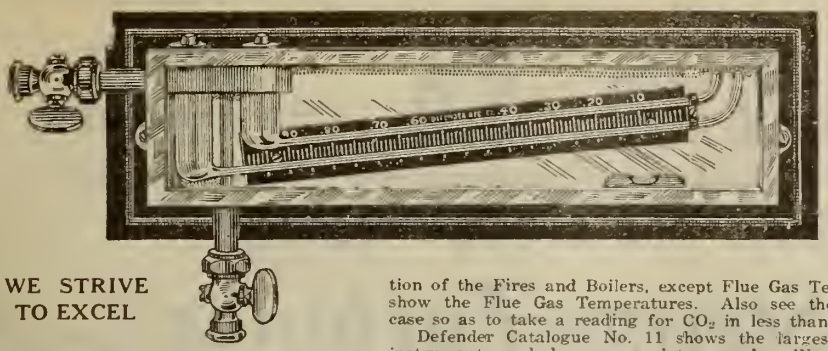

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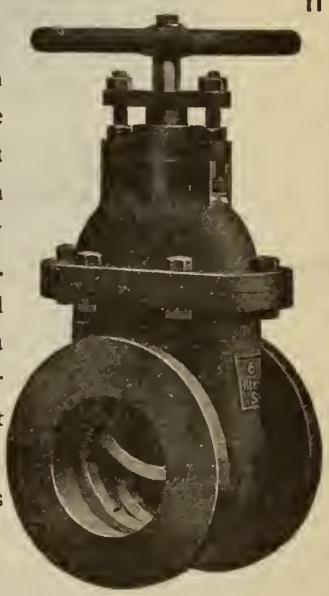

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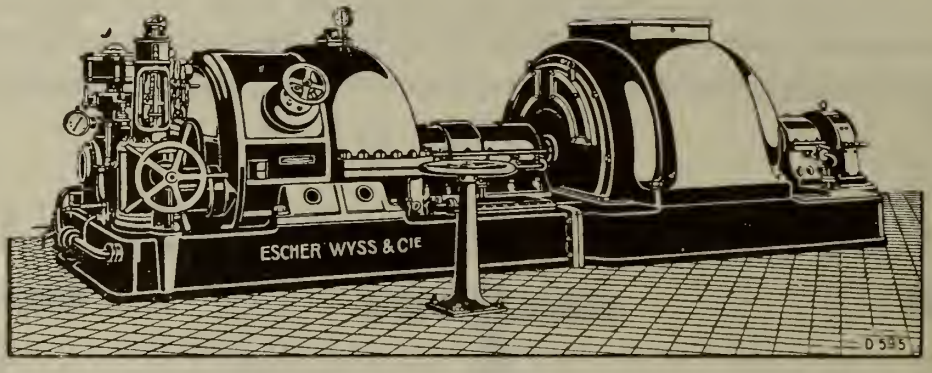

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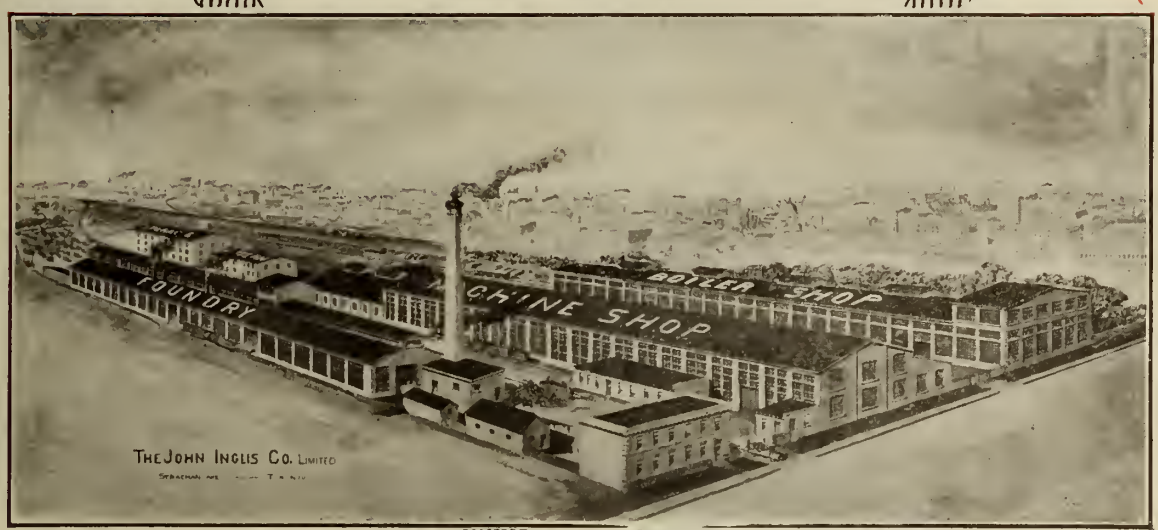

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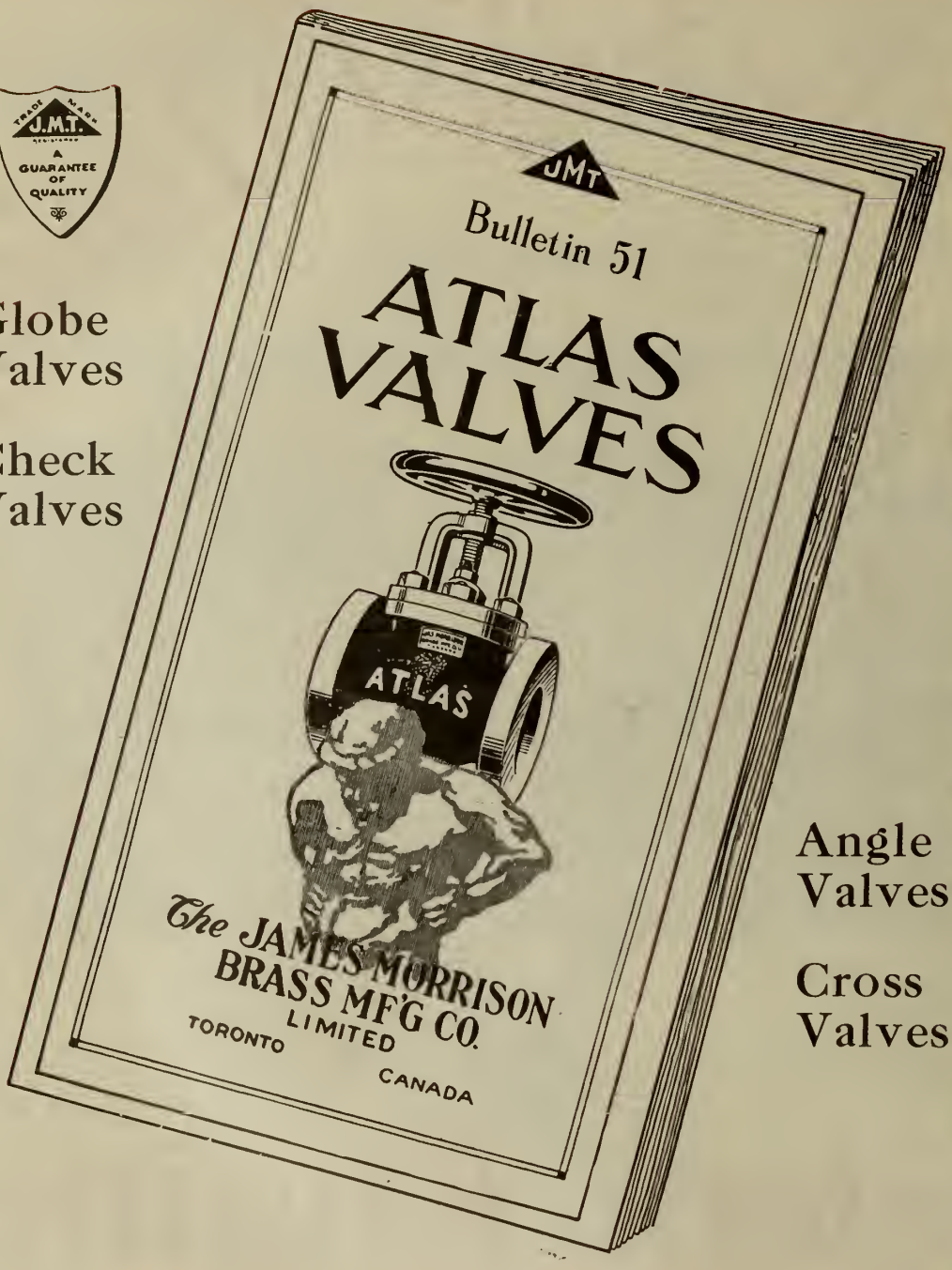

Angle Valves

Cross Valves

Flanged
Fig. 11-51

Flanged
Fig. 5-51.

Screwed
Fig. 2-51.

Screwed
Fig. 8-51.

Write For Bulletin 51

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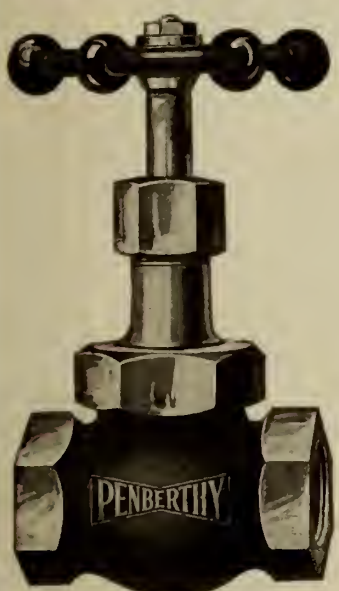

Figure 525
Exterior View

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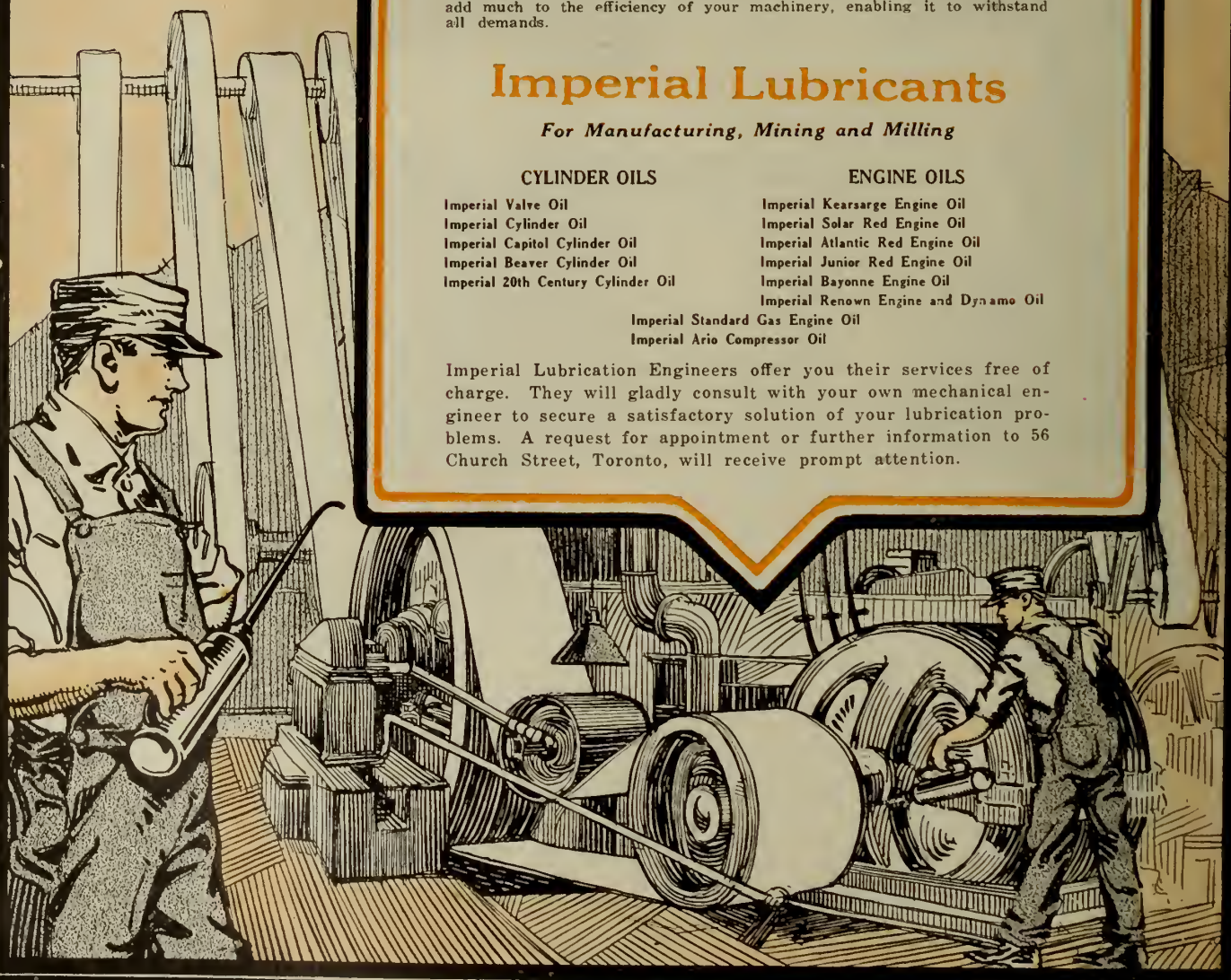

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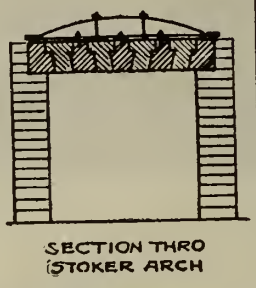

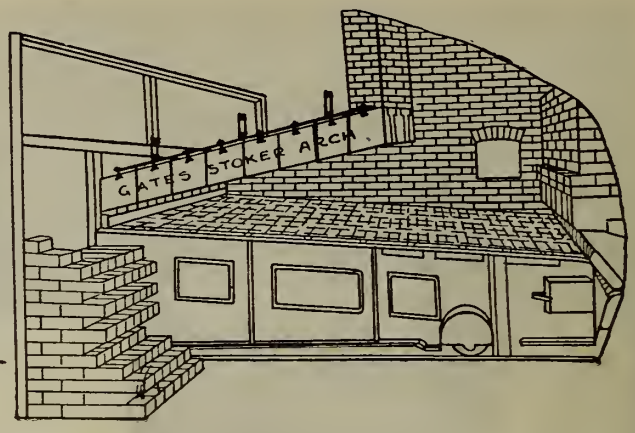

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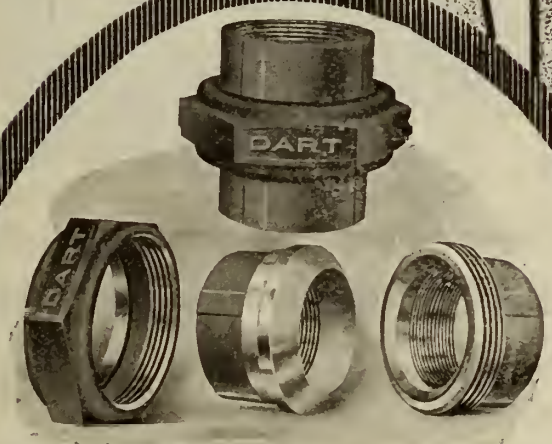

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Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)

Reduces Steam Cost

The cost of operation is cheaper than any known power product.

Require one-seventh the space of the ordinary boiler.

No brickwork is necessary.

Feed water and fuel burners are automatically controlled to adjust the boiler to varying demands for steam.

Tubes easily replaced under high steam pressure.

1-1000 H.P. Boiler in stock, immediate delivery.

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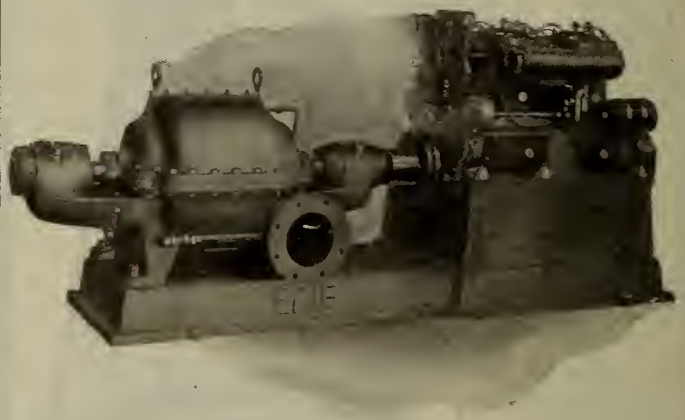
THE ENGINE of REFINEMENT

For the finest boats that float

Sterling Emergency Power

- Instantaneous, efficient, dependable, for centrifugal pump and electric generator drives. 10 to 300 Horsepower, 2, 4, 6 and 8 cylinder gasoline engines, 200 to 1400 R.P.M.



Sterling Model FS, 4 cylinder engine, 100 H.P. at 1400 R.P.M. direct connected to Erie Pump Co.'s 3-stage type M.S. centrifugal fire pump for U.S. Navy.

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Sterling Engine Company

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"The Coventry" Noiseless Chains

are the ideal form of Power Transmission for all kinds of Ventilating Machinery and Dust Extractors. They are silent and efficient in action, are unaffected by atmospheric conditions or extreme variations of temperature, and beyond being lubricated, require no attention.

A 25" Keith fan, driven by "The Coventry" Noiseless Chain Motor of 7½ h.p., running at 950 r.p.m., fan 400 r.p.m. This illustration shows how floor space is saved by using chain transmission.

"The Coventry" Chain Company, Ltd., Coventry, England

CANADIAN AGENTS--TAYLOR & ARNOLD, LIMITED, Bank of Toronto Building, MONTREAL

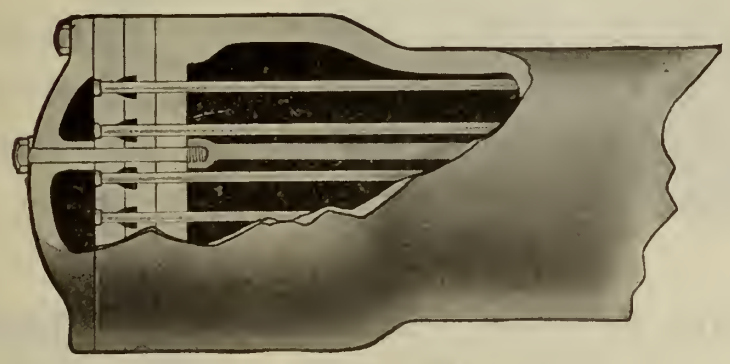
Featuring the Design of

NORWALK AIR & GAS COMPRESSORS

This announcement is one of a series featuring points of Norwalk Compressor design. It will pay you to watch for the others.

(2)

Skeleton View of Intercooler



Side View of Intercooler, Showing Arrangement of Head Plates and Water Tubes

Intercoolers are placed between the first and second and the second and third gas cylinders. In passing through the intercoolers the gas flows in thin streams between and around 5/8-inch water tubes in which cold water is circulating. It is thus effectually cooled after **each** stage of compression.

New Bulletins on Air, Oxygen, Hydrogen, Acetylene and Carbonic Acid Gas are ready.

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Many refrigerating engineers have been repaid for the confidence they placed in Durabla Gaskets by thousands of tight ammonia joints in both absorption and compression systems, regardless of the style of fitting.

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DURABLA Gasket Material is also guaranteed for air, oil, water, steam, gasoline and acids.

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Highest Grade Boilers

It is no light thing to tell you straight and definitely, over our signature, that we make Boilers of the highest grade possible and by exclusive and improved shop practice second to none. We do say so, and our records back us up.

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Engineering & Machine Works of Canada, Limited

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Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

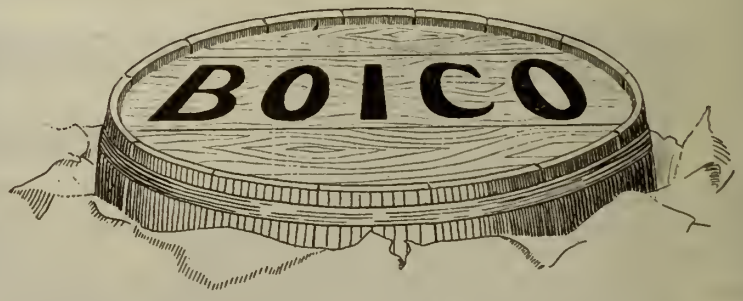
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

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Mason No. 55 Pump Pressure Regulator

Mason Standard Bronze Reducing Valve

The Age of Efficiency

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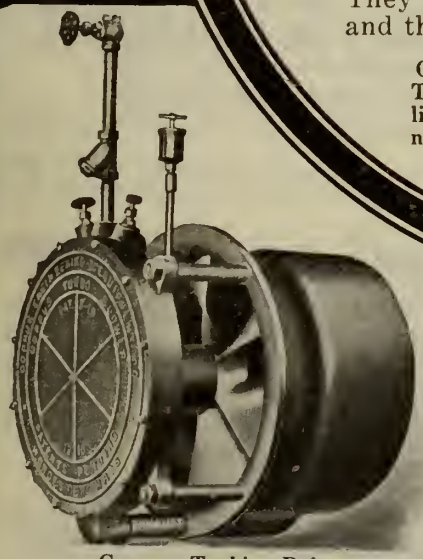
MASON

For Efficiency and Service

We are able to supply you with leading designs in Power House Specialties. We couple with this unequalled service a staff of competent engineers who help you to choose the equipment best suited to your purpose. They solve problems such as yours every day and their services are FREE.

Our salesmen, also, are practical engineers. They know the practical application of the lines they sell—they sell from knowledge, not from catalogue.



Coppus Turbine-Driven Blower

Full Details of MASON Equipment on request

The MASON Line

"Mason" Reducing Valves (genuine)
"Mason" Pump Governors.
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Bundy Steam Traps for every service.
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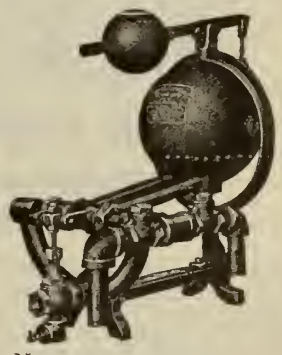

New Bundy Return Trap

Use Mason Service

The Mason Regulator & Engineering Co., Limited

Successor to H. L. PEILER & COMPANY

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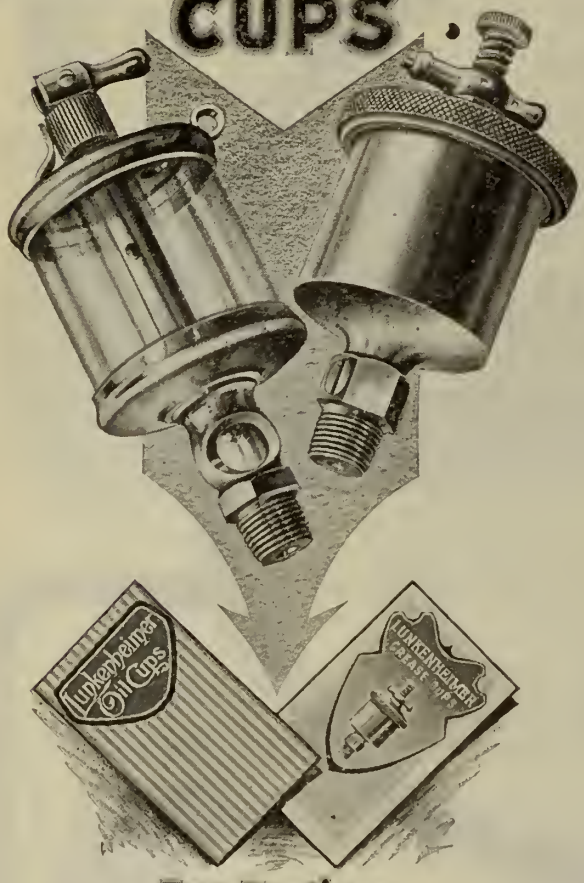
OIL AND GREASE CUPS



For Engine AND Transmission Bearings

By their unfailing reliability have won the reputation they enjoy. The engineer specifying "Lunkenheimer," knows that bearings thus equipped will get the amount of lubricant for which the feed is set—uniformly, until cups are empty, and that no further attention is necessary other than filling.

They are practical and durable; the feed regulation is simple and easily adjusted, and there is no danger of unsetting the feed when refilling.

The variety of types made embraces **Oil Cups** with Glass or Bronze Body, with or without Sightfeed; and **Grease Cups** of Bronze, Iron and Steel, with Screw or Spring Compression feed—a type for every service requirement.

Write **"Lunkenheimer—equipped"** in your engine and transmission specifications, and insist on having the genuine.

Descriptive Booklets Nos. 523 and 524-DC — will assist you in selecting the proper styles. Write for copies.

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—"QUALITY"—
Largest Manufacturers of High Grade Engineering Specialties in the World

23-12-43

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This is a 12-inch Spartan Double Belt, operating a 50 horsepower Gas Compressor. Its cost to date is ½c per horsepower per week. When this belt had been in use 18 months, the engineer wrote us that it had given double the length of service of belts previously used. This has now been in use over four years and is still going strong.

TOP NOTCH

This is another case where top-notch efficiency and economy have been obtained by simply installing the right belt for the work to be done. Spartan, the belt illustrated, well exemplifies the three principles back of Graton & Knight Standardized Series Leather Belts: First, they are made of the right material—leather. Second, they are tanned in our own tannery specifically for belting use, thus assuring the right kind of leather. Third, they are graded into a Standardized Series—a belt for each class of power transmission requirements—standardized in manufacture and standardized for the work to be done.

Write for book on Standardization as applied to Belting.

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Eight real advantages

in equipping water tube boilers, oil stills and superheaters with Key Boiler Equipment Company's

KEY SAFETY HAND-HOLE CAPS

They save time, labor, money, fuel, personal injuries, property damage, consequential loss, and add greater efficiency.

No gaskets required. Over 1,500,000 now in service. Let us send you our descriptive literature.

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Standards of accuracy

Starrett Tools

are made according to the standard set by Noah Webster in 1828, when he defined accuracy—"In exact or careful conformation to a standard of requirements, the result of care or pains; free from error, failure or defect."

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Manufacturers of Hack Saws Unexcelled

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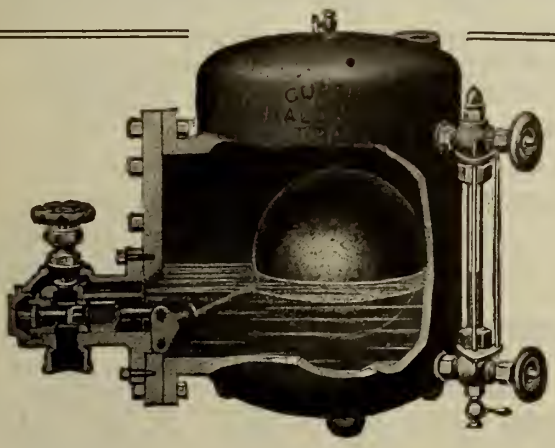
CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

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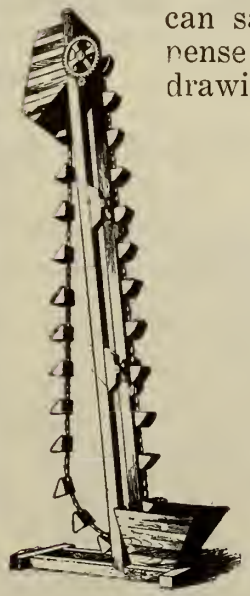
"See How Easy it is to Select the Right Elevator from this Jeffrey Catalog"

Chief Engineer:

"Here's a chance to save money on that new Elevator you need. All you need to do is to pick out the **number** of the Elevator from this Catalog and give me the **feet centers** and I'll wire **Jeffrey** for Price and Delivery. We can save the time and expense of making up new drawings and layouts."



Catalog No. 244-4 showing the advantages of using Jeffrey Standardized Elevators, should be in the hands of every Engineer, Contractor or Manufacturer. Send for copy.

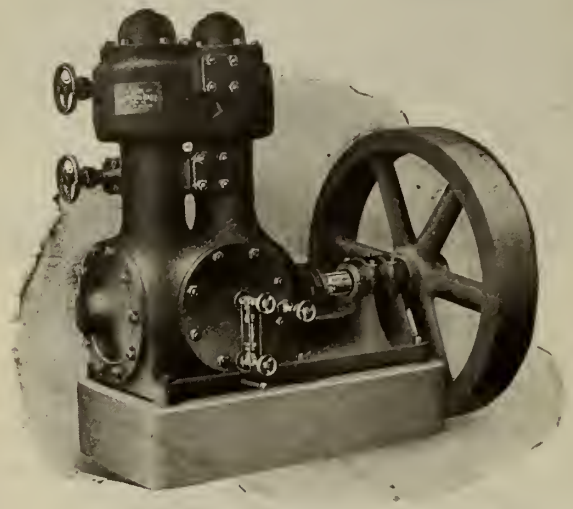
The Jeffrey Mfg. Co.

Canadian Branch and Warerooms: MONTREAL

Handle it Mechanically

MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS



"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

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(Ice-Making and Refrigerating Machinery exclusively

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"I certainly am in favor of a semi-monthly publication. In my opinion it cannot be published too often. I have been several times around the world as an engineer in the British Merchant Service and POWER HOUSE is the best paper of its class I have ever met."—Mr. Percy S. Hunter, Donavon, Sask.

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and Hundreds More Say the Same

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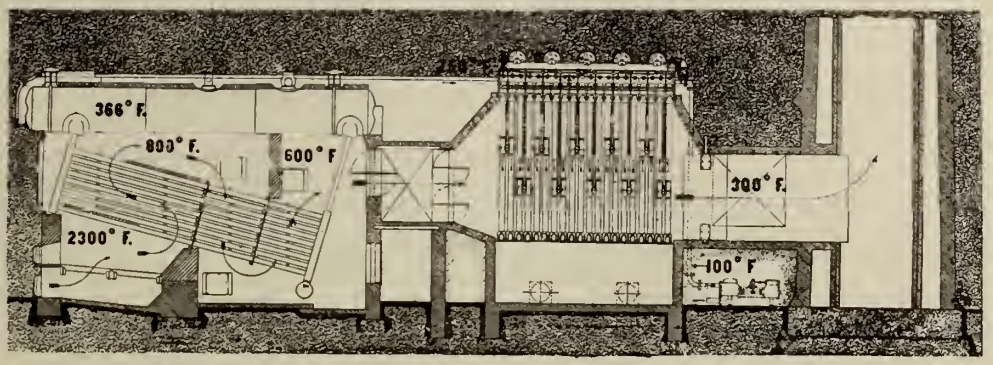
showing feed water rise of 150°F. Or a saving of 13.6%, based on 1% saving for each 11° increase in feed water temperature.



It does not pay to use extra boiler surface to cool the gases below 500° F.

Because below 500° F. the value of heat absorbed per square foot of heating surface does not equal the cost of maintenance.

It pays well to use Green's Fuel Economisers to cool the gases to as low as 250° F.

Because the heat absorbed by the boiler feed water at 100° F. is much greater than that absorbed by the steam and water at about 366° F. in the boiler. Also the economiser surface costs less to install and maintain.

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HIGHEST EFFICIENCY GUARANTEED

Instantaneous Heater, with connections for Fresh and Salt Water and Steam

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ROYLE'S Patent AUTOMATIC STEAM CONTROL ATTACHMENT maintains a CONSTANT TEMPERATURE.

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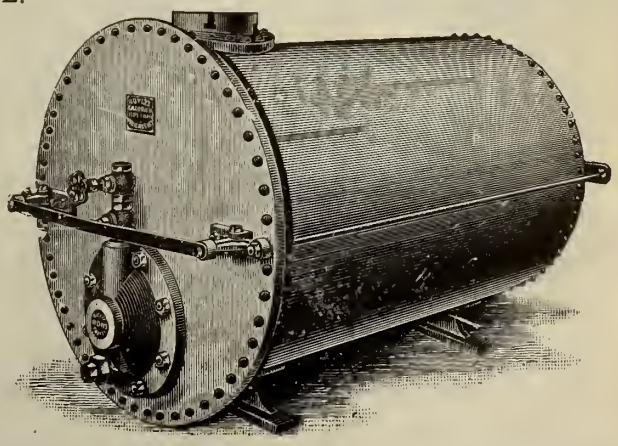

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Leading engineers and superintendents throughout the world have learned to recognize JENKINS BROS.' VALVES as the standard of valve efficiency. Scientific construction and extra good quality metal of the right kind account for the strength and rigidity of Jenkins Bros.' products.

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The steady, every day, year in and year out service of Jenkins Bros.' Valves comes from a thorough knowledge of valve requirements learned by over 50 years' practical experience and meeting them with a valve of the RIGHT construction for each specific use.

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The Diamond Trade Mark on every Genuine Jenkins Bros. Valve is our guarantee of dependability. Always look for it.

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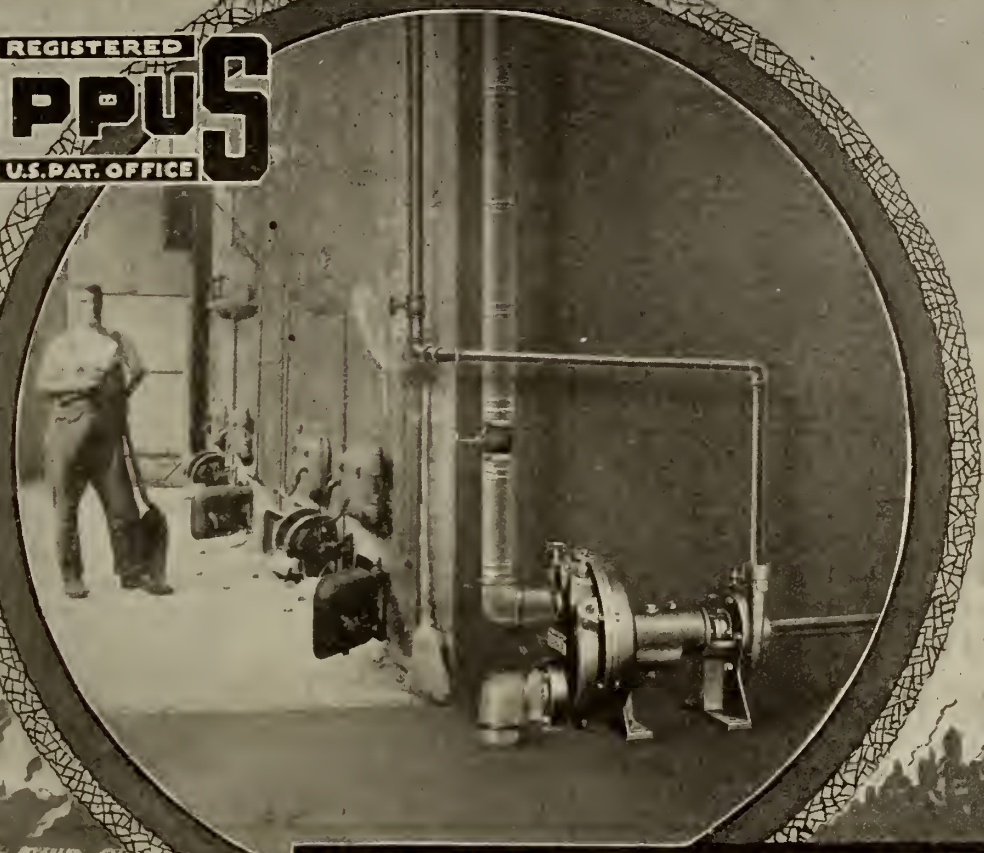
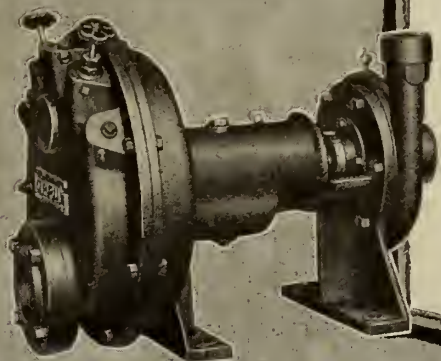


What Do You Want When You Buy A Feed Pump?

Do You Want—

low steam consumption
steady water pressure
absence of water hammer
easy regulation
great flexibility
minimum upkeep
freedom from repairs
dependable operation
behind every pump?

and—a guarantee that stands unqualifiedly. Then you want the catalog which describes the COPPUS Turbo Feed Pump — a pump which will give you all of these things. Just write for Catalog H13—we'll do the rest.



THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

Manufacturers of COPPUS Turbo Blowers and COPPUS Power Turbines
341 PARK AVENUE WORCESTER, MASS.
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THE OLD WAY.

You get steam by firing the old way, but what about the cost?

The coal and labour cost sheets show a remarkable reduction in power plants that replace the old method with

Jones Underfeed Stokers

SIMPLEST stokers built; no parts moving in contact with the fire; no grates; no losses through bars; no smoke.

A big paying investment for the large or small plant. Hundreds of them are effecting savings from 15 to 25% in plants like your own.

An investigation will prove a good thing. We'll gladly put you in touch with users.

Jones Underfeed Stoker Co. Limited

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THE JONES STOKER WAY.

ECONOMIC — Carling — BLOWERS — SUPERIOR

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

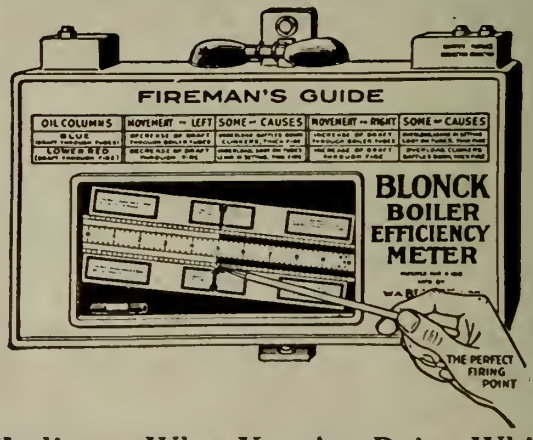
CARLING TURBINE BLOWER COMPANY

Engineers and Manufacturers WORCESTER, MASS

Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities

Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong



"Indicates What You Are Doing While You Are Doing It."

A True Guide to Coal Saving

LET US DEMONSTRATE IT TO YOU AT YOUR PLANT OR OFFICE.
IT WILL INTEREST YOU.
ALSO—STEAM METERS, GAS ANALYZERS and all BOILER ECONOMY APPARATUS.
TEMPERATURE AND PRESSURE REGULATORS.

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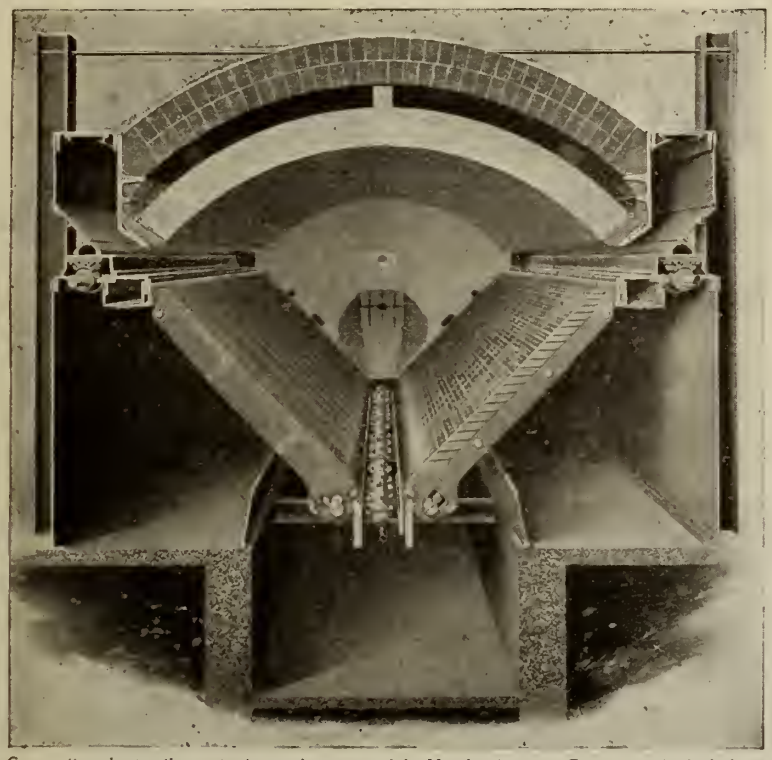

Cross section showing the construction and operation of the Murphy Automatic Furnaces. As the fuel progresses downward the alternate movement of the grates ¾" above and ¾" below the surface of the stationary grates breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder

Burns Anything

Yes! It burns successfully more different grades of coal than any other furnace ever devised.

MURPHY AUTOMATIC FURNACES

When you can't get bituminous coal you can keep the plant operating on slack—lignite—sawdust or even refuse, if the plant is equipped with Murphy Automatic Furnaces.

Why not send for catalog HM-8 and see what Murphy Furnaces are doing in plants right in your vicinity.

For information on the Riley Underfeed Stoker for large boilers see advertisement in last issue or send for catalog HR-8.

Murpy Iron Works

Detriot, Mich., U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

Dominion Belting Company, Limited
Hamilton, Canada

Sole manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.

Two Rees RoTURBo Pumps recently completed b y us for the Windsor Water Works at Windsor, Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

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Established 1907 — Published Semi-monthly

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The Father of Modern Industry and Commercial Progress

By W. F. Sutherland

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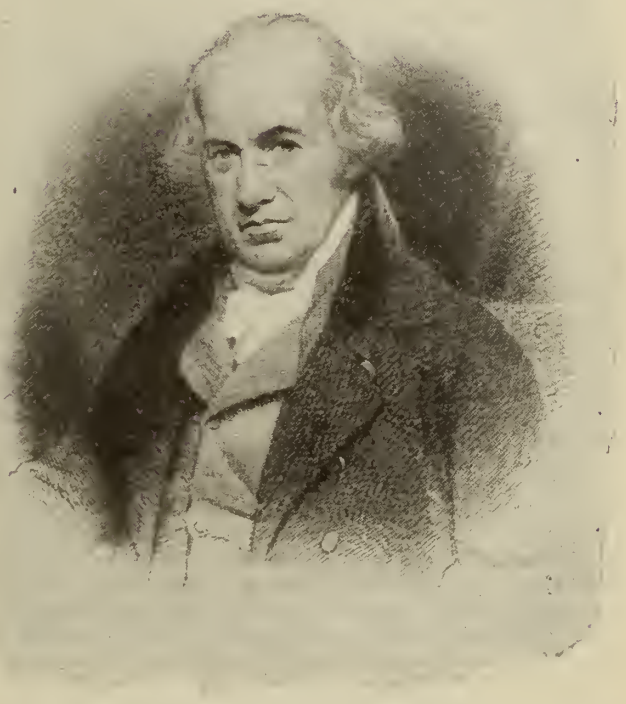
Which must endure while peaceful arts flourish,
But to show
That mankind have learned to honour those
Who best deserve their gratitude,
The King,
His ministers, and many of the nobles
And commoners of the realm,
Raised this monument to
JAMES WATT,

Who directing the force of an original genius,
Early exercised in philosophic research,
To the improvement of
The Steam-Engine,
Enlarged the resources of his country,
Increased the power of man,
And rose to an eminent place
Among the most illustrious followers of science
And the real benefactors of the world."



SUCH was the epitaph penned by Lord Brougham. Wordsworth has said that he looked upon him, considering the magnitude and universatility of his genius "as perhaps the most extraordinary man that this country (England) has ever produced." And while these eulogiums were written long before the present era of industrial activity his genius is all the more apparent in the changes it has wrought.

James Patrick Muirhead, in his "Life of James Watt," published in 1859, gives us some interesting facts relating to the family life of Watt and to his life in general. The family of Watt is first found in Aberdeenshire, and his great-grandfather, it is said, perished in one of the wars of Montrose, his property being confiscated and his orphan son later settling near Greenock. This son, Thomas Watt, was a teacher of navigation or, as he is styled, on his tombstone, a teacher of mathematics; so that James Watt's genius may find some explanation in the natural bent of his grandfather. At this date, Greenock was little more than a fishing hamlet, and Thomas Watt was so important in the affairs of the small community that he was made its chief magistrate, an elder of the parish as well as treasurer and clerk to the Kirk session. In these capacities he repaired the church, widened the bridge, and adjusted the weights and measures of the burgh by his standards. He imposed fines for the pranks of the roysterers on Hallowe'en night, regulated the keeping of "taim foules" and their scratching in gardens, discouraged the "sitting in and haunting of taverns on Friday and Saturday night," and also the "guilt of skippers" in "loosing their ships and taking them to seaward on the Sabbath day." The great feat of his administrative reign was his supposed discrimination in dealing with the complicated pretensions of a certain mountebank medicine vendor. To this worthy he forbade the attraction of "saltatory lassies and their demonstrative rope dancing" while he allowed him to expose his wares for sale.

Thomas Watt died in 1734, at about the age of ninety-five, leaving two sons, John and James, the latter being the father of James Watt. James Watt, the father, was a ship-chandler (supplying vessels with nautical apparatus, stores, and instruments), a builder and a merchant. He married Agnes Muirhead, herself a woman of exceptional attainments and striking qualities of her own. She had other children of whom three died in infancy or early childhood and one of whom was drowned at sea.

James Watt, the son, was born on the 19th day of January, 1736. His constitution was delicate and his mental powers precocious. There is a story of his having been observed, as a child of six years old, drawing mathematical lines and circles on the hearthstone. The famous story of his studying the condensation of steam while he was playing with the maternal tea-kettle, and while yet a boy will also be brought to mind and whether it be authentic or not it has been made the subject of a pretty picture and will ever remain a basis for speculation and inspiration.

During his early years Watt was sent to a commercial school where he was provided with a fair knowledge of Latin and some small smattering of Greek. But mathematics were his favorite study and "while under his

father's roof he went on with various chemical experiments, repeating them again and again, until satisfied with their accuracy. He even made himself a small electrical machine about 1750-53—no mean performance at that date.

From the aptitude which he displayed for all kinds of ingenious handiwork, and in accordance with his own deliberate choice it was decided that he should qualify himself for the trade of mathematical instrument maker and accordingly he proceeded to Glasgow in June, 1854, and a year later to London, where his education in things mechanical really commenced under the tuition of John Morgan, an instrument maker in Finch Lane. Cornhill. Here he gradually became profficient in making quadrants, parellel rulers, compasses, theodolites, etc., and on leaving London in 1756 was possessed of a considerable fund of knowledge.

Settling in Glasgow he was first employed in cleaning and repairing some of the instruments belonging to the College Museum and, restricted by municipal regulations from the uncharted pursuit of his trade or craft, was supported by the University. By midsummer, 1757, he had received permission to occupy an apartment and to open a shop within the precincts of the college, and to use the designation of "mathematical instrument maker to the University."

Among other developments of his skill, he undertook to construct an organ, studying for the purpose the whole theory of harmonies. "Fiddles also did he make, and if entreated mend."

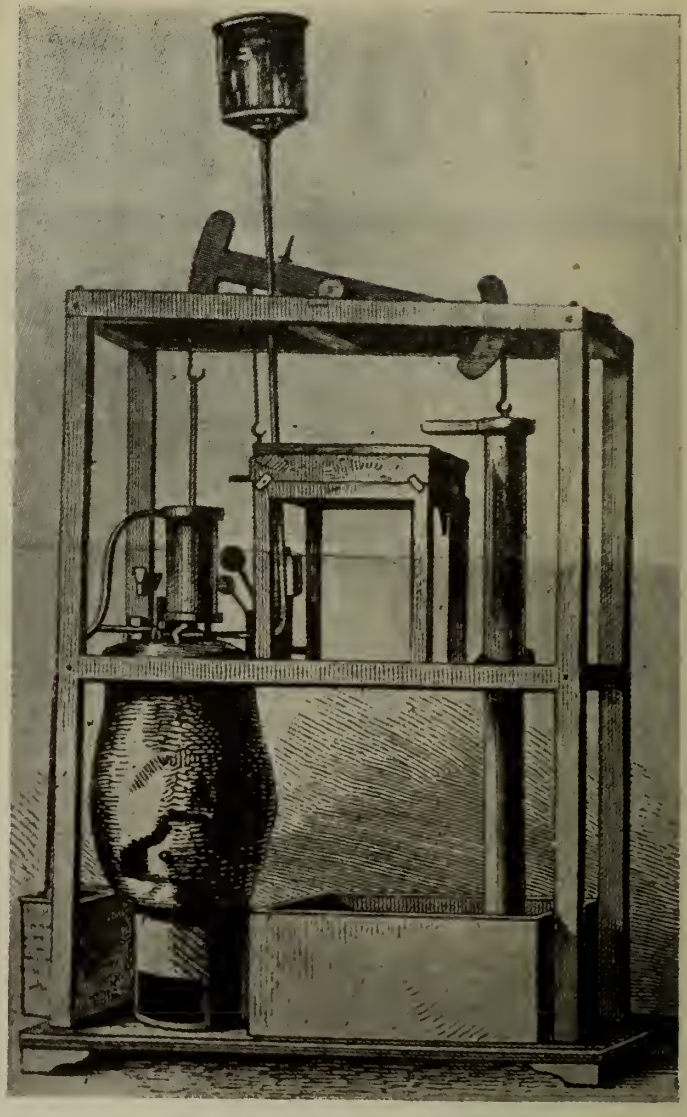
In 1763 he quitted his college rooms for a small abode in the city in contemplation of his marriage with his cousin, Miss Miller, to whom he had been long attached and with whom he was united in the July of the following year.

Watt's devotion to philosophical pursuits procured for him about this time the notice and friendship of Dr. Black, Professor of Anatomy, and afterwards of Medicine, in Glasgow College. In 1758 he also made the acquaintance of another university worthy, John Robinson; and both these learned persons have left interesting narratives concerning him. The latter tells of his introduction to Watt. "I saw a workman," says he, "and expected no more, but was surprised to find a philosopher as young as myself and always ready to instruct me." Watt's parlor had at this date become a rendezvous for all the loitering persons scientifically inclined. "Whenever," says Robinson, "any puzzle came in the way of any of us we went to Mr. Watt. He needed only to be prompted; everything became to him only a new and interesting study; and we knew he would not quit it until he had discovered its insignificance or had made something out of it. No matter in what line—language, antiquity, natural history, nay poetry criticism and works of taste; as to anything in the line of engineering, whether civil or military, he was at home and a ready instructor."

Watt's greatest contribution to the welfare of man came about while repairing a model of Newcomen's steam engine at the request of the Professor of Natural Philosophy in the University. This model was at first a plaything to Watt and Robinson, then a constant visitor at his workshop; but like everything which came into his hands, it soon became an object of most serious study.

The engine with which Watt became interested wasted about three-fourths of the steam through condensation on the up-stroke, owing to the cooling effect of the walls and piston from the injection of water on the previous down stroke for condensation. Robinson, in his record of this discovery, says:

"At the breaking up of the College (in 1765) I went to the country. About a fortnight after this I came to town and went to have a chat with Mr. Watt and to communicate to him some observations I had made on Desagulier's and Belidor's account of the steam engine. I came into Watt's parlor without ceremony and found him sitting before the fire, having lying on his knee a little tin cistern which he was looking at. I entered into conversation on what we were last speaking of—



NEWCOMEN ENGINE MODEL REPAIRED BY WATT.
—The "National Engineer."

something about steam. All the while Mr. Watt kept looking at the fire and laid down the cistern at the foot of his chair. At last he looked at me, and said briskly, 'You need not fash yourself any more about that, man; I have now made an engine that shall not waste a particle of steam. It shall be boiling hot—aye, and hot water injected, if you please.' So saying, Mr. Watt looked with complacency at the little thing at his feet, and seeing that I observed him, he shoved it away under a table with his foot. I put a question to him about the nature of his contrivance. He answered me rather drily. I did not press him further for an explanation at that time, knowing that I had offended him a few days before by blabbing a pretty contrivance which he had hit on for turning the cocks of an engine. I had mentioned this in the presence of an engine-builder who was going to erect one for a friend of mine, and this having come to Mr. Watt's ears, he had found fault with it."

"I was very anxious, however, to learn what Mr. Watt had contrived but was obliged to go to the country in the evening. A gentleman who was going to the same house said he would give me a place in his carriage, and desired me to wait for him on the walk by the riverside. I went thither and found Mr. Alexander Brown, a very intimate acquaintance of Mr. Watt's, walking with another gentleman (Mr. Craig, architect). Mr. Brown immediately accosted me with, 'Well, have you seen Jamie Watt?' "Yes." 'He'll be in high spirits

with his engine, isn't he?' "Yes," said I, "very fine spirits." 'Gad!' says Mr. Brown, 'the condenser's the thing; keep it but cold enough, and you may have a perfect vacuum whatever be the heat of the cylinder.' The instant he said this the whole thing flashed on my mind at once. I did all I could to encourage the conversation, but was much embarrassed. I durst not appear ignorant of the apparatus lest Mr. Brown should find that he had communicated more than he ought to have done."

In the summer of 1767 the whole contrivance was perfect in Watt's mind and so well defined there was the date of his invention, that on being asked in 1817 whether he recollected how the first idea came to him he replied, "Oh, yes, perfectly. One Sunday afternoon I had gone to take a walk in the Green of Glasgow, and when about half way between the Herd's house and Arn's well, my thoughts having been naturally turned to the experiments I had been engaged in for saving heat in the cylinder, at that part of the road it occurred to me that as steam was an elastic vapor, it would expand and rush into a previously exhausted space; and that if I were to produce a vacuum in a separate vessel, and open a communication between the steam in the cylinder and the exhausted vessel such would be the consequence."

To further his object of keeping the cylinder as hot as the steam that entered it, Watt supplemented his great invention of the separate condenser by several less notable but still important improvements. In Newcomen's engine a layer of water over the piston had been used to keep it steam tight; Watt substituted a tighter packing lubricated with oil. In Newcomen's engine the upper end of the cylinder was open to the air; Watt covered it in, leading the piston rod through a steam-tight stuffing box in the cover, and allowed steam instead of air to press on the top of the piston. In Newcomen's engine the cylinder had no clothing to reduce the loss of heat by radiation and conduction from its outer surface; Watt not only cased it in non-conducting coverings such as wood, but introduced the steam jacket.

All of these features were specified in his first patent which, however, was not obtained till January, 1769, nearly four years after the inventions it covered had been made. In the interval Watt had been striving to demonstrate the merits of his engine by trial on a large scale. His earliest experiments left him in debt and, finding that his own means were quite insufficient to allow him to continue them, he agreed that Dr. John Roebuck, founder of the Carron ironworks, should take two-thirds of the profits of the invention in consideration for his bearing the cost. An engine was then erected at Kinneil where Roebuck lived, giving Watt an opportunity of facing many difficulties in construction. But the experiments made slow progress, for Roebuck's affairs became embarrassed and Watt's attention was drawn to other more remunerative work by his own pressing needs and those of his family. He had taken to surveying and gained considerable reputation as a civil engineer. In 1767 he was employed to make a survey for a Forth and Clyde canal—a scheme which failed to secure Parliamentary sanction. This was followed by other surveys for canals and plans for harbors, etc. In the course of his work he invented the micrometer for measuring distances, consisting of a pair of horizontal hairs placed in the focus of a telescope through which sights were taken to fixed and movable targets on a rod at the place whose distance from the rod was to be determined.

Meanwhile progress had been made on the steam engine, the Kinneil trials had yielded him a store of valuable experience. Roebuck had failed, but another partner had been found in Matthew Boulton, a man of energy and capital, who owned the Soho engineering works at Birmingham.

Watt's arrangements were facilitated by the concurrence of Dr. Roebuck's creditors, because curiously enough, none of them valued his engine at a farthing; and for him, as for so many other men, success seemed to dawn at the moment when he was ready to despair of its possibility. For many years previously he had complained of his headaches and of almost constant ill-health; of what he called laziness, stupefaction, and confusion of ideas, which partially meant the mental weariness of unrecompensed toil.

Yet while in 1774 at his abode in Birmingham he was able to write to his father that "the fire-engine that I have invented is now going and answers much better than any other that has yet been made; and I expect that the invention will be very beneficial to me." A long series of trials was nevertheless necessary before the engine could be brought to the stage where it would be generally available to the public and profitable to the manufacturers.

In January, 1775, six years of the patent had elapsed and there seemed some probability of the remaining eight running out as fruitlessly. An application which was made for the extension of its term was unexpectedly opposed by the eloquence of Burke, but the orator and his associates failed, and the extension was accorded by act of Parliament. Such, however, was the low state of engineering arts that much difficulty was encountered in getting the parts of the engines fabricated with the necessary accuracy. At this turning point in his life Watt married again and narrowly escaped expatriation through an offer of employment from the Russian Government.

The first practical employment of Watt's engines to any considerable extent was in the mining districts of Cornwall, where he was himself in consequence, forced to spend much of his time. He had to contend not only with the natural obstacles in the dark abysses of deeply-flooded mines, but with a rude and obstinate class of men as deeply flooded by inveterate prejudices. After he had "forked" the heaviest waters in the whole county to his previous efforts was added the more odious task of having to observe and restrain the piracies which began to occur, at first secretly, but afterwards with greater frequency and daring. Speaking of Cornwall, he says: "Those wilds might be defined as a tract of hills without dales where the roads went straight up the hills without flinching and where (plumbing misery to its depths) the engine men actually eat the grease from the engine."

For some time royalties came in but sparingly to Watt and Boulton, but during this expectant stage Watt himself was more fertile in mechanical inventions than in any other portion of his busy life. Taking his patents in order the first subsequent to that of 1769 was for a new method of copying letters and other writings expeditiously, by means of copying presses. Of the same same date as his copying machine, was his invention of another machine "for drying linen and muslin by steam." On the 25th of October, 1781, he took out his third patent (the second of the steam engine series) "for certain new methods of applying the vibrating or reciprocating motion of steam or fire engines to produce a continued or rotative motion around an axis or centre and thereby give motion to the wheels of mills or other machines." One of these methods was that commonly known as the "sun and planet wheels." Later on he took out another, fourth, patent on the double-acting engine in consequence of his finding himself beset by a host of plagiaries and pirates.

Another patent in the steam engine series, taken out in 1784, contained besides methods of converting a circular or angular motion into a perpendicular or rectilinear motion the well-known and much-admired parallel motion of which Watt says, in a letter to Boulton, "I have started a new hare. I have got a glimpse of a method of causing a piston rod to move up and down perpendicularly by only fixing it to a piece of iron upon the beam, without chains or perpendicular guides or untowardly frictions, arch heads or other pieces of clumsiness. I think it a probable thing to succeed and one of the most ingenious pieces of mechanism I have contrived."

A still later invention was the throttle valve and centrifugal governor by which the speed of rotative engines was automatically controlled. One more item in the list of Watt's contributions to the development of the steam engine is too important to pass without men-

tion; the indicator was used by Boulton and Watt to measure the work done by their engines and so to give a basis on which the charges levied on their customers were adjusted.

Up to Watt's time, steam had been admitted for the whole length of the stroke and he was the first to conceive of the possibility of working it expansively, cutting off before the end of the stroke and so effecting a further economy in steam.

While Watt was thus busy with his steam engine and with other matters of a strictly engineering nature yet he found time for more philosophical pursuits and ventured into the realm of chemistry and physics. One of the matters which occupied his attention was that of the composition of water, and while engaged on this last he had opportunities of familiar intercourse not only with Priestly but with Withering, Keir, Edgeworth, Galton, Darwin, and with his own partner, Boulton, all men above the average for their common interest in scientific inquiries. These gentlemen met at each other's houses at stated intervals, and constituted a philosophic nucleus known as the "Lunar Society," because the time of their meeting was arranged to correspond to the full moon; and this designation earned for them the name of "Lunatics" from an unappreciative butler who had in his turn charge of their creature comforts.

In 1786 Watt and Boulton visited Paris in connection with the installation of some engines and both had a flattering reception in the French capital. Watt describes himself as having been greatly fêted—as having in fact been "drunk from morning to night with Burgundy and undeserved praise."

Returning to England his attention was turned to the defense of his patents now assailed by numerous rivals. Some of the competing engines, as Watt himself describes them, were simply asthmatic "Hornblowers at Radstoke, was obliged to stand still once every ten minutes to snore and snort." "Some were like Evan's mill, which was a gentlemanly mill; it would go when it had nothing to do but it refused to work. After a long and costly litigation the validity of the patents was sustained and he ever afterwards referred to his specifications as "his old and well-tried friends."

With the year 1800 came the expiration of the patent of 1769 as extended by the statute of 1775; and also the dissolution of the original partnership of Boulton and Watt, then of twenty-five years' duration. The contract was renewed in the persons of their sons on whom the business fell.

By this time the business had become so profitable that Watt and his children were provided with a source of independent income, and at the age of 64 the inventor could contemplate the future with a considerable degree of equanimity. Watt himself became stronger, and less oppressed by his bodily infirmities. His spirits became more equable as time went on and his intolerable headaches became fewer.

While resting in his latter days from the severer labors of former years his mind was still occupied with creative work and dwelt on the possibilities of adapting the steam engine to navigation. He lived to know that a steamboat had been used in America, that the British Channel and the Rhine navigated by another; both vessels, the American and British, having been impelled by engines manufactured at Soho. He also made a voyage from Greenock to Rothesay and back again in a steamboat.

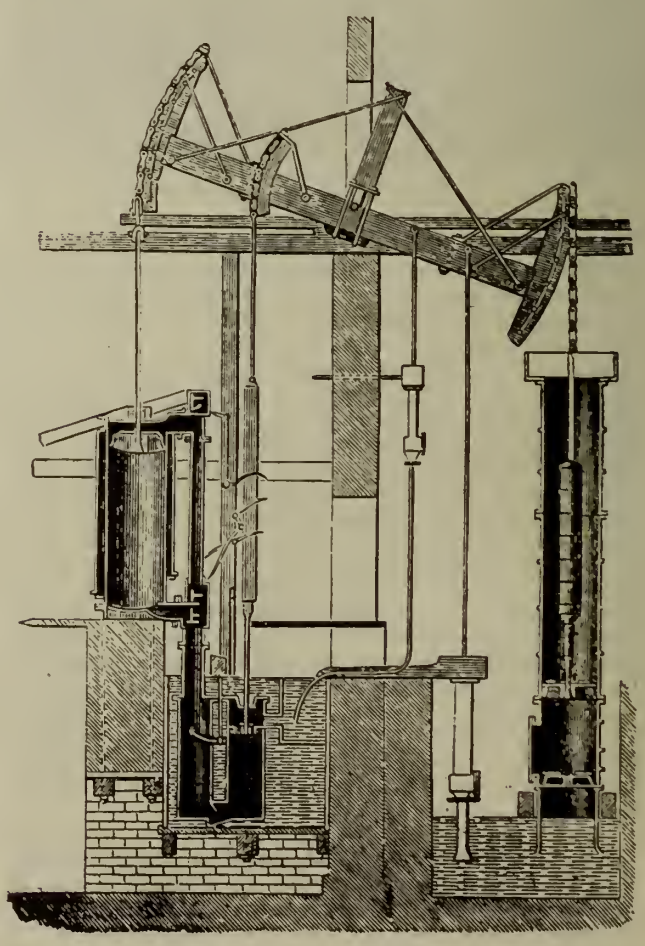
The locomotive, however, was left to a later genius, George Stephenson, for its complete development.

"Some of his idle thoughts" were also turned towards the construction of an arithmetical machine, but he does not appear to have prosecuted his design beyond considering the manner in which he could make it perform multiplication and division. Another of his contrivances, happy in its conception and less difficult of completion, belongs to the 19th century. He was consulted by the proprietors of the Glasgow waterworks as to how they should lay pipes to bring pure spring water across the river Clyde to the company's engines at Dalmarnock; and he devised for this purpose an articulated suction pipe, with joints formed so as to be capable of accommodation to the bottom of the river.

One engrossing occupation, nearly akin to those of his better days, was found in the perfecting of a machine to copy sculpture. The idea of this machine was suggested to him by an implement he had seen in Paris in 1802 where it had been used for tracing and multiplying the dies for medals. The new machine was to do for solid masses and in hard materials what his copying machine had already done for drawings and writings. He himself worked at the machine, set up in the garret of his house assiduously and some of the sculpture still exists. So interested in this work did he become that it is said by one of his biographers that "He even had a touch at the work on Sunday.

Watt was also a great novel-reader, was fond of his garden, fond, too, of a pinch of snuff, but a sufferer from the assiduous proscription of the snuff box by his wife. The second Mrs. Watt was a domestic tyrant to say the least. "On his evenings at home, at a certain hour fixed by Mrs. Watt the door of the dining-room opened, an old servant appeared, and altogether disregarding the greater presence in which he stood, with a few active evolutions swept out at once the fire, the lights and—his master. "And so to bed."

Various persons of note who came into contact with him in the height of his fame and during the closing years of his life have borne witness to the charms of his presence. "His friends," says Lord Jeffrey, speaking of a visit which he paid to Scotland when upwards of eighty, "in that part of the country never saw him more full of intellectual vigor and colloquial animation, never more delightful or more instructing." It was then, also, that Sir Walter Scott, meeting him, "surrounded by a little band of Northern literati," saw and heard "the alert, kind, benevolent old man, his talents and fancy overflowing



WATT'S SINGLE-ACTING PUMPING-ENGINE FOR MINES.

on every subject, with his attention alive to everyone's question, his information at everyone's command."

Campbell, the poet, who saw him later in the beginning of 1819 (he was then 83) describes him as so full of anecdote, that he spent one of the most amusing days with him he ever had. In the autumn of the same year, on the 19th of August, James Watt expired gently and tranquilly at his house at Heathfield. He was buried at Handsworth, and honored afterwards by a public monument in Westminster Abbey.

Boiler Water Treatment

IF you cover a steam pipe with asbestos, magnesia, or other heat-insulating material, you keep the heat in the steam; if you line or coat a boiler tube with scale or other heat-insulating material, you keep the heat out of the boiler water and send it to the stack. By lagging your pipes you save fuel easily. By lining your tubes with scale you waste it continuously and needlessly.

All natural waters contain more or less of this heat-insulating material, partly as suspended matter (such as clay, fine sand, insoluble forms of iron, aluminium, etc.), partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium and other mineral salts.

Much of the suspended matter, as well as most of the dissolved matter, may form scale, but the suspended matter may generally be removed by filtration, which will be discussed later.

Dissolved Matter Which Forms Scale

Of the material commonly in solution in boiler waters, the bicarbonates and sulphates of calcium and magnesium are the most important scale formers. Natural waters containing in solution bicarbonate of calcium or magnesium or both exhibit what is called "temporary" or "carbonate" hardness; those containing dissolved calcium or magnesium sulphate or both possess "permanent" or "sulphate" hardness. In the case of the sulphate scale the temperature required to separate it is too high to make its removal by heating alone a practical means of treatment. In the case of water exhibiting carbonate or temporary hardness, great improvement in its properties may be effected by the use of open heaters of the exhaust steam type. As a rule sulphate scale is denser in structure with a higher heat-insulating value than carbonate scale, but the conditions of formation affect this considerably. Where a porous structure permits water to penetrate the scale its heat-insulating effect is greatly reduced.

The Effect of Scale

In many respects the effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is very similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the water tube, the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water. So in the case of a boiler tube covered with a dense scale, the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the "heat pressure," so to speak—that is, to burn more fuel.

Heat Loss.—The most important effect of scale is due to the fact that in certain forms it is a wonderful heat insulator. Its chemical composition seems to have little to do with its heat-insulating power, the big question being the density or mechanical structure of the scale. A series of experiments by Prof. Schmidt, of the University of Illinois, gave the following results, showing decrease in heat-transfer efficiency of tubes coated with scale of different thickness and composition (see table top of next column).

Character of scale	Thickness Inch	Composition.	Loss of efficiency Per-cent.
Hard	1/50	Mostly carbonate	9
Soft	1/32	Ditto	7
Hard	1/32	Ditto	8
Soft	1/25	Ditto	8
Hard	1/25	Mostly Sulphate	9
Hard	1/20	Ditto	11
Soft	1/16	Ditto	10
Soft	1/16	Mostly carbonate	11
Soft	1/16	Ditto	12
Hard	1/16	Ditto	12
Soft	1/11	Ditto	15
Hard	1/9	Mostly sulphate	16

This, expressed in dollars and cents, means that with a deposit of 1-9 in. of scale, 16 cents of every dollar paid for coal is lost.

The data just given must not be regarded, however, as indicating that the decrease in the heat-carrying capacity of scale-covered tubes can always be calculated with the accuracy that these figures would indicate. The important facts are, though, that the loss is easily prevented, and that the advantages of soft water abundantly justify all expenditure necessary to secure it.

Just what the loss is in any particular case may best be determined by comparing the fuel consumption with clean and then with scale-covered tubes, other operating conditions being kept uniform.

Means of Removing "Scale Formers" From Water.

The methods employed in softening water may be divided into two main classes, (a) those in which the scale-forming property is removed before the water enters the boiler; (b) those in which the softening is effected within the boiler itself by means of so-called "boiler compounds."

As to which one of the two classes of methods should be employed in any particular case, would depend on the size of the plant and on the character of the water to be softened. In the case of waters of abnormal composition, it would frequently be impossible to produce a satisfactory water by either method and a new water supply would be necessary.

It cannot be too strongly emphasized that this question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water, even when secured from the same source, varies widely from time to time. These variations are not only seasonal and monthly, but daily and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase, probably to a much greater degree, the amount of suspended matter.

As a consequence, a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period.

As an instance of the serious danger of an unintelligent "dosing" of boiler waters may be cited the results of a long series of investigations which have apparently shown that carbonate of soda in solution produces brittleness in boiler steel. Carbonate of soda (soda ash) is used in most water-treating processes, and its unintelligent use may readily lead to a very dangerous condition in a boiler.

When Boiler Compounds May Be Used

Boiler compounds afford a very useful means of boiler-water treatment in plants whose size or value of output would not justify the use of a more expensive method. This would be true of a large percentage of the plants of the country.

In spite of a great variety of trade names, a very large percentage of all boiler compounds consist most largely of carbonate of soda, to which caustic soda is sometimes added, and occasionally phosphate of soda. Starchy materials, and those containing tannin are frequent ingredients. The supposed effect of these last two materials is to coat the particles of precipitated incrusting material and prevent its cohesion into compact scale.

*Technical Paper No. 218, Bureau of Mines, Washington, U.S.A.

Bonus System for Boiler Room Employees

One of the Series on Power Plant Management—This Article Treats of the Bonusing of the Boiler Room Employee and Its Effect Upon Economy in Operation

By ROBERT JUNE, Mechanical Engineer.

THE writer is fortunate in numbering among his friends and acquaintances the chief engineers of a dozen or more of the largest power plants in Canada. Recently he addressed a general letter to these men, asking for a brief description of the bonus systems, if any, used by them as a basis for reward of boiler room employees. To his surprise, these letters were not especially productive of results—most of the replies containing requests for information instead of furnishing it. One answer is typical of the present situation with the majority of the large power plants.

"We try to educate our boiler room men to the fact that power must be produced economically and that this means that high operating efficiencies must be maintained. We instruct our men carefully in their individual and collective duties, pay them high wages and generally give them to understand that we regard them as skilled operatives from whom we have a right to expect high grade results. As an incentive to good work, we post each Monday on the bulletin board in the boiler room the record of overall boiler efficiency for the preceding week.

"While our results in the main are good, we want to improve them. For one thing, we are going to try to separate the percentage of our 24-hour load handled by each of the three shifts. We are doing this on the principle that if one shift handles 50% of the load, and another 30%, and the third 20%, that we should get correspondingly better results from the shifts handling the larger loads. After we have established the proper efficiency for each shift, we are going to put in a bonus system of some sort. We are already working on this, but as you realize, there are a good many angles to the problem, and we should be glad to have any information which you may possess, etc."

This, then, is the situation in many large power plants. They are paying high wages, and trying to educate their men, in some cases by weekly conferences, in conjunction with occasional lectures on various phases of power plant operation. Close supervision of the work of the individual, and personal leadership, evoking a high esprit de corps, are the principal reliance at present. It is considered, however, that these are not enough and that a properly devised bonus system probably offers the necessary supplementary incentive.

Turning now to the smaller power plants, we find that they have been readier to adopt bonus systems. Presumably this is due to the fact that they find it more difficult to provide educational facilities for their men and to exercise close supervision over their work. While the systems used are not elaborate they seem to be effective. The point here worth noting is that the tendency in both large and small plants is increasingly toward the use of bonus systems.

Principles Upon Which Bonus Should Be Based

The term "bonus" may be taken as meaning additional compensation above a fixed amount, based upon net savings effected above a certain minimum through the personal efforts of the recipient. It means that if the operator can reduce the cost per unit of the product he should receive a portion of the savings. As applied to the boiler room a reasonable efficiency, based not alone upon the results previously attained in the particular plant under consideration, but also upon results attained in other power plants of approximately the same size and general characteristics, must be determined upon as a base line or starting point. Before blindly assigning an arbitrary value to performance above this base line, we ought to ascertain with some exactitude the relation of power plant expenses to manufacturing operations as a whole.

Our reason for this is that it will practically always be found that power plant expenses for any business, whether central station, brick and clay, textile, refrigeration, paper, etc., so far as the individual plant is concerned, vary along the line of a fixed curve, depending upon the output of the plant. That is, if the factory as a whole is operated at 100% capacity, power costs will bear a definite relation to the product in terms of pounds,

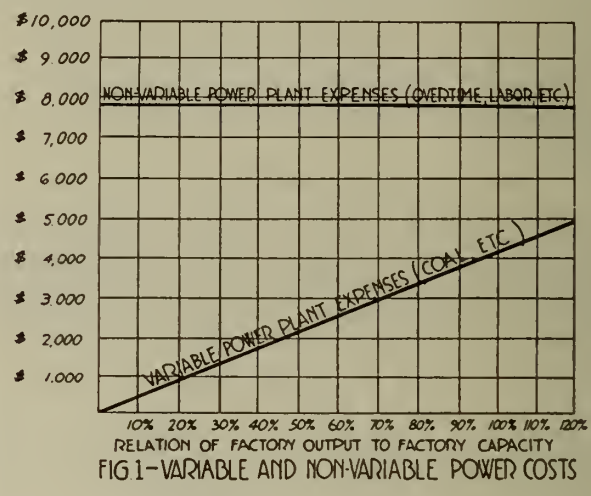


FIG 1—VARIABLE AND NON-VARIABLE POWER COSTS

bushels, yards, tons, or whatever unit the product is measured by. Let us say that our power cost is 10c, or $1.00, or $10.00 per unit, at 100% factory output. If we reduce factory output to 80% we will find that we have a different power cost per unit, say 12c, or $1.20. or $12.00, and if we reduce factory output still further, say to 50% capacity, we will find our cost per unit further increased to say, 15c, or $1.50, or $15.00.

The determination of this curve is not a simple matter. It cannot be done in a week or month, but it is well worth the effort, even if it takes a round dozen of months. The first step is a complete appraisal of the power plant which should include the value of the land and buildings occupied, the complete steam generating equipment with all accessories, the turbines, engines, feed water heaters, condensers, pumps, generators, switchboards, fire pumps, sprinkler systems, all piping and all wiring which apply wholly to the power plant proper, as well as all main lines of pipe and wire on which steam, water and energy are carried to the factory centres.

With our appraisal in hand we at once discover that the reason that our power-cost-per-unit curve is a curve is because power plant costs fall into two divisions—those which do not vary with the volume of product and those which do vary with factory production. As an illustration of the non-variable costs we have interest, depreciation, taxes, and insurance. To these must be added, if the power plant is ready to serve the factory with any amount of power up to 100%, cost of labor, fuel required to bank fires and to keep prime movers turning over, but doing no useful work, and the lubricants, water, ash removal required for this purpose, heat and light for the power plant, etc. These items vary but

little regardless of the factory output—whether it be 30% or 100% capacity.

The variable costs are, of course, coal, equipment maintenance, and a certain amount of general supplies, such as waste, packing, gaskets, etc.

Figure 1 is a typical graph, illustrating the relation of the variable and non-variable cost factors to the volume of production. Figure II is the curve (in this case assumed) resulting from the combination of the variable and non-variable costs. Armed with this curve, the manager is ready to talk business to his chief engineer.

First, be it noted, that in using the curve the manager does not have to be concerned about a single detail of plant operation. He does not have to study boiler efficiencies, engine performance, economical or uneconomical uses of steam, water or electricity. All he needs is the average factory output for a given period, and a summary from the accounting department of the complete costs of power plant operation for the same period. It is a matter of simple division to establish the power costs per unit of output, and to see how it checks with the standard curve. If the power cost is higher than the standard curve indicates it should be, something is wrong and it is up to the chief engineer to find and correct the trouble, and to explain to the manager why it should have occurred; if the actual costs check with the curve, the plant has simply done what it should and no one is entitled to a bonus; if the actual power costs are less than those indicated on the curve for the volume of product, good management and constructive effort has been exercised in the engine and boiler rooms, and the chief engineer and every man under him who has helped in the improvement is entitled to a share in the savings.

At this point it may be well to digress for a moment on the point of responsibility of the chief engineer for all items included in the curve under power costs. Warren E. Lewis, whose engineering record certainly makes him a competent witness, is quite emphatically of the opinion that the chief engineer should be held wholly responsible. He states:

"Some engineers have argued that it (the curve) is not a fair basis of payment, that all that the operating engineer can do is to make steam efficiently, run his engines, pumps, heaters, etc., as well as he knows how, and that he has no control of the situation beyond his department. That is partly true and partly not true. The functions of the chief engineer should extend beyond the confines of the engine and boiler rooms. He should spend at least one-third of his time around the plant, and he should have an inspector going around the plant continually watching out for improper use of power, light, steam, etc. The chief engineer should be directly concerned in seeing that the process machinery is maintained in an efficient condition. This is particularly true with regard to apparatus that uses steam in any form. If we include in the power plant all the equipment which in any way affects the use of fuel, it becomes a comparatively simple matter to place upon the chief engineer the responsibility for the efficiency of the entire power-making and power-using equipment, and for its cost per unit of production."

Now, getting back to the bonus, let us suppose that the management decides to set apart, say 33 1-3 per cent. of the savings effected, to be distributed as a bonus. Clearly, the chief engineer, individually, is entitled to a certain portion of this, and this portion should be determined by the manager. The proportioning of the remainder among the various power plant employees should be practically in the hands of the chief engineer for the reason that he is in constant touch with the work of the various individuals.

That the just proportionment of the bonus among the various individuals will cause the chief engineer some serious study is not denied. It is important, however, that individual rewards be established, and that the bonus be not simply divided among the men on a pro-rata basis or with reference to their respective wages. The final results are due to the combined efforts of all of the men, and are beyond the control of any one man.

It is necessary, therefore, to judge each man on the basis of his performance of his individual task. If boiler efficiency falls off it may be due to improper firing, in which case the fireman should be penalized, or it may be due to failure to keep the boiler clean, free from soot and scale, in which case the man who does the cleaning should lose all or a part of his bonus, or again the loss in efficiency may be due to leaky boiler settings, a condition clearly outside of the jurisdiction of the fireman, and clearly up to the boiler room foreman.

This principle of individual responsibility applies all along the line. For instance, if a new grade of coal is brought into the plant and the chief's assistant engineers do not make it their business to see that the firemen are fully instructed regarding the proper method of firing, they are guilty of a breach of duty for which they should suffer. The engineers are, of course, responsible for permitting radiation losses to continue because of failure to insulate pipes, and for failure to correct leaky valves, traps, worn gaskets, etc. The engineers or boiler room foreman must be held responsible for economical operation in cutting boilers in or off the line, operating them at economical ratings, and banking or killing fires.

When the bonus is not earned by a particular individual it may be due to his own fault in not following instructions, to faulty maintenance, making compliance with instructions impossible, or to faulty supplies. With so many angles to the problem, it is evident that close inspection and constant supervision of the work of the individual is absolutely necessary if material reductions in power plant costs are to be made.

It is realized that the program here outlined may seem elaborate. The small plant operator, in particular, may think it complicated, but it is precisely in the small plant that astonishingly good results can be attained. Admitting elaborateness, this basis of bonus is certainly thoroughgoing. To the writer's mind there is no point whatever to paying firemen a bonus for high CO_2, or for high boiler efficiency, if no corresponding effort is made to see that the steam, when produced, is utilized without preventable waste.

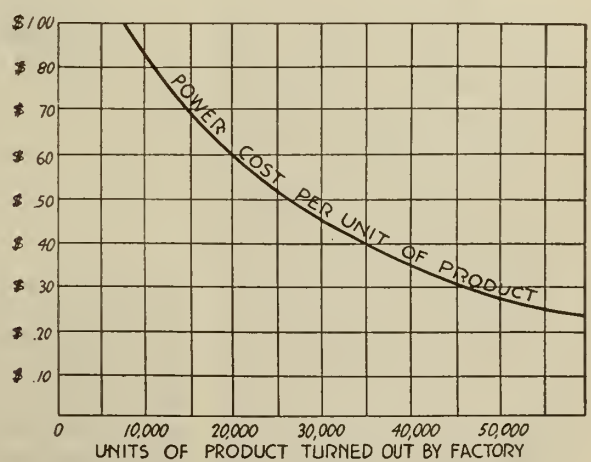


FIG. 2. POWER COST PER UNIT OF PRODUCT

Railway Dynamometers and Their Use

The Following Article Gives Some Interesting Details Relating to That Branch of Steam Engineering Identified With Locomotion and Takes Up Some of the Underlying Principles of Traction

By G. S. BALDWIN

FREIGHT is the dividend-paying business of all railroads and therefore it is of the first importance to know exactly how much tonnage each class of locomotive will haul over every division. It is just as expensive to overload an engine and have it stalling all over the road as it is to let it travel light. This is, of course, assuming that there is an evenly balanced flow of traffic in both directions. But this, which would be an ideal condition, does not usually hold good, particularly in Canada, where the preponderance of traffic is westbound for about six months and eastbound for the other six. In that case it is all the more important that a locomotive shall take her full load in the direction of traffic, since she will possibly have to make the return trip 20 or 30 per cent. light, or even with a "caboose hop."

A locomotive is rated as to the tractive effort she will exert on the drawbar, and to facilitate tonnage rating, this is usually expressed in percentage. A tractive effort of 20,000 lbs. is called 100 per cent., and an engine which should develop 30,000 lbs. is called a 150 per cent. engine, and so on.

The tractive effort is usually calculated as follows:

$$E = \frac{C^2 \times s \times p}{d}$$

when

E = the tractive effort in lbs.; c = the diameter of the cylinder in inches; s = the stroke in inches; d = the diameter of the driving wheels in inches, and p = the mean effective boiler pressure in pounds per square inch.

Of course the effective boiler pressure will vary considerably at different speeds, since the faster the engine travels the earlier the cut-off will be, and consequently the lower the effective pressure. But as we are considering the maximum load an engine will haul over heavy grades we are dealing with slow speeds. In fact engines usually develop their greatest tractive effort at a speed in miles per hour equal to between one-eighth and one-ninth of the diameter of their driving wheels. For instance, an engine with a 63 in. wheel will develop her greatest pull between seven and eight miles per hour, and an engine with a 54 in. wheel between six and seven miles per hour. We are therefore pretty near the mark in assuming the mean boiler pressure to be 85 per cent. of the maximum pressure.

Take an engine with 28 in. cylinders, 21 in. stroke, 63 in. driving wheels, and 180 lbs. of steam, and we get:

$$E = \frac{28 \times 28 \times 21 \times 157}{63} = 41.039 \text{ lbs.},$$

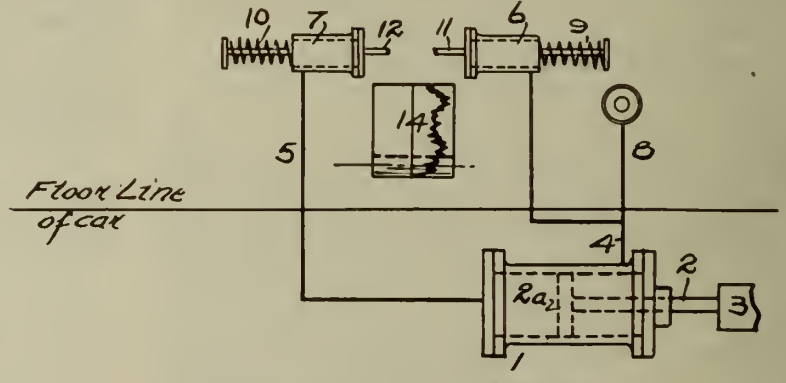
or 205 per cent.

The ruling grade over a division, except in mountainous country is usually .4 per cent., and if the line and surface of the track is in good condition and there is a good length of straight track where the maximum effort has to be exerted it will require something like 17.7 lbs. to move each ton of load. In which case the engine above referred to could be expected to haul in the neighborhood of 2,316 tons.

Now you will say if you can figure out so exactly what load can be hauled, why go to the trouble and expense of making dynamometer tests at all? For the following reasons: Firstly, though the track profile may show a .4 per cent. grade, the road may not. There may be a curve on which all trains carrying full rating stall because sufficient allowance in the way of grade reduction has not been made. On a slight curve it is usually found that the locomotive has an additional resistance of 1.5 lbs. per ton of its own weight for each degree of curve, which dynamometer records will not show, because only the actual pull on the drawbar can be indicated in that way, and the train will show an additional resistance of about .751 lbs. per ton for each degree of curve. The radius of any degree of railroad curve is 5729.65 feet divided by the number of degrees, for instance, a 10 degree curve has a radius of 572.965 feet. On a single track road, if a curve is at all sharp the outer rail is raised to take care of fast moving traffic in the opposite direction, in which case there would be a considerably greater resistance than that mentioned above. Consequently curves on a grade are usually compensated, that is a reduction is made in the climb to offset the extra work necessary to get round them. This is frequently taken at .02 per cent. for each degree of curve.

Other points must be taken into consideration also. For instance, in very exposed places a strong wind blowing across the track will have a marked effect. Or if a station is located near a heavy piece of road so that trains do not get a swing on before starting to climb they may get into difficulties. In short, there are so many local conditions which govern each division that, without making a test it is almost impossible to put on a fair rating. Of course tests can be made without a dynamometer, but in that case it is impossible to know whether the engine developed her rated drawbar pull before she turned round and counted the cars.

Before starting on a test the first thing to do is to ascertain the weight of the train, which is made up of two things, the tare weight of the cars and the weight of their contents. Roughly speaking the tare should be one-third and the contents two-thirds of a fully loaded train. Supposing the train to be 2,250 tons, and made up of loads, the consist would show approximately 1,500 tons contents and 750 tons tare. On the other hand, if there were a number of empties and partially loaded cars we might find that the contents only came to 750 tons and the tare 1,500 tons. Now obviously this would be a considerably longer train and a far harder one to pull, consequently an allowance is added to the sum of the tare and contents in all cases where the contents is less than twice the tare. A frequent method of figuring the allowance is as follows: Deduct half the contents from the tare and add 10 per cent. of this amount to the tonnage. In the case mentioned above the total tonnage would figure like this:



DIAGRAMATIC VIEW OF DYNAMOMETER.

	Tons
Tare	1,500
Contents	750
Allowance	112
Total tonnage	2,362

The dynamometer is arranged immediately behind the tender and consists of a cylinder, 1, having a piston-rod, 2, connected to the drawbar, 3, which is coupled in the ordinary way to the tender drawbar. From the ends of the cylinder, 1, which is filled with oil, pipes 4 and 5 lead up to the recording cylinders 6 and 7 respectively, and a pressure gauge 8 is also provided on the pipe 4. Behind the cylinders 4 and 5 springs 9 and 10 are so arranged that they must be compressed as the pistons 11 and 12 move forward.

The whole load of the train is on the tender drawbar, and is therefore carried by the piston 2a in the oil-filled cylinder, 1. This load is evenly distributed over the oil, which communicates the pressure to the gauge 8 and the cylinder 6.

Supposing the bore of the cylinder is 11.75 in. and the piston rod, 2, is 3.28 in. in diameter, the effective area of the oil is 100 square inches. Therefore, when a pull of 40,000 lbs. is exerted there will be a pressure of 400 lbs. per square inch on the oil. This pressure is communicated through the pipe, 4, to the gauge 8, and the recording cylinder 6. If the latter has a bore of 1.187 in., and the piston rod, 11, is .370 in. in diameter, the effective area of the cylinder will be 1 sq. in. The springs 9 and 10 are calibrated to say 100 lbs. to the inch, and both the cylinders and the springs must be of sufficient length to take care of the maximum pressure that may be exerted through the oil. With a pressure of 400 lbs. per sq. in. operating in the cylinder, 6, the pressure will be 400 lbs., acting against the springs, on account of the effective area of the said cylinder being one sq. in. Consequently the piston and rod, 11, will move forward 4 in. against the 100 lb. spring. Usually for recording cylinder pressures of from 400 to 600 lbs., spring calibrated to 150 lbs. are used.

A suitable pantagraph arm system must be connected to the near ends of the piston rods 11 and 12, so that an automatic record may be made on a sheet, 14, which is fed under the pen at so many feet to the mile, the drive being obtained direct from the car axle.

The object of the pressure gauge is to check up the oil pressure when making a scale from which to read the records; the scale is usually divided off into 500 lbs., up to 60,000 lbs. of whatever load is anticipated. A second pen draws a constant datum line on which the pen in the pantagraph arm also rests when no pull is being exerted on the drawbar.

When reading compression on the oil cylinder it must be remembered that the scale is only approximate in that case as the effective area is greater on account of there being no piston rod on that side of the cylinder. In the case in question the effective area would be 108.43 square inches against 100 square inches on the opposite side of the piston, but if these readings are required it is quite easy to make another scale on which the graduations would be slightly larger.

Any suitable arrangement of piping to and from a pump is also installed so that oil may be pumped from one side of the cylinder to the other, as for safety's sake it is always advisable to keep the main piston about the centre of the cylinder. And the piping is also so arranged that fresh oil may be pumped into either end of the cylinder, or so that pressure may be put on the line, 4, for making or checking up scales.

THE FRACTURE OF A FURNACE WHILE ITS BULGE WAS BEING SET BACK

Expertness in setting back bulged furnaces has improved very much of late. This is probably partly due to the increasing number of cases, due to war conditions, and partly to the difficulty of obtaining plates for replacing damaged furnaces. One of two cases which ended in failure should, therefore, prove of interest as it indicates the dangers to be avoided. When the bulges are relatively slight they are usually set back cold, but when deep they are heated by fires, usually by Wells lamps, set back hot and finished-off cold. In one case during the cold finishing-off process on a bulged furnace, a circular piece of plate measuring 10 in. diam. burst out of the furnace plate. The nature of the fractured surface left no doubt that the fracture was an instantaneous one, except over a length of about 1½ in. where the edges of the plate were slightly bent. This curious piece of plate is to be seen in our museum. The following is the most probable explanation of this mishap: In 1886 a paper was read before a meeting of the Institute of Civil Engineers in which a large number of experiments were discussed which proved clearly that both wrought iron and mild steel have a common critical temperature, usually called blue heat, because bright steel or iron changes color through straw to purple or blue, at which temperature the material, although softer than when cold, is in a rotten condition and usually breaks if bent. If the bending be stopped before either breakages or cracks occur, and if the sample be put aside for a short period and the bending continued, or the sample straightened, then it is almost sure to break. Other mechanical manipulations while the steel is "blue hot" will also impart to it permanent brittleness. Thus on the occasion of the reading of the above paper, a bar of mild steel about 1 in. wide and ½ in. thick had been bent double at one end while cold in order to demonstrate its ductility or toughness, the other end of the bar had been polished and warmed between heaters until it commenced to change color from straw to purple and blue. While at this temperature it was placed under a steam hammer and reduced in thickness from ½ in. to ⅜ in., and was then laid aside for the meeting, at the end of which it was struck against a small anvil and broke in two. The ends of this sample were preserved and retested after waiting about 30 years, when they were still found to be as brittle as at first. Evidently age has no beneficial effect on improperly worked steel; it can only be restored to its originally good condition by annealing. These experiments explain why the application of heaters to flanges, and other parts of boilers which have to be slightly bent, very often leads to cracks, which are called mysterious, because the true cause, the heaters, are either not mentioned or have been forgotten. Now what had happened in the present furnace mishap was very simple. The bulge had been heated by a Wells lamp. The centre was said to have been red hot, and there must therefore have been a circular zone over which the temperature was a "blue heat" during the time that the bulge was being pressed back. The setting back appeared to be perfectly satisfactory, but next day it was thought that a further improvement could be effected by re-applying ram pressure on the cold plate, with the result that the plate fractured in a circular line through the zone which had been made permanently brittle by being bent while "blue hot." It is therefore evident that in future, if furnace bulges have to be heated before being set back, they should be re-heated after they have been set back.

The annual output of thirteen billion gallons of petroleum in the United States consists of 1,800,000,000 gallons of kerosene and about twice as much gasoline, the remainder being gas oil, distillate and light and heavy residuals.

* * *

Where great power is applied slowly, particularly when space is at a premium, the worm-and-wheel drive is seen at its best. Another advantage of this type of drive is the ease with which it can be kept oiled. Perhaps greased would be a better term because the worm frequently works in grease. The whole drive is usually enclosed in a grease-tight box, though which passes the driving shaft.

* * *

In a certain plant the technical magazines which are received are first read by the engineers in the office. They are then placed in a box made especially for this purpose, at the employees' entrance. Any worker may take one at a time home, and after reading it, return it to the box so that other employees may read it. This scheme is worthy of more general application.

* * * *

The elephant has what a dentist calls "magazine gun teeth" because of the curious fact that when the big pachyderm wears off a front tooth it is replaced by the one tooth just behind it, the whole row moving up a tooth. It is said this takes place continually, so Jumbo always is guaranteed a set of teeth, no matter how many he wears out.

Resuscitation from Electrical Shock

The Commission on Resuscitation From Electrical Shock Have Recently Revised the Rules for the Carrying on of Resuscitation and in View of the Importance of This Work They Are Here Reprinted in Full

The prone-pressure method of artificial respiration is applicable to resuscitation from electrical shock and all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes or to other causes.

AN accidental electrical shock usually does not kill at once, but may only stun the victim and for a while stop the breathing.

The shock is not likely to be immediately fatal, because:

(a) The conductors may make only a brief and imperfect contact with the body.

(b) The skin, unless it is damp with perspiration or wet, offers some resistance to the current.

The life of the victim depends upon the prompt and continued use of artificial respiration. The reasons for this are:

(a) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(b) If the body is not thus repeatedly supplied with air, suffocation occurs.

(c) Persons whose breathing has been stopped by electrical shock have been reported restored after artificial respiration has been continued for approximately four hours, and the treatment should be continuously applied until rigor mortis (stiffening of the body due to death) sets in.

The Schafer, or "prone pressure" method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(a) It is immediately available.

(b) Easy performance; no apparatus and little muscular exertion required.

(c) Larger ventilation of the lungs than by the supine method.

(d) Simplicity, the operator makes no complex motions and readily learns the method.

(e) No trouble from the tongue falling back into the air passage. The first impulse is expiration, and any foreign substance in the mouth or air passage will likely be expelled.

(f) No risk or injury to the liver or ribs if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

Instructions for Resuscitation

Follow these instructions even if victim appears dead.

I.—Free the Victim From the Circuit Immediately

1. Quickly release the victim from the current, being very careful to avoid receiving a shock. Use any dry non-conductor (rubber gloves, clothing, wood, rope, etc.) to move the victim or the conductor. Beware of using metal or any moist material. If both the victim's hands are grasping live conductors endeavor to free them one at a time. If necessary shut off current.

Begin at once to get the subject to breathe (resuscitation) for a moment of delay is serious. Use "Prone Pressure Method" for four (4) hours if necessary, or until a doctor has advised that rigor mortis has set in.

Observe Following Precautions

(a) The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous. If this is impossible, use rubber gloves, a dry coat, a dry rope, a dry stick or board, or any other dry non-conductor to move either the victim or the conductor, so as to break the electrical contact.

(b) If the bare skin of the victim must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting or dry cloth, or stand on a dry board or on some other dry insulating surface. If possible, use only one hand.

If the man receives a shock while on a pole, first see that his belt is secure around the pole, if possible above cross-arm, so victim will not fall, then break the current. Pass a hand-line under his arms, preferably through his body belt, securely knot it, and pass the end of the line over the first cross-arm above the victim. If you are alone, pass the line once around this cross-arm. If you are not alone, drop the line to those at the base of the pole. As soon as the rope is taut, free the victim's safety belt and spurs and descend the pole, guiding the victim. When the victim is about three feet from the ground, lower rapidly so that the victim's feet hit the ground hard.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle, turning your face away to protect it from electrical flash.

II.—Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign body (tobacco, false teeth, etc.) If the mouth is tight shut, pay no attention to the above-mentioned instructions until later, but immediately begin ressucitation. The patient will breathe through his nose, and after resuscitation has been carried on a short time the jaws will probably relax, and any foreign substance in the mouth can then be removed. Do not stop to loosen the patient's clothing; every moment of delay is serious.

FIG. 1.

2. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face resting on hand or forearm so that the nose and mouth are free for breathing. (See Fig. 1.)

3. Kneel, straddling the patient's hips, with the knees just below the patient's hip bones or opening of pants pockets. Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, the thumb alongside of the fingers, the tips of the fingers just out of sight. (See Fig. 1.)

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject (see Fig. 2). This operation, which should take from two to three seconds, must not be violent—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs, the diaphragm is kept i nnatural motion, other organs are massaged and the circulation of the blood accelerated.

5. Now immediately swing backward so as to completely remove the pressure, thus returning to the position shown in Fig. 3. Through their elasticity, the chest walls expand, and the pressure being removed the diaphragm descends and the lungs are thus supplied with fresh air.

6. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or clock is not visible, follow the natural rate of your own deep breathing, the proper rate may be determined by counting—swinging forward with each expiration and backward with each inspiration.

7. As soon as this artificial respiration has been started, and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest or waist. **(Keep the patient warm.)** Place ammonia near the nose, determining safe distance by first trying how near it may be held to your own. Then the assistant should hit the patient's shoe heels about twenty times with a stick, and repeat this operation every five minutes, until breathing commences. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. Continue artificial respiration without interruption (if necessary for four hours) until natural breathing is restored. Cases are on record of success after three and one-half hours of effort. The ordinary tests for death are not conclusive in cases of electric shock and doctors must be so advised by you, if necessary.

9. When the patient revives he should be kept prone (lying down)—and not allowed to get up or be raised under any consideration unless on the advice of a doctor. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of hot ginger tea or coffee.

The patient should then have any other injuries attended to and be kept warm, being placed in the most comfortable position.

10. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition, and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, he should be kept in a prone position and placed upon a hard surface (door or shutter) or on the floor of a conveyance, resuscitation being carried on during the time that he is being moved.

FIG. 2.

11. A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and, if normal breathing stops, artificial respiration should be resumed at once.

III.—Send for a Doctor

If other persons are present when an accident occurs, send one of them for a doctor without a moment's delay. If alone with the patient, do not neglect the immediate and continued resuscitation of the patient for at least one hour before calling a doctor to assist in further resuscitation efforts.

A published, up-to-date list of doctors posted by the company is recommended.

IV.—First Care of Burns

When natural respiration has been restored, burns, if serious, should be immediately attended to while waiting for the doctor to arrive.

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent.). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water, or it may be protected with vaseline, carron oil, olive oil, castor oil or machine oil, if clean. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchief, or other soft cloth, held tightly in place by a bandage.

The same coverings should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.

An electric-heating system which utilizes power that would otherwise go to waste has been installed in a school in a southern European city. The existing hot-water pipes and radiators are connected with a well-insulated water tank of 1,300-gal. capacity. In this reservoir electric resistances are built and at night are supplied with current which raises the water to well above the boiling point. The cost of the current is low because the water power used to produce it normally would go to waste. During the day the hot water is allowed to circulate through the radiators, its volume being sufficient to warm the rooms without using more current. The desired temperature is maintained by a thermostat.

FIG. 3.

Is Your Heating Plant Ready for the Winter?

While the Weather is Warm is the Time to Prepare for the Cold Time Coming—Cold Rooms in a Factory Are a Cause of Dissatisfaction to All Concerned

By T. H. FENNER, Associate Editor

IN that locality which is popularly supposed to be paved with good intentions, we are led to believe that no trouble is ever experienced with the heating arrangements. It is also an attribute af fallible human nature that once the immediate incentive of the said paving material has disappeared, action is delayed in favor of some more pressing need, till the recurring season brings along the old troubles, and a crop of vain regrets. All of which is merely a way of saying that to avoid six months of misery in the winter, a few days or weeks should be devoted in the summer to a thorough examination of the heating arrangements.

There are few things that lead to more lost time and bitter recriminations than the failure of the heating system to properly function at the required time. Workmen coming in to a cold room first thing in the morning are usually disgruntled for the remainder of the day, and are prone to stand around the shop, with their hands in their pockets, calling down anathema on the engineering department, rather than attempt to forget the temperature by an assiduous attention to the job in hand. In many cases they are not to be blamed, for a man who is engaged on monotonous repetition work, which entails but little bodily activity, is usually supersensitive to uncomfortable shop conditions. Furthermore, the plant superintendent, who has to sit in an office where the temperature is around 50 degrees, is not disposed to kindly feelings towards his chief engineer. The latter may not be entirely to blame, as oftentimes lack of sufficient or competent help has caused him to delay the necessary overhauling until an unusually early cold snap brings down trouble on his prematurely gray head.

A winter season such as we had in Canada in 1918-19 did not strain the capacity of the heating plant over-much, and the early spring, followed by the gloriously warm summer, was likely to dispel all thoughts of heating systems from the minds of the engineering staff, but there have been some chilly mornings and evenings lately which serve as a sharp reminder that our summers are short. If not already done now is the time for a sharp and systematic campaign, started at the exhaust line and carried through the factory.

The Right Time To Do It

The proper time to overhaul the heating system is the early summer, just as soon as one can feel that there is no chance of the system being required again that season. All its most obvious needs are, or should be, fresh in the mind then, and the unpleasant remarks caused by them still rankling in the breast. That main reducing valve, for instance, that requires a new diaphragm, the leaky joints in awkward corners of the basement, the vacuum valves which have ceased to justify their existence, and the countless other small things that have had to be neglected for the time being. Small things in themselves, but what a cause of misery in the aggregate.

Perhaps there has been no lack of heat in the factory, but the heat has only been maintained by the expenditure of a totally disproportionate amount of coal or else there has been both a lack of heat in certain sections, as well as a large coal bill. In the small and compactly arranged factory it may not have been very bad, but in the plant that covers a large area of ground, with the heating done from a central plant, the waste may be enormous.

Two Points to be Considered

There are two things to be taken into account. The heating system itself and the state of the buildings. There is little use in having a perfect heating system if there are ½-inch openings around window frames, door jambs, pipe entrances to buildings. The chief engineer should send his foreman bricklayer or painter or go himself if possible, and make a systematic inspection of the buildings, taking careful notes of all places where the cold winds can find entrance, and then take effectual steps to stop them. A little spring yarn caulked tightly into the spaces between window frame and brick work will work wonders in the way of comfort and saving of fuel. Where roofs are built with lanterns take a good look at the joint of roof and lantern, and see that there is no open space under the flashing, and that the flashing itself is in good repair. Count up the broken panes of glass and order the required quantity immediately so that it can be all replaced before the summer is over. There will be quite enough work to be done on building exteriors to keep a man or two busily engaged all summer, and there is no one more vitally interested in having this work done than the chief engineer. Every bit of cold air that enters a building by unauthorized inlets has to be heated up, and it all requires some of his dearly bought b.t.u.'s. Furthermore, a building that is reasonably tight will retain the heat for the better part of the night, when the main engines are stopped, and makes less demands on the live steam.

Coming to the heating plant itself, there is ample scope for useful work to be done. In a large factory there are miles of coils, thousands of feet of main feeders, risers and returns, and hundreds of steam and thermostatic valves, outside of the engine room altogether. The majority of plants using exhaust steam for heating are equipped with a vacuum return system, the returns being delivered to the feed water heater, and thence to the boiler. Where feed water has to be paid for, the more water that is reclaimed from the heating system the less has to be paid for. But it must be free from oil, and it is also necessary to have the oil extracted from the exhaust before it enters the steam heating system, otherwise it will coat the coils and form an excellent non-conductor. Therefore, the oil extractor on the main exhaust line should be thoroughly cleaned, and the trap or other drainage arrangements examined and put in good shape. The vacuum pump should next be overhauled, both steam and water ends, and rods turned up if necessary. The suction and discharge valve plates should be taken out, and if the valve seats are worn unevenly, they can be put on the shaper and faced up. Failing this, they should be faced up with a surface board and file and scraper. Overhaul the valve springs and valves, pack the plunger, and see that the pump barrel liner is not worn in the middle. If it is have it bored out. Once the pump is as perfect as possible you are in a position to start testing out your system. The usual arrangement of piping is a main carried from power house to factory basement, and individual branches carried to different sections of the building. The return branches are brought back to a return main, which is connected to the suction of the vacuum pump. The function of the vacuum pump is two-fold. It has to deliver the condensation from the returns to the feed heater, and also maintain a difference of pressure between the main exhaust and the return system, to ensure a circulation of steam through all the coils. If the pump is not doing its duty, there will be an increase of back pressure on the engine, and the heating system will be filled with water, the result being more fuel consumed, and a cold factory, while the heat that should be going into the building will be carried up the atmospheric exhaust to the open air. If there are leaks in the system anywhere the pump will be drawing air into the returns instead of maintaining a vacuum. Air leaks should be eliminated as far as practicable. Now shut off every branch valve, both steam and return, leaving only the length of the main return open to the pump. Better still blank off the

return branches in case there may be leaky valves on the branch where it joins the main. Blank off the water connection to the small condenser on the suction pipe and start the pump. You should get a vacuum immediately, and if your pump is in good shape you will be able to drain from 20 to 24 inches on the gauge. Now stop the pump, and if the length you are testing is tight, the vacuum will be maintained for a considerable time, say 10 to 15 minutes. If it disappears in three or four minutes there is a leak, which must be stopped. Now take the blank flange from one branch and connect it to the return main. This branch may carry four or more coils. Blank these coils off at the steam end, one at a time, and take the thermostatic valve out of the return end, and get the vacuum again. If it does not hold, take a candle, keeping the pump running, and try the flame at every joint till the leak is discovered. Try every coil in this way, till you are morally certain that your return system is airtight.

Then comes the steam side. You can test this out by taking out the thermostatic valves and pulling the vacuum right through, but a more convenient way is to blank your main, one section at a time, and attach a small branch from the air compressor to it. Pump up about five pounds pressure, and see how long it remains. You will soon discover the leak and can remedy each section as you go along. There remains one very important feature, the thermostatic valves. There are various types of these, some being controlled by the expansion and contraction of a volatile liquid and others by the expansion and contraction of a carbon. Those operated by the liquid usually are non-adjustable, but the carbon ones are, and if not adjusted correctly will allow steam to blow right through the coil. Now the latent heat of steam is much more than the sensible heat, but if the steam is not held in the coil till condensed, the latent heat will be given out where it is not wanted, in the return pipe. Therefore, the thermostatic valve must be adjusted so that it will remain closed unless surrounded by water. The best way to ensure this is to disconnect the union on the return side of the valve and then put steam in the coil. If steam blows through screw the carbon body down a little by the screw provided in the top, until the steam stops. Then note if it opens to let the condensation out. It should open and shut precisely as a steam trap does.

When the system is in operation send a man around to every coil at least once a week, to see that valve spindles are tight and nothing leaking on the coil itself.

These precautions will well repay the work involved by the peace and comfort obtained. A factory uniformly warm in every department, Monday morning as well as Saturday noon, will produce more and better work than one in which these conditions are not maintained.

TEST FOR GROUNDS ON INTERIOR WIRING

By James V. Shannon

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A NUMBER of public utility companies follow the practice of testing for grounds on the interior-wiring circuit each time the watt-hour meter at the installation is tested. The method which is, usually, followed, is that shown in the diagram Fig. 1. At I is indicated the interior installation. The secondary circuit is, usually, as shown at Gp, grounded. An accidental ground, Ga, is indicated in the interior wiring.

Now, to test for this ground, Ga, the meter tester removes the house leads from the meter and twists them together as shown at T. Then he connects up his test lamp, L, between the live side of the line and T. If the ground at Ga is of sufficiently low resistance his test lamp will light. Sometimes grounds on interior wiring are of such high resistance that they will not light a test lamp. In such a case a rotating standard (a watt-hour meter-testing instrument) is inserted as shown at R, Fig. 2-I. By following the directions which accompany the rotating standard, it is possible, by counting the number of revolutions which the pointer of the instrument makes in a certain period of time, to determine the watts power consumed by the ground. Then the voltage of the circuit being known, the current flowing may be ascertained and from the current and voltage values the resistance of the ground in ohms can be computed.

The above-described methods apply particularly to alternating-current installations. For direct-current work a millivoltmeter can be used somewhat as indicated in Fig. 2-II. The resistance of the ground on the interior wiring circuit can be computed in ohms by following the usual method for ascertaining the value of a high resistance with the millivoltmeter.

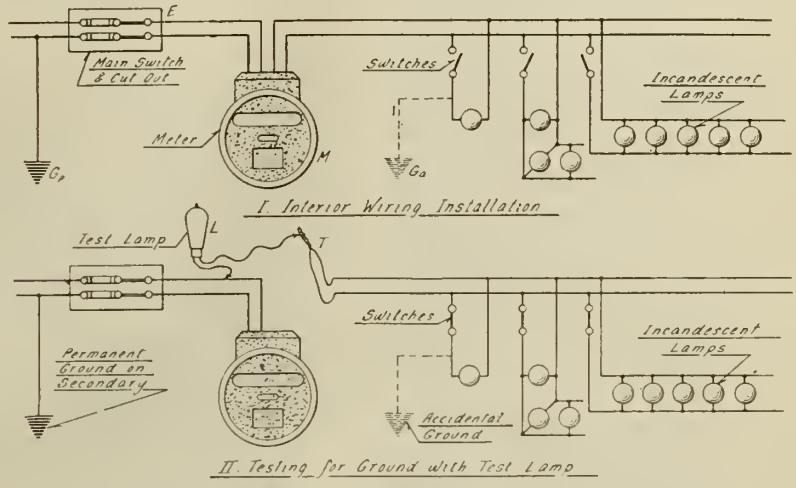


FIG. 1—TESTING FOR GROUNDS WITH TEST LAMPS.

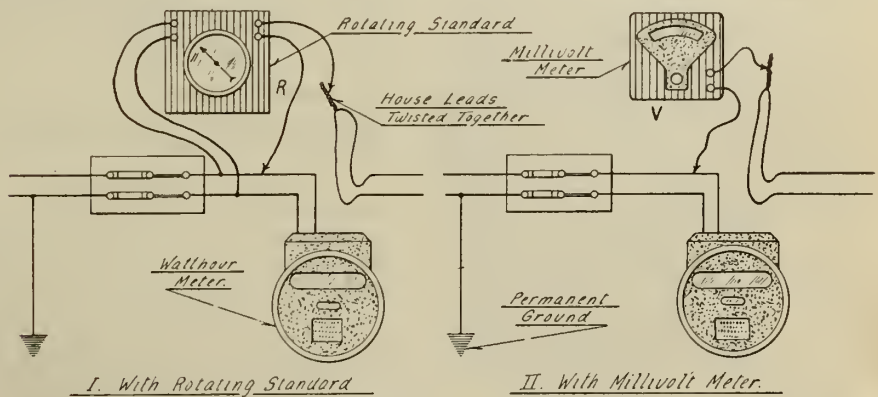


FIG. 2—APPLICATION OF ROTATING STANDARD AND MILLI-VOLTMETER.

The Johns-Pratt Company, Hartford, Conn., cordially invites all members of the N.A.S.E., as well as all superintendents, master mechanics and operating engineers to visit booths No. 221 and 222 during the coming exhibition.

The use of a cold chisel by anyone inexperienced with it usually results in the hammer occasionally striking the hand instead of the chisel, with disastrous results. For the use of beginners, and possibly some of the older workmen who occasionally fail to hit the chisel directly on the head, it will be helpful to cut out a disk of old leather belting, making a hole of the proper size in the centre, and mount it on the end of the chisel to break the force of any misdirected blow.

Central Station Heating in Detroit

The Author in a Paper Read Before the American Society of Mechanical Engineers in Detroit Describes a Successful Central Station Heating Installation in Detroit

By J. H. WALKER

ONE of the natural results of the grouping together of human beings in civilized communities is the existence, in our cities, of central plants for the generation and distribution of heat to surrounding buildings. The advantages of central heating service to the user, over the alternative of operating a heating plant in his own building, are comparable to those accompanying any other public service. To the community also a properly operated central heating plant is a distinct asset, commercially and economically.

The Utilization of Exhaust Heat

The heat carried away by the condensing water in the central electric stations of the United States, equivalent to about 60 per cent. of the total fuel burned by them, is one of the more obvious, although not by any means the greatest waste, of the country's resources. Like many other similar losses this one exists, not because its reduction is theoretically impossible, but because it is seldom commercially practicable. But although commercial considerations have always dictated certain practices in the utilization of fuel and will continue to do so in the future, the increasing cost of coal and the present impulse towards its conservation now direct attention to some of the fundamental problems involved.

This great quantity of heat, rejected at low temperature from the generating units, may be considered as a by-product of electricity supply and as such its rate of production will depend upon the rate of production of electricity, the primary product. The complete utilization of any by-product becomes possible only when an outlet for it exists or can be created. Moreover, since neither electrical energy nor heat can be stored to any great extent, it is necessary for the complete recovery of this by-product that the demand for it be equivalent, hour by hour, and day by day, to the rate of electricity supply. The warming of the interior of buildings is, of course, a natural means of utilizing this heat, but the great diversity in the rate of use of the two commodities renders impossible even an approximately complete realization of the theoretical economy.

The possibility of establishing a better relation between the rates of use is rather slight. The rate of heat supply is largely fixed by unalterable climatic conditions. The use of electricity for lighting is also governed by natural elements. The demand for electricity for industrial use, which now constitutes a major fraction of the output of most central stations, is not governed by these factors and is the only kind of load whose characteristics could conceivably be adjusted to suit the requirements for exhaust heat, and even this could probably not be done to any practicable extent.

Another important obstacle to the full use of this by-product heat through the warming of buildings is due to the great development of the central electric stations which in many industrial centres in the United States have so increased in size that the amount of exhaust heat which would be available as a by-product

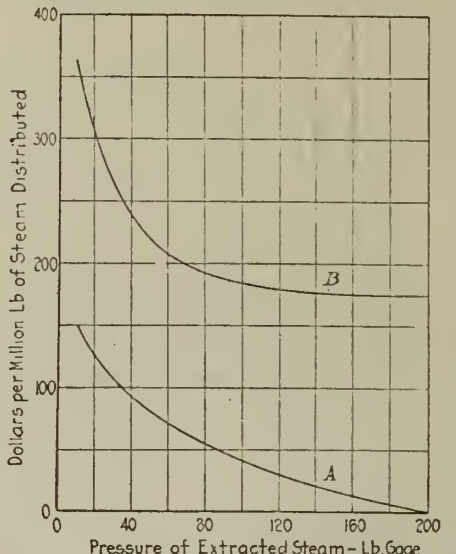


FIG. 1—CURVES SHOWING CREDIT (A) AND DEBIT (B) TO BLEEDER TURBINE PLANT FOR VARIOUS EXTRACTED STEAM PRESSURES.

is greatly in excess of that which it would be commercially feasible to distribute for the heating of buildings.

Systems of Central Heating

Assuming that a central heating load exists and is to be supplied by the electric company, there are in general three methods by which this can be done:

(a) The heating load can be served from a condensing generating station so designed that steam is available for heating at pressures above atmospheric after partial expansion in the electric generating units, the remainder of the steam used for current generation being fully expanded and condensed at high vacuum.

(b) Separate heating plants may be built in locations near the heating load and equipped with non-condensing generating units which will generate current only to the extent of the requirements for exhaust steam for heating, the remainder of the electricity being produced in a condensing station.

(c) The heating system may be supplied entirely with live steam from boiler plants located near the centre of the heating load.

It may so happen that the natural location for the main generation station serving a city is near the heating load, and if this is the case, the first method is preferable. In such a plant the use of bleeder turbines, designed so that steam can be extracted from the intermediate stages after partial expansion, offers great advantages. This arrangement has been successfully carried out in some instances and is probably the nearest possible approach to ideal conditions, since the duplication of equipment is reduced to a minimum.

Often, however, a consideration of land values or of railroad connections requires that the main condensing station be located at such a distance from the heating load as to preclude the possibility of transmitting steam from it. The Delray plant and the Connors Creek plant, the two main generating stations operated by The Detroit Edison Company, are respectively 3½ and 4½ miles from the heating district. A condensing plant, located on high-priced land near the heating district and with inconvenient railroad connections, or none, would be necessary if this first method were to be used. To such a plant, built for electricity supply and consequently, for reasons previously stated, burning more coal than a plant built solely for heating, this matter of proper railroad facilities is particularly important. Here again enters the matter of the transmission of steam, for seldom could the bleeder-turbine plant be located as favorably with reference to the heating load as could live steam plants, and the additional investment in transmission lines must therefore be charged against this plan.

The size of the pipes required to transmit a given quantity of steam over a given distance decreases as the density of the steam and the amount of pressure drop along the pipe increase. The most economical method from the standpoint of investment costs would be to extract steam from the high-pressure stages of the turbine; but the amount of electricity which could be generated per pound of steam would then be reduced. The relative values of these factors for an assumed river-front bleeder-turbine plant in Detroit are illustrated by the curves in Fig. 1. Curve A shows the total credit for the saving in coal and boiler capacity which could be allowed such a bleeder-turbine plant located on the river front and serving the existing Detroit heating system. Curve B shows the total

of the additional investment charges due to the higher-priced land on which the plant would be built, plus the investment charges and line losses involved in transmitting the steam from this river-front plant to the centres of the heating load. Even at higher extraction pressures the bleeder plant would not be justified under Detroit conditions because of its unfavorable location with respect to the heating load.

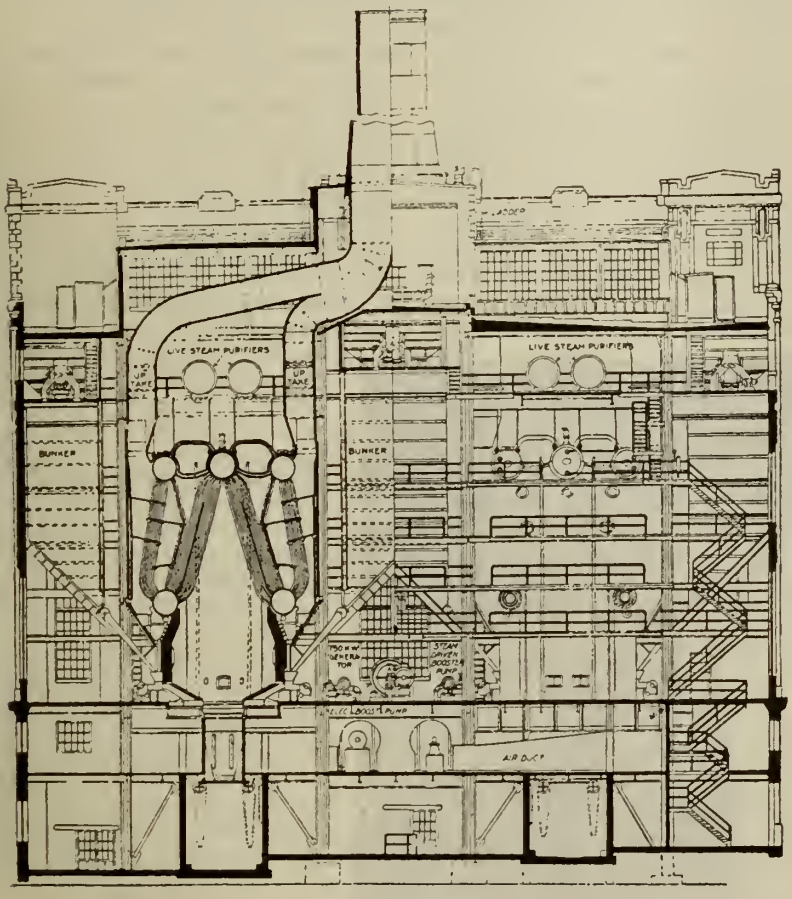


FIG. 2—CROSS-SECTION OF THE CONGRESS STREET PLANT.

The second plan above mentioned, namely, the building of plants located near the heating load and generating current only to the extent of the exhaust-steam requirements, involves somewhat different factors. In this case the capacity of the generating units will be determined by the heating requirements and the electricity generated by them will be the by-product. An essential requirement for the success of this plan is that the relation of these generating units to the electrical system as a whole be such as to allow their loads to be adjusted without restriction according to the momentary requirements for exhaust steam.

The value of such current as the heating plant will produce will be determined largely by the cost of producing an equal amount in the condensing stations. If the condensing stations do not produce current at an extremely low cost and, if other conditions are not unfavorable, this plan may prove very attractive and is in fact the mostly widely used method of combining the electrical and steam-heating plant. But unfavorable conditions surrounding the production of this relatively small amount of current may render its cost unattractive. The size of such generating units as might be installed in the heating plant may be so insignificant compared to the large size of the units in the condensing plant that the investment in the main station is not measurably reduced and the smaller units are therefore additional investment. The investment in steam-distribution mains is also much greater than when steam at higher pressures is used.

Development of Central Heating in Detroit

The immediate motive which, in 1903, led to the establishment of the central heating industry in Detroit was the possibility of obtaining a high thermal efficiency in the generation of electricity through the utilization of the exhaust steam. The generating plant from which steam was first supplied for heating had previously discharged its exhaust to the atmosphere. Owing to the building, at this time, by the Detroit Edison Company, of a large condensing plant, the smaller plant, with several others, would have been shut down, but the possibility of selling the exhaust steam made it appear desirable to continue the generation of current there to the extent of the exhaust steam requirements. Also, since the plant was located in a district served with direct current, the loss involved in converting an equivalent amount of alternating current received from the main plant to direct current would be saved for such current as might be generated there. The plant was in a high-class residence district and the heating service proved very popular, but the actual overall economy of the plant was not as great as had been anticipated.

A year later the construction of a central heating plant was begun in the business district of the city. This second project was undertaken, not as a means of disposing of exhaust steam, but for the express purpose of supplying the demand for central heating service among the owners of downtown buildings, who were considering shutting down their plants and purchasing electric service. The downtown plant was built primarily as a heating plant, and though provision was made for electric generating units they were never installed and the heating mains were supplied with steam from the boilers through reducing valves.

With the development of the large condensing generating stations the generation of current in the heating plants grew less and less attractive and when a third heating plant became necessary, because of increasing demand for steam heat, no provision was made for electric generators. The same practice was followed when, in 1916, the original exhaust-steam plant was rebuilt; and when the steam-distribution system of another company which had been engaged in the generation of electricity and the distribution of exhaust steam in the business district was purchased by the Detroit Edison Company, the new plant which was built to supply this district was also designed as a heating plant only. The entire combined distribution system is now being supplied with live steam from the boilers through reducing valves.

Since there are no generating units exhausting into the heating system the pressure carried on it is not limited by considerations of back pressure. On those sections of the system formerly supplied with exhaust steam at from 2 to 5 lb. pressure, the pressure now maintained ranges from 5 to 15 lb. and is being increased from year to year, toward the upper limit permitted by the strength

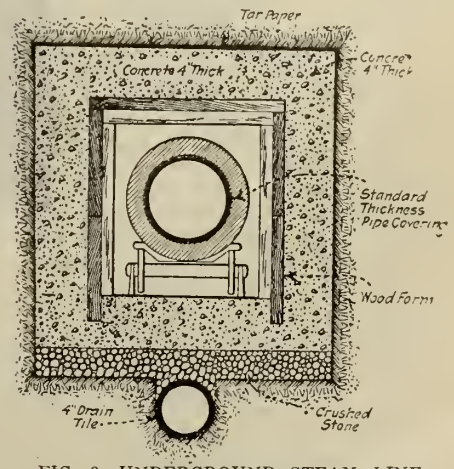


FIG. 3—UNDERGROUND STEAM LINE CONSTRUCTION.

of the pipes. The pressure on the section originally designed as a live-steam system is about 30 lb. Because of the increased capacity of the distribution system at higher pressures, due to the greater density of the steam and the greater allowable pressure drop, these higher distribution pressures are desirable.

The steam is delivered to the network of mains through connections made at the plants and also through feeders, from the plants which deliver steam to certain feeding points in the distribution network, the method being similar to the feeder and main method employed in electric-distribution systems.

Reasons For Using Live Steam

The supplying of live steam to the heating system and the abandonment of the generation of current in the heating plants is commercially justifiable, even though such current would be generated at a high thermal efficiency. The underlying reason for this is that there exist certain unfavorable conditions which outweigh the thermal advantage and make the total cost of such current higher than the generating cost at the large and efficient main generating stations.

The method of live-steam operation was adopted in Detroit before the recent great advance in the price of coal. The present high price of coal makes exhaust-steam operation appear somewhat more favorable and it is, of course, conceivable that at some future date a very high coal price may compel a change of policy. But with the cost of underground lines also increasing, the saving in distribution investment will probably continue to be sufficient to justify a continuation of the present methods.

Distribution System

The popularity of the heating service in Detroit has led to its development on an extensive scale. The present distribution system covers an area about 2 miles long and half a mile wide which includes the entire central shopping, business, and financial districts and a small portion of the residence district. About 2,700,000 sq. ft. of radiation, besides numerous water heaters and cooking fixtures, are served. The distribution system contains about 20 miles of tunnels. The four boiler plants which supply steam to the system contain 17,470 rated boiler horsepower, and they delivered in 1918 nearly two billion pounds of steam to the system. Over 1,700 consumers are served.

Though originally built in three distinct sections, the system is now a practically continuous network, and the plants are so much interconnected that the load can readily be shifted from one to another. In the spring and early autumn two of the four plants were the entire area.

The four boiler plants in Detroit which supply steam to the heating system are equipped with water-tube boilers and underfeed stokers and are of modern design throughout. Their location in the central district of the city necessarily restricts the amount of land which they may occupy and demands a suitable type of architecture, absolutely smokeless operation, and extreme cleanliness in the handling of coal and ashes.

A cross-section of the Congress street plant, the newest of the four, is shown in Fig. 2. It is designed to eventually contain four 1,300-h.p. boilers and two 2,600-h.p. boilers of the "W" type. In the effort to reduce the amount of attendance labor at this plant the auxiliaries are located, for the most part, on the boiler-room floor so as to be within convenient reach of the few men constituting the operating crew. Coal is hauled from bunkers at the railroad sidings to the plant in drop-bottom buckets of 5 tons capacity, which are lifted by a crane and emptied into overhead hoppers from which the coal is distributed by belt conveyers to the boiler bunkers. Ash-handling equipment is practically nil, the boilers being set at a sufficient elevation to allow wagons to be driven beneath the hoppers.

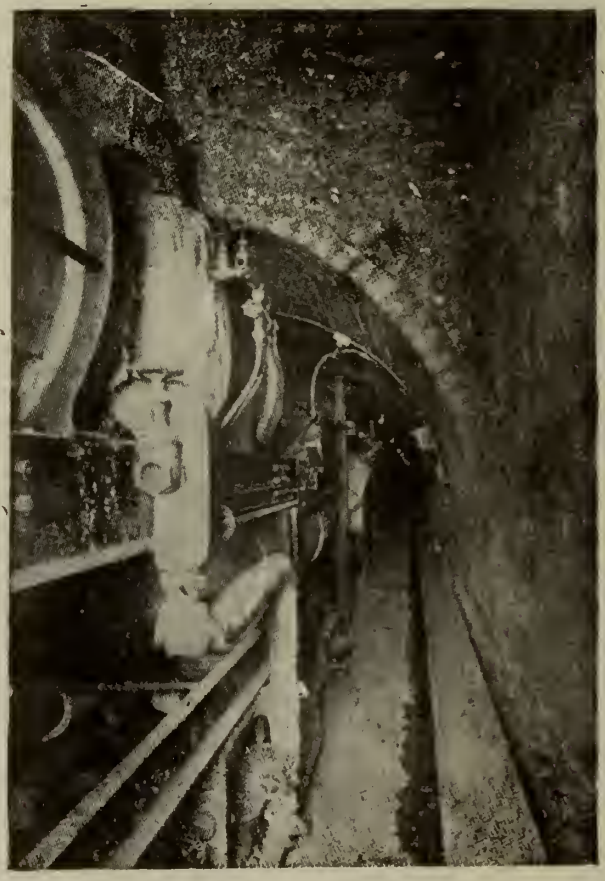


FIG. 4—TUNNEL CONSTRUCTION FOR STEAM LINES.

Because of the fact that only a relatively small amount of condensation is returned to the plants, careful treatment of the raw water is necessary. The feedwater flows through live-steam purifiers, operating at boiler pressure, in which the scale-forming materials are precipitated. In addition, sodium carbonate is fed in automatically graduated amounts to reduce the slight amount of hard scale-forming material which finds its way into the boiler. Although Detroit water is not a bad boiler water, these precautions are necessary because of the large percentage of make-up water and the rather high rates of steaming at which the boilers are sometimes driven.

The auxiliaries are almost entirely motor driven. The current is supplied by a 750-kw. turbo-generator unit exhausting into an open feedwater heater. The load carried on this generator is adjusted according to the requirements for exhaust steam for heating the feedwater and any excess current generated is delivered to the outside electric-distribution system. Conversely, if the electricity requirements of the plant exceed the output of the generator, current is drawn from the outside supply. Exhaust steam is thus made available for heating the feedwater and the advantages of motor-driven auxiliaries are also secured. Moreover the turbo-generator constittues a source of electricity supply for the plant in case of local interruption of the outside service.

Steam is generated at a pressure of 130 lb. gauge. This pressure is chosen in order to provide for considerable pressure drops in the outgoing feeders as calculated for present conditions. It may be raised to 160 lb. at some future date. The outgoing steam lines leave the plant through a tunnel shaft.

Feeders

Because of the great increase in connected load the transmission capacity of the distribution network, most of which was installed several years ago, is now quite inadequate. To have raised the pressure throughout the system would have increased its capacity; but the system pressure was permanently limited by the fact that most of the underground fittings are of a low-pressure pattern, and temporarily by the fact that in those sections of the system formerly supplied with exhaust steam the customers' installations are not provided with reducing valves Instead of attempting to change these conditions, which would have involved the reconstruction of much of the distribution network, the less expensive plan was adopted of running feeders from the plants to various centres of distribution. In selecting the pipe sizes for feeders, advantage is taken of the difference between boiler pressure and distribution pressure, and the size of the pipe is so chosen that at times of maximum load much or even all of this pressure drop will take place in the pipe itself. The diameter and the cost of the pipe line are thus materially reduced. In operation, the pressure of the steam de-

livered to the feeder is raised or lowered as required by the adjustment of a reducing valve at the plant, in order to maintain a constant pressure at the centre of distribution which the feeder supplies. The pressure existing at this centre of distribution is recorded at the plant by a long-distance gauge, electrically operated.

The velocity of the steam flow in the feeders at times of heavy load is very high. Velocities as great as 75,000 ft. per min. have been measured. This high velocity does not appear to be at all objectionable, however, there being no apparent erosion of the pipe and no hammer, or objectionable vibration. The fact that the steam is in a superheated state because of the pressure drop is an advantage in these respects. Feeders are constructed with long radius bends and where the connection is made to the distribution mains the diameter of the pipe is gradually increased by special taper fittings so as to reconvert a portion of the velocity head to static pressure.

A considerable pressure gradient is also allowed to take place in the distribution mains as well as in the feeders; but this is relatively small, since the upper limit is fixed by the allowable working pressure of the older mains. The more recently laid mains are capable of withstanding a working pressure of 125 lb. and the gradient in the mains can therefore be increased at some future date. From a standpoint of safety, however, the desirability of carrying pressures in excess of about 50 lb. on the service connections to buildings is questionable until further development in pressure-reducing apparatus is made.

This method of steam distribution is obviously an adaptation to previously existing conditions and would doubtless be modified if an entirely new system were being laid out.

Underground Construction

The distribution mains range in size from 20 in. near the stations to 4 in. at the outskirts of the system. The original underground pipes were laid in a segimental wood casing bound with wire. This construction has been fairly successful under favorable soil conditions, but the concrete conduit shown in Fig. 3 has been found to be superior in many respects and has been used exclusively for several years in all new construction. In this construction the pipe is insulated with a standard thickness of pipe covering and surrounded with an envelope of concrete poured over a wooden form, leaving an air space around the pipe. Proper underdrainage is of course essential.

The longitudinal expansion and contraction of the pipe, due to changes in its temperature, are absorbed, in the earlier construction, by means of expansion fittings of the copper-diaphragm type. In recent construction a slip joint, consisting of a brass sleeve, sliding in a packed gland, has been used. The use of slip joints decreases somewhat the cost of the pipe line as they will absorb more travel and can be placed at wider intervals than the diaphragm fitting.

The underground mains have not been laid sufficiently long to permit of an accurate estimate of their life. The oldest lines laid in wood casing have now been in service 15 years and, while the casing in many places has deteriorated considerably, in other places it is in fairly good condition. The concrete construction, dating back 10 years, seems to have deteriorated very little. The only repairs or replacements which have been made to date have been made necessary by external corrosion or pipe arising from some outside and local cause such as a water-pipe leak. An average life of 20 years for the wood log construction and 30 years for the concrete construction would seem to be a very conservative estimate. Soil conditions in that part of the city where the heating mains are laid are particularly favorable, the soil being very well drained. Manholes are located at intervals of about one city block (300 to 400 ft.), to house the slip joints, valves and bleeder traps.

In the heart of the business district the pipes are in tunnels, of which there are about 2 miles, lying from 25 to 40 ft. below the street level. In cross-section they are similar to a horseshoe and are built of brick, with concrete floors. (Fig. 4). For the most part they are about 6 ft. in heiht and 6 ft. wide. The tunnels are ventilated by suction fans which draw a small amount of air through them continuously and much larger amounts when it becomes necessary for men to work in them. Their temperature ranges between 90 and 130 deg. Fahr. When two or more pipes are to be laid under a street in a congested district it has proved desirable to build a tunnel to avoid the inconvenience to the public attendant upon tearing up the street, either for the original construction work or for subsequent changes. The tunnel permits of ready access to the pipes at any time, and since it is far below any other structures, no obstructions are met with. Tunnel construction is exceptionally simple in Detroit where the subsoil is a blue clay nearly impervious to water and well adapted to tunneling operations. The cost of tunnel construction is high, but the advantages gained are compensatory.

Distribution Losses

Distribution losses from various sources are considerable. Heat losses from the mains are the principal item. This loss can be controlled within limits in designing the system of the application of the proper amount of insulation, so as to produce the most economical relation between heat loss and investment costs. Besides the condensation losses in the mains and service connections, there are losses due to the leakage of steam from consumers' piping and air valves, and loss due to the escape of unmetered condensation, and the slip of meters. About 80 per cent. of the steam delivered by the plants is metered as condensation in the consumers' buildings. This figure compares favorably, considering the nature of the business, with the efficiency of electrical distribution. In 1918, for example, the ratio between the electrical plant output and the consumers' meter readings for the Detroit district was 83 per cent., the large items of loss being transmission, transformation and conversion.

The condensation from the buildings heated is returned to the plants only to

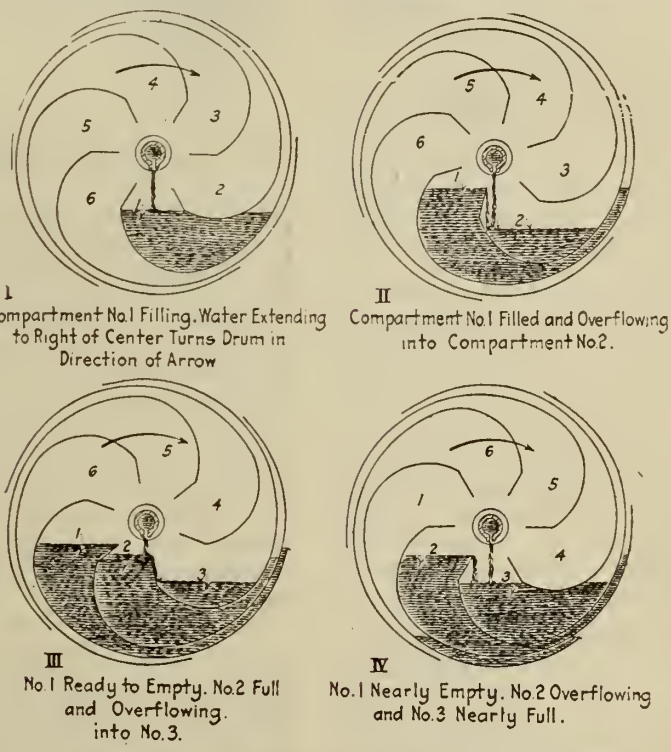

I
Compartment No.1 Filling. Water Extending to Right of Center Turns Drum in Direction of Arrow
II
Compartment No.1 Filled and Overflowing into Compartment No.2.
III
No.1 Ready to Empty. No.2 Full and Overflowing into No.3.
IV
No.1 Nearly Empty. No.2 Overflowing and No.3 Nearly Full.

FIG. 5—CONDENSATION METER AND PRINCIPLE OF OPERATION.

a very limited extent. In the tunnels it is necessary to install a return line to receive the discharge from the traps on the steam lines, and wherever possible the condensation is drained from the adjacent buildings to this line. It is difficult and costly, however, in many cases, to arrange a gravity discharge from the building basements to the tunnel, and the cost of installing and operating pumps to handle the condensation would more than offset the value of the heat and the feedwater which would be salvaged.

In the districts not served from tunnels, all of the condensation is wasted to the sewers. Even with the present high cost of coal, return lines would scarcely be a profitable investment. Furthermore, they are short-lived, and any leakage from them is disastrous to adjacent steam lines. The proper method of salvaging the heat in the condensation is by means of an economizing coil in the consumer's building.

Consumer's Installations

The consumer's equipment includes, besides the usual radiators and piping, a pressure-reducing valve, which reduces the service pressure to the lower pressure required for heating, and a trap whose function is to discharge the water of condensation from the system.

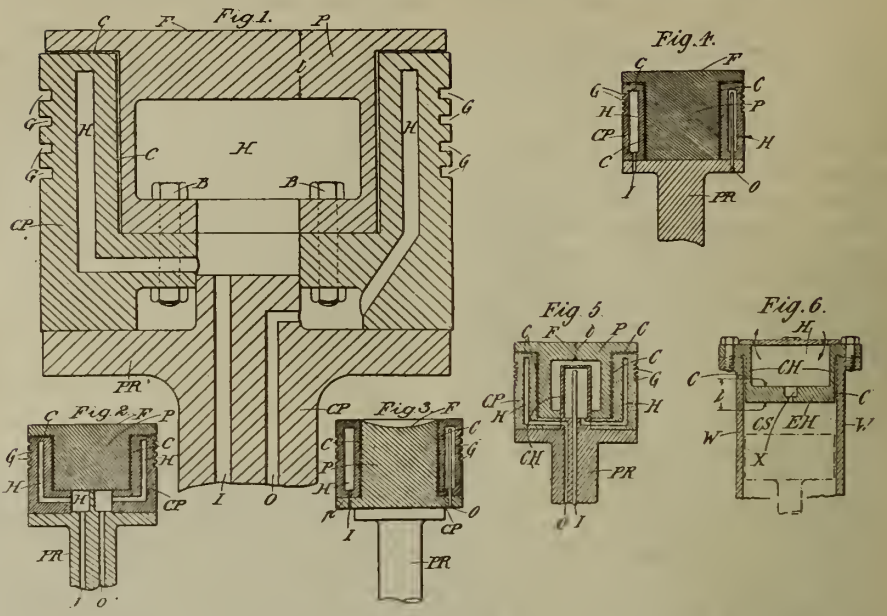
Economizing coils, utilizing the heat in the condensation, are recommended by the company, but not required. They are seldom installed in any but the largest buildings, as few consumers care to make the necessary investment even though a demonstrated saving can be made. In some buildings the condensation is passed through a surface heater which preheats the water used for lavatory purposes, and this seems to be the most satisfactory form of economizer for large buildings.

The regular heating season covers 8 months of the year, though summer service for cooking and water heating is supplied to a few consumers conveniently located. Cool weather in September usually makes necessary the commencement of service before the contract date of October 1. It has, in fact, been started in August. Steam was originally sold to some extent for power purposes, but this service is now practically discontinued.

Meters

The meter first used in Detroit was of the tilting type, consisting of a rectangular pan of two compartments hung on knife-edge or ball bearings, the compartments filling alternately and, when full, tipping the pan so as to bring the opposite compartment to the filling position. In 1907 a revolving meter was devised, consisting of a drum of four compartments which filled and dumped successively, the drum being revolved by the weight of the water. This meter was fairly successful and a few of that design are still in use, but a greatly improved design of revolving meter, operating on the same general principle (Fig. 5), was originated in 1909 by Hans Resert and is being used at present, with slight modifications.

THE DOXFORD DIESEL ENGINE



FIGS. 1-5—DIESEL ENGINE PISTON WITH PLUG MAINTAINING TEMPERATURE OF 800° F. FIG. 6—CYLINDER HEAD DESIGNED FOR SAME PURPOSE.

IN the ordinary Diesel engine the temperature to which it is necessary to raise the air within the cylinder at the end of the compression stroke necessitates a high degree of compression, which is generally about 480 lb. to 500 lb. per square inch. If it is possible to maintain some portion of the surfaces of the combustion chamber at a high temperature throughout the whole cycle, say at a temperature of not less than 800 degrees Fahrenheit, then it would be permissible to employ a much lower compression pressure, which could be in the neighborhood of 320 lb. per square inch.

The advantages derived from such an arrangement are obvious; in the first place it allows of a lighter design of engine owing to the reduced pressures, whilst it also facilitates the adoption of a system of solid injection of fuel, which does not present so many difficulties when the pressure to be overcome is not more than 320 lb. per square inch instead of the usual 480 or 500.

In a recent arrangement, patented by Mr. R. P. Doxford and Mr. K. O. Keller, this principle has been carried into effect. The design is intended to apply either to an ordinary vertical Diesel motor with a single piston and a normal cylinder head, or in an opposed-piston engine such as is being developed by Messrs. William Doxford and Sons, wherein two pistons moving outward and inward form on their inward stroke the combustion chamber between the surfaces of the two pistons and the cylinder walls around them.

Dealing with the patented design as it applies to this type of engine, and referring to Fig. 1, it will be noticed that there is a large plug (P), which is exposed at one end to the combustion chamber and to the hot gases, and is bolted at its inner end with the cylindrical portion (C P) of the piston, this being secured to the top end of the piston rod in any convenient manner. In the cylindrical portion of the piston rod are the usual grooves (G) for the piston rings, and in other respects there is no novelty in the design.

There is a large water space (H) for cooling both the cylindrical portion of the piston, the bolts holding the piston to the plug and the bottom of the plug, but the thickness of the plug "t" is sufficient to prevent the cooling water lowering the temperature of the plug at its outer face (F). There is a clearance (C) between the plug and the cylindrical portion of the piston, which allows expansion and contraction of the plug without causing any undesirable stresses in the piston. The plug should be preferably of mild steel, while the piston can be of cast-iron of suitable mixture. In an opposed-piston engine each piston would be designed in this way, whilst in the ordinary Diesel engine the cylinder cover would have a plug instead of the piston, the piston being of normal design. This is illustrated in Fig. 6, whilst Figs. 2, 3, 4, and 5 show alternative arrangements with the opposed-piston type of motor.

Apart from the advantages of lower compression pressure, as mentioned above, it is claimed that with this design, since the high temperature is maintained throughout the whole of the stroke, the efficacy of combustion does not fall off, which is liable to happen with the usual type, especially if solid injection is employed with heavy fuel oil. It is for this reason that with solid injection it is the custom to use the lighter grade of fuel oil.

We understand that this system is to be employed in the 3,000 h.p. four-cylinder motor of the opposed piston which is now being built by Messrs. Wm. Doxford and Sons, Ltd., at their Sunderland works for installation in a cargo ship.

Rules for Computing Required Radiation

"Domestic Engineering" Gives the Following Abstract of the Rules Submitted to the National District Heating Association by the Rules and Regulations' Committee

IT has been the desire of a great many members of the association for the past few years to have the National District Heating Association adopt a standard rule for figuring required steam and hot water radiation. There have been several papers on this subject presented before the association in the past and as there was such a great number of rules used by the various member companies, some of which did not check within 50 to 75 per cent. of each other, the adoption of a standard rule has been carried over from year to year by the association with no action taken.

Two years ago when the educational committee decided to get up an association handbook, it was suggested that they adopt a standard rule for figuring radiation, which would be known as the National District Heating Association rule, and make it a part of the handbook.

The Educational Committee was so busy that year with other matters that very little work was done on the radiation formula, and when the new committee on rules and regulations was appointed last year, the formulating of a standard rule for figuring radiation was turned over to them.

There have been numerous drafts of a proposed rule submitted to the committee members in the past three months, and as there are fourteen members on the committee, there has been a great deal of criticism and discussion on same, which resulted in a great many changes and additions to the original draft. Some of the members were of the opinion that the scientific method was too complicated, and that we should adopt a rule similar to rules Nos. 2 and 3. Other members were of the opinion that further additions should be made to the rule. As a result the rules which the committee is now submitting to the association for its approval and adoption do not meet with the individual ideas of each member, but the committee is agreed as a whole that if the proposed rules are adopted by the association as their standard, there is sufficient data in same so that the various members of the association can compile simplified formulas to fit their local conditions if they do not care to adopt rule No. 1 for general use.

Table No. 4 of rule No. 1, which gives the coefficients of heat transmission from the various types of radiation and pipe coils, is the latest addition to the proposed rules, and while they will probably not be used for general use, they are included for use by engineers who wish to go into complete detail in the design of heating systems.

Suggested rules Nos. 2 and 3 are samples of simplified rules which can be computed from the data in rule No. 1 to fit and fixed local conditions. It is the desire of the members of the Rules and Regulations Committee in publishing the proposed rules in the bulletin to have all members of the Rules and Regulations Committee in before the convention in June, at which time the formal adoption will be requested.

Rules for Determining Square Feet of Radiation Required to Heat a Building

The following rule No. 1 is what is known as the B.t.u. rule for figuring radiation and can be applied to any condition of temperature differences or any type of heating system, either steam or hot water. It is recommended for use to member companies, heating engineers, architects and heating contractors.

Rules Nos. 2 and 3 are examples of rules which are known as simplified or short-cut methods for computing required radiation. They are made up from the factors in rule No. 1 and fit a certain type of building construction and temperature difference. When circumstances make it advisable, in the case of any particular heating company, to have in use a simplified formula, a rule similar to rules Nos. 2 and 3 can be made up from the factors in rule No. 1 to fit local conditions, with an average type of building construction.

Any room or space having an opening which may communicate with the rooms or space to be heated, whether radiation be installed or not in such rooms or space must be considered in the measurements for space heated in either of the following ways, depending on the existing conditions:

1. If the unheated space is an active room and has a door or other opening which opens into the adjoining heated space and such doors or openings are left open the majority of the time, the entire space should be included in the measurements and sufficient radiation installed in the heated rooms.

2. If the unheated space is an active room and the doors or other openings are left open the majority of the time, the space and exposures of the unheated room should not be included in the measurements, but the walls adjoining the unheated and heated space should be taken as exposed surface in the measurements for the heated room. Basements and attics, which are used for storage purposes only, should not be considered as space to be heated.

Following are the three rules referred to above.

Rule No. 1

Since the radiation in any room must emit sufficient heat to compensate for all heat losses from that room and since heat is transmitted by different building materials at different rates, it follows that:

Radiation required = B.t.u. lost per hr. from room ÷ B.t.u. emitted per sq. ft. of radiation per hr. = H ÷ B.t.u. per hr. from radiation.

R = H ÷ X (temperature difference between contents of radiator and room temperature).

The value of X in the following computations is taken as 1.7 B.t.u., which is the coefficient of heat transmission from the type of radiation most generally used. See table No. 4 for coefficients for various types of radiation and pipe coils.

Gravity straight steam systems having from 1 to 3 lbs. pressure:

$$R = \frac{H}{1.7(220-70)} \text{ per season 3-lb. gauges} = \frac{H}{255}. \text{ Safe Value} = \frac{H}{250}$$

Vapor systems with individual traps on the return end of each radiation:

$$R = \frac{H}{1.7(212-70)} \text{ for steam at atmospheric pressure} = \frac{H}{241}$$

$$\text{Safe value} = \frac{240}{H}.$$

Atmospheric systems with open trap return and excess radiation for cooling surface:

$$R = \frac{H}{1.7\ (212-70) \div 120} = \frac{H}{200}$$

Hot water systems having an average of 170 degrees water:

$$R = \frac{H}{1.7(170-70) \quad 170} \qquad \frac{H}{165}$$

Theoretically, one B.t.u. will heat 55 cu. ft. of air one degree F., allowing for safety and simplicity in figuring. Fifty cu. ft. are used, which makes the constant for one change .02 B.t.u. per degree difference in temperature.

In computing required radiation for well-constructed residences and office buildings, good practice allows one change of air per hour; well-constructed store buildings two air changes per hour. For buildings of loose construction and those employing some method of forced ventilation, more air changes per hour will be considered, depending upon the existing conditions of buildings and ventilating system.

Table No. 1 shows the B.t.u. required to heat one cubic foot of space at various temperatures and air changes.

Table No. 2 shows the B.t.u. losses per hour through one square foot of various building materials with varying temperature differences.

Table No. 3 shows the percentage by

TABLE NO. 2.

	B.T.U. Difference K	Difference in Temperature Between Room and Outside. 50°	60°	70°	80°	85°	90°
Windows, single glass, full sash area	1.25	62	75	87	100	106	112
Windows, double glass, full sash area	.60	30	36	42	48	51	54
Plate glass	1.00	50	60	70	80	85	90
Skylight, single glass, full sash area	1.10	55	66	77	88	94	99
Skylight, double glass, full sash area	.60	30	36	42	48	51	54
Wooden door, 1-inch	.40	20	24	28	32	34	36
Wooden door, 2-inch	.36	18	22	25	29	31	32
Brick wall, 8½-inch plain	.37	18	22	26	30	32	33
Brick wall, 13-inch plain	.29	14	17	20	23	25	26
Brick wall, 17½-inch plain	.24	12	14	17	19	21	22
Brick wall, 22-inch plain	.21	10	13	15	17	18	19
Brick wall, 27-inch plain	.19	9	11	13	15	16	17
Brick wall, furred and plastered, use .7 times non-furred.							
Stone wall, use 1.5 times brick wall.							
Concrete, 2-inch solid	.78	39	47	55	62	66	70
Concrete, 3-inch solid	.71	35	43	50	57	60	64
Concrete, 4-inch solid	.66	33	40	46	53	56	59
Concrete, 6-inch solid	.56	28	34	39	45	48	50
Frame wall (plaster, lath, stud, clapboard)	.50	25	30	35	40	43	45
Frame wall (plaster, lath, stud, sheathing, clapboard)	.28	14	17	20	22	24	25
Frame wall (plaster, lath, stud, sheathing, paper, clapboard)	.23	11	14	16	18	20	21
Hollow tile, 2-inch, ½-inch plaster, both sides	.41	20	25	29	33	35	37
Hollow tile, 4-inch, ½-inch plaster, both sides	.33	16	20	23	26	28	30
Hollow tile, 6-inch, ½-inch plaster, both sides	.28	14	17	20	22	24	25
Solid plaster partition, 2-inch	.60	30	36	42	48	51	54
Solid plaster partition, 3-inch	.50	25	30	35	40	43	45
Concrete floor on brick arch	.20	10	12	14	16	17	18
Fireproof construction as flooring	.10	5	6	7	8	9	9
Fireproof construction as ceiling	.14	7	8	10	11	12	12
Single wood floor on brick arch	.15	8	9	11	12	13	14
Double wood floor, plaster beneath	.15	8	9	11	12	13	14
Wooden beams planked over, as flooring	.17	9	10	12	14	14	15
Wooden beams planked over, as ceiling	.35	17	21	25	28	30	32
Lath and plaster ceiling, no floor above	.62	31	37	43	50	53	56
Lath and plaster ceiling, floor above	.25	13	15	18	20	21	22
Steel ceiling, with floor above	.35	17	21	25	28	30	32
Single ¾-inch floor, no plaster beneath	.45	23	27	32	36	38	41
Single ¾-inch floor, plaster beneath	.26	13	16	18	21	22	23

Percentage of Increased Radiation Due to High Ceilings.

Room 12 to 14½ ft. from floor to ceiling	3%
Rooms 14½ to 18 ft. from floor to ceiling	6%
Rooms 18 ft. and above from floor to ceiling	10%

which the B.t.u. loss obtained from table No. 2 will be increased when the exposure is other than southern.

To compute the radiation required in any room:

First—Compute the B.t.u. required to heat the air in the room by multiplying the cubical contents by the proper factor.

Second—Compute the B. t. u. lost through the doors and windows by multiplying their area by the proper factor.

Third—Compute the B.t.u. lost through the walls, floor and ceilings in the same manner.

For steam radiation (one to three lbs. pressure)—Divide the sum of these results by 250 and the quotient is the number of square feet of straight steam radiation required.

For vapor radiation (with radiator traps)—Divide the sum of these results by 240 and the quotient is the number of square feet of vapor radiation required.

For atmospheric radiation (with extra cooling surface)—Divide the sum of these results by 200 and the quotient is the number of square feet of atmospheric radiation required.

For hot water radiation (water at 170 degrees F.)—Divide the sum of these results by 165 and the quotient is the number of square feet of hot water radiation required.

Percentage by which the heat losses given in table No. 2 are increased if the exposure is other than southern:

TABLE NO. 3

Location.	Heat Loss is Increased Per Cent.
E. or W. rooms	5-10
N.E. or N.W. rooms	10-15

Value of X, coefficient of heat transmission from radiators:

TABLE NO. 4.

Height of Radiators Inches	One Column	Two Column	Three Column	Four Column
20	1.93	1.85	1.75	1.64
23	1.89	1.80	1.70	1.59
26	1.86	1.76	1.66	1.56
32	1.79	1.69	1.59	1.49
38	1.74	1.65	1.55	1.45
45	....	1.60	1.50	1.40

B.T.U. per sq. ft. per hour per deg. dif. in temperature

WALL COIL:

Heating surface—	
5 sq., ft., long side vertical	1.02
5 sq. ft., long side horizontal	2.11
7 sq. ft., long side vertical	1.70
7 sq. ft., long side horizontal	1.92
9 sq. ft., long side vertical	1.77
9 sq. ft., long side horizontal	1.98

PIPE COIL:

Single horizontal pipe	2.65
Single vertical pipe	2.55
Pipe coil 4 pipes high	2.48
Pipe coil 6 pipes high	2.30
Pipe coil 9 pipes high	2.12

TABLE NO. 1.

No. Air Changes	B.T.U. 1° Difference	Difference in Temperature Between Rooms and Outside. 50°	60°	70°	80°	85°	80°
½	.01	.50	.60	.70	.80	.85	.90
¾	.015	.75	.90	1.05	1.20	1.27	1.35
1	.02	1.00	1.20	1.40	1.60	1.70	1.80
1½	.03	1.50	1.80	2.10	2.40	2.55	2.70
2	.04	2.00	2.40	2.80	3.20	3.40	3.60
3	.06	3.00	3.60	4.20	4.80	5.10	4.50
4	.08	4.00	4.80	5.60	6.40	6.80	7.20

Rule No. 2

Rule No. 2 is to be used for computing the required steam radiation for a building assuming a temperature of 70 degrees inside with an outdoor temperature at zero, with 13-inch brick walls or average frame construction. Windows, single glass, set tight, and assuming one and one-half changes of air per hour in the building.

R=.008C+.08W+.35G.

R=Required steam radiation with system using steam at 1 to 3 lbs. pressure.

C=Cubic feet of space to be heated.

W=Square feet of exposed wall surface.

G=Square feet of exposed glass surface.

Note—No allowance made for extreme exposures.

Rule No. 3

Rule No. 3 can be used for computing required hot water radiation for a building, assuming a temperature of 70 degrees inside with an outdoor temperature at zero, with 13-inch brick walls or average frame construction. Windows, single glass, set tight, and assuming one and one-half changes of air per hour in the building.

R=.013C+.12W+.53G.

R=Required hot water radiation with average temperature of water in system of 170 degrees F.

C=Cubic feet of space to be heated.

W=Square feet of exposed wall surface.

G=Square feet of exposed glass surface.

Note—No allowance made for extreme exposures.

A simple device for improving the shearing strength of bolted joints in wooden structures has been brought out by Professor C. Forssell, of Stockholm. It takes the form of a corrugated washer, which is threaded on the bolt between the two pieces to be joined. The bolt is tightened against a pair of plain washers on the outside with sufficient pressure to force the corrugations into the wood. The strength of the joint is thus unaffected by the bolt hole, and depends on the friction between the two surfaces which are proportionate to the size of the washer and the depth of the corrugations. The strength of the joint is increased, according to Ingenioren, about twofold. The washers are known as "Bufo" washers, and made in various sizes, but all 1-16 in. thick, with corrugations about 9-32 in. high. In order to permit sinking into the wood, it is necessary to remove all knots at the joints to a depth of 3-16 inch. to 3-8 inch. The bolt is screwed up with spanners not less than 2 ft. to 2½ ft. long, and it is necessary to repeat the process after the first 48 hours and a further 72 hours.

An American still holds the world's airplane altitude record with 28,900 ft., as recent rereading of the British claimant's instruments showed a revised height of only 27,000 feet.

DIRECT USE OF COAL AS FUEL WASTES MANY VALUABLE BY-PRODUCTS

In a monograph on the subject of the "Coal Resources of Canada—Their Relation to the Industrial Development of the Country," by Mr. F. E. Lucas, published in The Final Report of the Fuel Controller, the advantages of using coal in the production of coke, rather than using coal directly as fuel, are pointed out. After showing the favorable qualities of coke as a fuel, the paper says:

"In the production of coke many valuable by-products are obtained; gas tar, ammonia, benzol, toluol, xylol, and naphtha, or combining the latter four, a motor fuel much superior to the best gasoline obtained.

"We are not getting anything like the amount of light, heat, or power we should, or could get, and in getting this extra light, heat, or power, we would not only be conserving the coal supply but geting cheaper power and at the same time recovering other products which would be of great economic value to the country and lead to the extension of existing industries and the establishment of new ones.

"Starting with the importation of anthracite, which is practically all used as domestic fuel. This can be almost entirely eliminated, and in so doing give as large returns on the invested capital as any industrial concern in the country.

"Referring back again to the by-products, a word now about their use and the markets available.

Gas

"If the plant is near a large city or thickly populated district, it might all be sold for domestic lighting and heating. This is done in many districts by selling direct to existing gas companies, for no gas company can produce gas at the price at which a by-product coke plant can afford to sell it. Or if there are large industrial works within reach, it can be sold to them and at such a price as to be more economical than coal, or it can be used in gas engines and power developed. The figure generally accepted as being reasonably conservative for gas-engine practice is 11,500 B. T. U. per horsepower, and it will readily be seen how tremendous quantities of power can be made available from this source.

Gas supplies for domestic use must have the sulphur extracted. This is done by iron oxide, from which the sulphur can be recovered for the manufacture of sulphuric acid, which is needed for the production of ammonium sulphate.

Tar

"This product can be used directly as a boiler or furnace steel by being burned in the same manner as oil, or it can very cheaply be dehydrated and the more highly volatile matter extracted and then used for road binding. Even for firing it would be found advantageous to dehydrate. Some tars, depending on the temperature and conditions of the coking process, can be used as fuel for Diesel engines. The most economical way to handle the tar, however, is to distill it and recover the various volatile fractions, such as the benzol, tuluol, naptha, the carbolic oils, creosote, naphthalene, and pitch.

"The benzol, toluol, naphtha, etc., can be added to that recovered directly from the gas, for motor fuel. The crude carbolic finds a market with manufacturers of antiseptics, colors, explosives, and a great deal is used in recent years on the manufactures of phonographic records, imitation amber for pipes, etc.

"So far as the value to the country is concerned, the creosote recovered is one of the most valuable by-products of the coal. Railway ties have doubled in price in the past ten years, and there is every prospect of a pro rata increase in further years. The forestry branch reports 19,-100,000 ties used on Canadian roads in one year. A fairly safe assumption would be a complete renewal of all ties every five years, while fifteen years might be taken as a reasonable average life for creosoted ties. The cost of creosoting is less than the cost of a new tie, so that the creosoting of the ties becomes not only a commercially attractive proposition, but will save many millions of feet of lumber annually.

"The same process of reasoning may be applied to mine ties and timbers, and also to bridge timbers.

"The general adoption of the creosoting proces would materially reduce this number in a few years. If we assume a consumption of only 10,000,000 ties per annum there would be required about 25,-000,000 gallons of creosote oil per year, or the distillation of 85,000,000 gallons of tar, which would in turn require the carbonizing of 8,000,000 tons of coal.

"The naphthalene finds a market as a color base. For the manufacture of deodorizers, disinfectants, moth balls, etc., and also in the manufacture of a chlorinated wax for use in electrical work.

Benzol

"Under this name is often included the tuluol, xylol and naphtha, which are recovered at the same time. Each of these products, together with naphthalene, can be recovered separately and refined to their chemically pure state, and there will undoubtedly be a market for a small quantity of each for solvents, dry cleaning, dyes, explosives, etc. During the war the toluol and a considerable portion of all benzol recovered was used in the manufacture of explosives.

"The greatest market now the war is over is undoubtedly to combine the four products, benzol, toluol, xylol and solvent naphtha, as a motor fuel, giving a product which distills between 78 and 165° C. This fuel has been carefully tested and found to give from 20 to 30 per cent. greater mileage than the best gasolene, with about 15 per cent. greater power, easier starting, no knock with advanced spark and actually less tendency for the formation of carbon in engine cylinders. Benzol itself comprises approximately 70 per cent of the fuel and this freezes at 44° F. The addition of the toluol and other products named, in the proportion in which they are recovered, brings the total fuel mixture down to a freezing point of approximately zero F., so that to make an all-year fuel for our climate we have to mix with sufficient gasolene to lower the freezing point still further. The addition of 25 to 30 per cent. of gasolene gives a freezing point low enough for most places, except in the north, where it might be necessary to add as high as 50 per cent.

"According to Government statistics, Canada's consumption of gasolene in 1916 was 74,000,000 gallons, of which 18,000,000 gallons was imported as distilled product, and most of the remainder was made from imported crude oils. So that it is evident that with a total Canadian production of say 20,000,000 tons of coal, if it was all carbonized and the motor fuel recovered, the market would still be far short of being satisfied. This does not take into consideration the fact of the continued yearly increase in consumption which is bound to occur.

"The pitch remaining can be made of almost any consistency desired. It can be made so hard that it can be pulverized and used as boiler fuel or in the same state that it can be used as a binder for briquettes. In its softer state it is also used as a binder for briquettes, for roofing and road making. It is also mixed with the lighter portion of the distillate for the manufacture of paint for special purposes.

Ammonia

"While this has been shown in the balance sheet as sulphate of ammonia which is used almost entirely as a fertilizer, yet it can be recovered in the form of concentrated liquor containing from 16 to 25 per cent. ammonia for the manufacture of explosives, or in the form of dry ammonia gas for refrigerator purposes, or as the aqua ammonia of commerce and chemistry. However, these are only small markets when compared with the market as a fertilizer. Its only competitor, as a nitrogenous fertilizer, is nitrate of soda from Chili, and as the population of the country increases and virgin lands become exhausted, we must, if we are to be fed, keep up the productiveness of the land in a great measure by the use of artificial fertilizers.

"An investigation into the yield per acre of Great Britain and the amount of nitrogenous fertilizer used when compared with America will readily substantiate these statements and set at rest any doubt regarding future markets. Considering the agricultural acreage of Canada and the fact that except for such parts as are growing leguminous crops the dressing for some crops should be even as high as 250 pounds of sulphate of ammonia per acre per year, we have further proof of the continuity of the market."

The Combustion Engineering Corporation, New York, has issued a bulletin on the C.E.C. tube scraping device. This bulletin describes a new and novel method of scraping the cinder and ash from the lower boiler tubes.

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James Watt

THE one-hundreth anniversary of the death of James Watt, occurs at a time when the fruits of his genius have been fully manifest to the world. His discoveries and improvements in the use of steam marked the beginning of a new era in human progress, one in which the forces of nature were harnessed to do man's bidding and to work subservient to his will. For what his work stands for in human accomplishment as well as for the man himself the anniversary of his death, August 19th, is of more than passing interest to the engineer.

Suffering poor health and faced with many adverse circumstances, Watt found time and energy not only to engage in the inventive career which brought him fame, but also turned to philosophical pursuits and secured for himself the friendship of men of science and letters.

His contributions to engineering knowledge were much wider than those embraced in the science of steam engineering and included a machine for drawing in perspective, one for the automatic duplication of carved work of any kind, and in another line of endeavor an investigation into the composition of water, then unkown.

Artificial Respiration

THE use of artificial aids to respiration in the treatment of electric shock has been given much attention of late years by various engineering bodies. The Commission on Resuscitation from Electric Shock representing the American Medical Association, the National Electric Light Association and the American Institute of Electrical Engineers has recently issued a revised code of rules for this purpose. This set of rules reprinted in another part of this issue should be carefully read and memorized by all having to do with the operation of electrical equipment of any nature.

Better still it is strongly recommended by those having the safety and accident prevention features of plant operation at heart, that active instruction and training be given to those employees most likely to have use for resuscitation methods.

The value of the prone pressure method has been amply demonstrated in the past few years and it has rapidly supplanted older methods. It is also preferred by many to the use of mechanical respiration apparatus.

Aside from its use in the treatment of electrical shock it is also the best method for the resuscitation of those overcome by drowning, inhalation of gas, smoke or fumes, etc.

Familiarity Breeds Contempt--of Waste

IN an analysis of 100 colliery steam plants recently made in Great Britain a woeful state of affairs was found to exist. The average net efficiency of the boiler plants was only about 55.5 per cent., and that by carrying out a reorganization of these plants on modern lines it was estimated that a 70 per cent. efficiency could be easily obtained. This would correspond to a saving of about 3,900,000 tons of coal per annum and by burning refuse coal the total saving could be brought up to 6,600,000 tons for the same period.

Many of the boilers are of the old Lancashire type working in the open air and with chimney draught and hand firing, so with the conditions encountered the low efficiency is not to be wondered at. The same analysis also estimates the efficiency of the steam boiler plants for the whole of Great Britain was 60 per cent.

The above figures are worth while pondering over. While many of Canada's boiler rooms could hardly be as wasteful as the one hundred horrible examples cited above, yet in the majority of them 60 per cent. efficiency could be taken as a representative figure and one which could be improved upon in many cases.

Feed water is also treated of in this report and it is stated that, "Like all other industries, collieries have not realized the necessity of treating the feed water on correct lines in order to obtain fuel economy. . . . It would be very interesting to know how many thousands of pounds the colliery industry has lost in the way of damaged boilers from neglect of proper feed water treatment."

Most colliery steam plants are not fitted with economizers and have no means of utilizing the waste heat in the flue gases. Economizers installed on modern lines will reduce the coal bill, say 17.5 per cent. under average conditions.

Mr. A. M. Wickens is Bereaved

THE many friends in Canada and the United States of Mr. A. M. Wickens, to most of whom he is affectionately known as "Dad," will be grieved to hear of the death of Mrs. Wickens in her 81st year.

It is fifty-three years since the then Miss Taylor became the wife of Mr. Wickens, and it is a remarkable fact, that although there are three sons and three daughters, all of whom with the exception of one daughter, are married and have families, this is the first occasion that death has visited any of them. Mrs. Wickens was born in London, England, and lived for some years in Brantford, to which town she came from England at the age of seventeen years. For the past thirty-five years she has been a resident of Toronto.

"Dad" Wickens himself is probably the best known man in the stationary engineering life of this country. Born in Brantford 78 years ago, he has been connected with engineering ever since the beginning of his business career. The first firm he was connected with was that of Waterous, in his home town. He went from there to the United States and was employed for some years as a machinist, and during the Civil War was on some of the river gunboats which served in that memorable campaign. Returning to Canada he became connected with Warswick Guelph, making the Brown engine, and it was here his reputation as an engineer was made. He went from there to assume the responsibilities of chief engineer of the Toronto *Globe*, and was in charge there at the time they were burnt out, and during the rebuilding. This was one of the first plants in Toronto to generate their own electric current, and drive the presses by motor. His next position was that of Chief Mechanical Engineer to the Ontario Government, which position he resigned in 1903 to become Chief Engineer of the Canadian Casualty and Boiler Insurance Co., now the General Accident Assurance Co. of Canada. He was the first to hold this position, as the company had just been formed when he was appointed. He held this position until 1911, when he was appointed Special Excutive of the same company, and resigned a few months ago to become Assistant Plant Engineer of the Consolidated Rubber Company, with headquarters at Kitchener.

Mr. Wickens has been very active all his life in movements to elevate the position of the stationary engineer. In 1887 he was active in forming the Canadian Association of Stationary Engineers which has grown to be a factor of importance in engineering circles. He was also a member of the Technical School Board before that body was absorbed in the Board of Education. It is in a great measure due to his persistent interest and efforts that the graded certificate is to become an accomplished fact in Ontario.

Mr. Wickens is also a charter member of Canada Council 27 of the Universal Craftsmans' Council of Engineers.

Mrs. Wickens accompanied her husband to many of the conventions of the C.A.S.E., and was well known to many of the members. Members of the C.A.S.E., and POWER HOUSE readers all over Canada will join in the heartfelt sympathy we express here for the Grand Old Man in his sad bereavement.

The tendency in France at the present time is to favor the manufacture of internal combustion engines of the Diesel type, and of those types which resemble it in the use of heavy ores. Before the war the manufacture of these was a prosperous undertaking. Submarine engines of this type have been built in France weighing only 27 kg. per h.p., whereas the highest German engines weighed 50 kg. per h.p.

* * * *

Peat is found in Canada in deposits from a few acres to many square miles in area, and from a few feet to as much as 50 feet thick. Even when properly drained it contains from 85 per cent. to 90 per cent. of water, although this is not apparent from its appearance. There are great deposits in Ontario and Quebec, where other fuel is conspicuously scarce. Much money has been lost in the endeavor to convert it into a commercial fuel, and experiments are still being carried out. Investigation in the Alfred Bog, where the most extensive operations in Canada have taken place, show that the peat there weighs 66 lbs. per cubic foot and contains 87½ per cent. water and 12½ per cent. solids, even when properly drained. The solid material analyzes out as 68 per cent. volatile and combustible material, 24 to 26 per cent. fixed carbon, and 5 to 7 per cent. ash. In no case has the phosphorus content been found as more than 0.09 per cent., and it is on the average about 0.03 per cent. The nitrogen content varies between 1.13 and 2.7 per cent.

* * * *

The chief reasons which have militated against the successful use of peat fuel have been the failure to recognize the fact that, owing to the colloidal properties of peat, enough water cannot be pressed out of it; that there are not enough heat units in peat to drive off the surplus water and still leave enough heat for other purposes; that the combination of driving off water by pressure and by heat compares unfavorably in the fuel produced with that obtained by grinding the peat up in its wet state and drying it atmospherically, which is a much cheaper method of preparation; and finally, that artificially dried peat has to be briquetted before use, which is a very difficult operation.

* * * *

One ton of peat containing 50 per cent. or even 60 per cent. moisture, if the latest producer gas plants are used, contains about 20,000 cubic feet of high-grade illuminating gas with 160 B.t.u. per cubic foot, or 40,000 cubic feet of medium-grade heating and power gases, with 130 B.t.u. per cubic foot, or 80,000 cubic feet of low-grade heating and power gases at about 100 to 110 B.t.u. per cubic foot. This latter grade of gas is the most economical per heat unit for steel works. In addition to the above, there are also the following by-products to be obtained by retorting per ton of peat:—800 lbs. of coke, 100 lbs. of ammonium sulphate, 40 lbs. of crude oil, 16 lbs. of paraffin, 4 to 8 lbs. of pitch, and 5 lbs. of creosote, benzol, alcohol, toluol, and antiseptics.

* * * *

An electric-heating system which utilizes power that would otherwise go to waste has been installed in a school in a southern European city. The existing hot-water pipes and radiators are connected with a well-insulated water tank of 1,300-gal. capacity. In this reservoir electric resistances are built and at night are supplied with current which raises the water to well above the boiling point. The cost of the current is low because the water power used to produce it normally would go to waste. During the day the hot water is allowed to circulate through the radiators, its volume being sufficient to warm the rooms without using more current. The desired temperature is maintained by a thermostat.

* * * *

Next time you "light up" think of this: About 10,000 matches are scratched in this country every second that passes, and of these 95 per cent. are used by smokers to fire pipe, cigar, or cigarette.

The man whose head for figures turned out that information also estimates that the time lost by the smokers in lighting matches—not in smoking—is worth $513,024 each eight-hour working day. He arrives at his estimate by figuring that it takes fifteen seconds to scratch a match and use the light, and that 213,759 men, whose time is worth thirty cents an hour, are holding matches at the same time, thus losing golden minutes at the rate of $1,068 a minute, or $64,128 an hour.

No one, so far as we can learn, has figured out how large a percentage of the match-scratchers throw away the matches while they are still burning, but it has been estimated that half of the fires which cost the United States $250,000,000 a year are caused by carelessness.

Wood, phosphorus, chlorate of potash, rosin, whiting, and powdered flint are the makings of this little device.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

64. Explain the difference between outside lap and inside lap of a D slide valve?

65. Explain the difference, if there is any, between piston clearance and clearance volume?

66. Is it possible to cut off with a D slide valve operated by an eccentric, having no outside lap and no lead?

67. Suppose you had a plain slide valve engine, and you wished to make the cut-off earlier, what would you do? The port opening is to be the same as before.

68. What is the effect of increasing the inside lap of a D slide valve?

69. How can the valve be given a greater travel than the throw of the eccentric?

70. How does the angularity of the connecting rod effect compression?

71. A 14 in. by 28 in. engine has a clearance volume of 247 cubic inches. Express the clearance in per cent.

72. In a 36 in. by 60 in. engine the steam is cut off when the piston has moved over 21 inches of its stroke. The clearance being 2 per cent.; find the real cut-off.

73. What is the ratio of expansion of the engine given in question 9?

74. A 44 in. by 80 in. engine is to run at 75 r.p.m. What actual diameter of steam and exhaust pipes should be used?

75. About what scale of spring is usually selected for a given boiler pressure?

76. What is the principal objection to the lazy-tongs and pantograph reducing motions?

77. What is meant by the vacuum line on an indicator diagram, and how is its position located?

78. In plain slide valve engine, how would you remedy too early admission, and what effect would this have on the other events of the stroke?

79. If one end of a cylinder with a slide valve is found to be doing more work than the other, how can the fault be remedied?

Questions Answered

Question.—47. What is the object of the safety valve?

Answer.—To prevent the steam pressure from rising above a fixed limit.

Question.—48. How should a safety valve be connected to a boiler?

Answer.—The safety valve should be connected directly to the boiler so that there is no possible chance of cutting off communication between the boiler and the safety valve.

Question.—49. How are safety valves, in practice, adjusted for a given steam pressure?

Answer.—Spring loaded safety valves are always adjusted by comparison with an accurate steam gauge, and this practice is now generally employed when setting the lever safety valve also.

Question.—50. What is the object of a gaugecock?

Answer.—A gaugecock is a simple cock or valve attached either directly to the boiler or, preferably, to a water column for the purpose of testing the water level in the boiler. Three gaugecocks are generally employed. The lowest is placed at the lowest level the water may safely attain, and the uppermost at the higher desirable level, the third is placed midway between the other two.

Question.—51. What is the purpose of water alarms and fusible plugs?

Answer.—A water alarm is a device attached to a boiler to give warning by blowing a whistle when the water in the boiler is either too low or too high. The fusible plug is another device which gives warning when the water is too low. It consists of a threaded brass plug filled with some alloy which has a low melting point, and if the water gets too low the plug is exposed to the hot gases and the alloy melts, thus allowing steam to escape and warning the attendant in charge.

Question.—52. What is the object of running boiler feed-pumps at a slow speed?

Answer.—As the boiler is constantly evaporating the water supplied to it, it is only necessary to replenish an amount equal to that evaporated. Therefore, feed pumps ought to be run as low as possible, thereby reducing the wear and tear on the valves.

Question.—53. What is combustion?

Answer.—Combustion is the chemical combination of oxygen with carbon or hydrogen, or both.

Question.—54. What is the principal element in the composition of all fuels?

Answer.—Carbon.

Question.—55. How many pounds of water at 212 deg. can be evaporated into steam at the same temperature by a pound of coal of the following composition: Carbon, 74 per cent.; hydrogen, 8 per cent.; oxygen, 5 per cent., and ash, 13 per cent.?

Answer.—The quantities of heat produced by the complete combustion of the elements composing the fuels have been found by experiment and are as follows:

	B.t.u. per lb.
Hydrogen	62,000
Carbon burned to CO_2	14,600
Carbon burned to CO	4,400

RULE.—To find the heat of combustion of one pound of fuel, multiply the percentage of carbon by 146 and the percentage of hydrogen by 620 and the products and the sum will be the required heat of combustion in B.t.u.

The heat of combustion, according to this rule of this fuel is $146 \times 74 + 620 \times 8 = 15{,}764$ B.t.u. The steam table shows that it takes 966 B.t.u. to change one pound of water at 212 deg. into steam at 212 deg., therefore

$$15{,}764 : 966 = 16.32 \text{ lbs.}$$

Question.—55. In what way will the presence of sulphur in steel affect the latter?

Answer.—A very small percentage of phosphorus or sulphur will render the metal useless.

Question.—56. What joint in a cylindrical boiler is subjected to the greater stress?

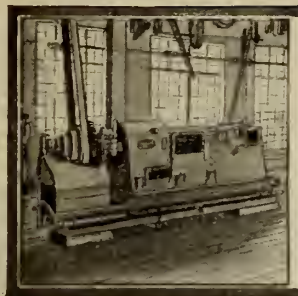
Answer.—The longitudinal joint.

Question.—57. What is the bursting pressure of a seamless steel tube 12 in. in diam., 3-16 in. thick, and having a tensile strength of 64,000 pounds per sq. in.?

Answer. — $64{,}000 \times 3\text{-}16 \times 2 : 12 =$ 2,000 lbs. per sq. in.

Question.—58. What is the working pressure allowable on a boiler shell 60 in. in diam. and 11-32 in. thick, if the material has a tensile strength of 60,000 lbs. per sq. in. and the longitudinal joints

(Continued on page 379)



NEW POWER PLANT EQUIPMENT

RENEWABLE FUSES

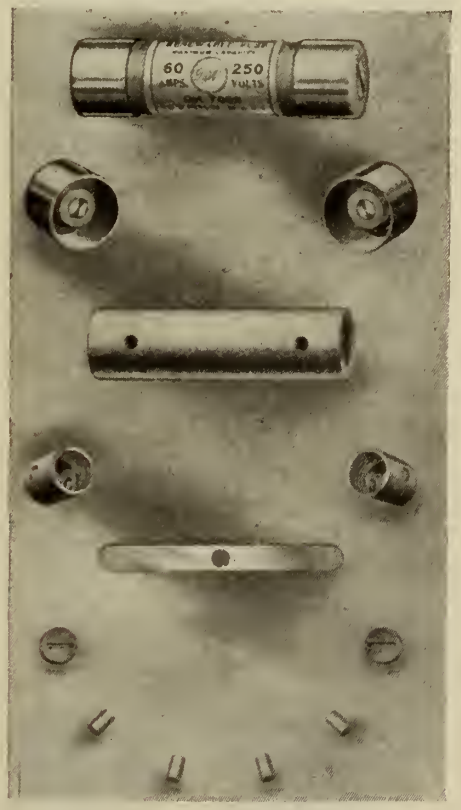
DURING the past few years a type of enclosed fuse in which the fusible element can be readily renewed has been favorably received by many buyers. It has appealed particularly to certain classes of industrials who employ numerous motors and whose consumption of fuses is large.

The renewable fuses that have heretofore been supplied to the trade have been so expensively designed that their use has been restricted to a limited field. The first cost of these fuses ranges between two to three times that of the standard type. Thus an actual saving could be effected only in plants where the percentage of blowouts per installation is very large. Moreover, the expense of carrying an increased fuse investment has considerably reduced this saving.

The object of the renewable fuse is to afford less expensive protection. It has, therefore, been the goal of the manufacturers in the design of the "D & W" renewable fuse to provide one which will enable the user to secure a maximum saving. Its introduction permits those who desire this type of fuse to obtain a saving from every standpoint, since it not only effects a saving in the first cost but also a reduced labor cost of reassembling, due to the ease of renewing the blown link. Furthermore, in event of the tube becoming scorched or weakened in long service, the tube only need be replaced, as the brass caps are removable.

The mechanical construction of the "D & W" renewable fuse is simple and effective. The ferrule type consists of a fibre tube having a steel sleeve held in each end by two pins. The inside of each sleeve is threaded to receive a metal plug, which is securely attached inside of the brass ferrule. The sleeve has a seat beyond the threaded portion, on which a slotted washer rests. The link is clamped between this metal washer and the end of the metal plug, both of which are held in position by the threaded sleeve. By this means permanent electrical contact between the link and terminal structure is insured. This eliminates the trouble experienced with that type of renewable fuse in which the pressure necessary to maintain link contact is transmitted through a part of the fibre tube. Shrinkage expansion or warping of the fibre so depended on results in a corresponding change in the pressure applied to the contacts. It is impossible to maintain a permanently good connection between the link and terminal with such a construction.

The steel parts of "D & W" renewable fuses are oxidized to prevent the molten or vaporized link metal from attaching itself to these parts. In some other types of reloadable fuses much difficulty is experienced in taking the fuse apart after it has blown on a great overload or short circuit because the fusible metal readily solders itself to the terminal parts of the fuse when these are made of brass. The construction embodying oxidized steel absolutely prevents this difficulty.



RENEWABLE FUSE.

In the design of the "D. and W." knife blade type renewable fuses, the makers, the D. and W. Fuse Co., Providence, R.I., have carried out the same idea as in the fuses of smaller capacity, that of making a fuse very easy to load and disassemble after the fuse has blown; and with extra heavy parts to withstand the great strain developed when the fuse blows.

A rugged type of fuse casing is most essential in the renewable type, for unless a fuse casing is strong enough to be refused over and over again the whole object of a renewable fuse is lost.

In these fuses the heavy fibre tubing is reinforced by permanently fastening inner cap to both ends of the tube. These caps are slotted to receive the fuse link and are designed to engage the blades and lock when in position when given a quarter turn. Asbestos lined metal washers are then slipped over the blades to align them properly, and to regulate the escape of gas. The outer caps are then screwed into place, engaging metal threads on the outside of the inner caps, completing the assembling of the fuse.

All parts subject to severe strain are made of steel, brass plated to prevent corrosion.

The makers have also developed a type of fusible element which they designate as their expulsion or jacketed fuse link.

This link consists of a flat strip of metal with the central portion slotted and closely wrapped with a covering of specially treated asbestos. The jacket is unaffected by the high temperatures in service, and remains intact even when the fuse blows on a short circuit. When the rupture occurs an arc is formed, converting the metal within the jacket into vapor, thereby developing internal pressure within the jacket. This causes a blast of hot gases in each direction from the centre of the fuse, tending to extinguish the arc. As the metal is burned back towards the terminals the jacket drops out, thus breaking up mechanically any strata of vaporized gas which might extend from one terminal of the burning link to the other, and thereby positively opening the circuit.

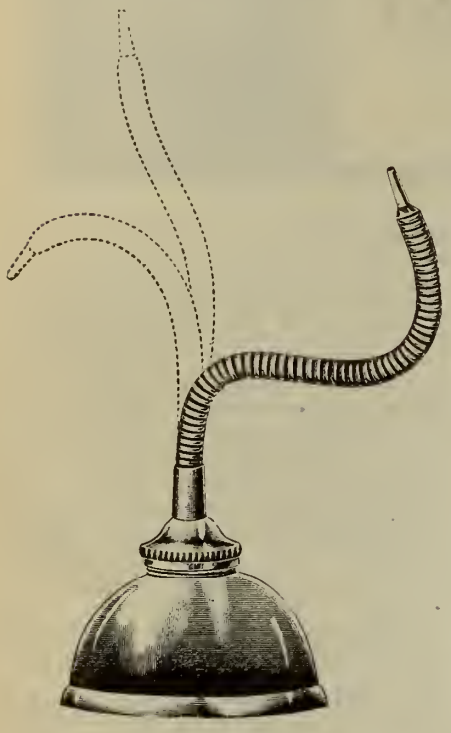
With this design is secured an effective expulsive action, tending to materially reduce the arc, particularly on moderate overloads, thereby securing a greater factor of safety and longer life of the casing. Another advantage of this link is its increased radiation surface, effected through the use of the jacket, which makes possible a considerable reduction in the total mass of metal required for a given current. By this means a material lowering of the pressures developed when the fuse blows on a dead short circuit is obtained.

ALL-WAY OILERS

The ordinary oil can with rigid spout is at best an awkward thing to handle and use in all positions. A new development recently placed on the market should find much use in the engine room

and other places where much oiling has to be done.

It is in brief an oiler fitted with a flexible steel spout, made to be bent in



ALL-WAY OILER.

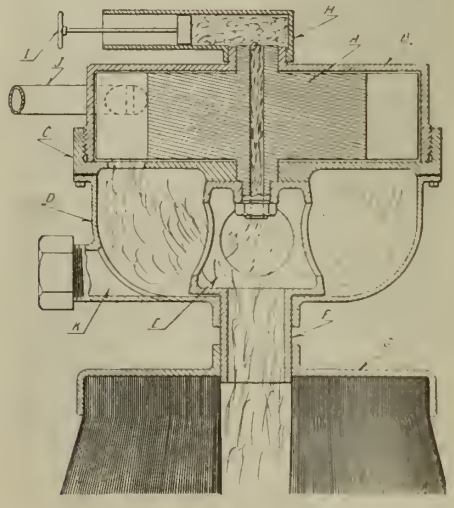
any desired angle or position without breaking or interfering with the flow of oil. There is no waste of oil when using this oiler, as no matter where oil hole or parts of machinery to be oiled are located, they can easily be reached without any trouble or waste of oil. The spout is simply bent to suit the position where oil is to be applied.

This oiler is fitted with a cleaning device at the end of the spout, and the same device also prevents oil from flowing too freely. The all-way oiler is strongly made of copper plated steel in different sizes and shapes by the All-way Oiler Manufacturing Co., Toronto, Ont.

SMALL LABORLESS WATER MOTOR

The washing of automobiles, railway coaches, boats, etc., is a task that often tries the patience of the operator handling the brush, as it is generally necessary to frequently apply the brush into the bucket that contains the washing material. The sketch herewith illustrates a convenient form of water motor, in conjunction with a cotton brush, that performs the washing operation with the minimum expenditure of effort on the part of the person using the appliance. The turbine wheel, A, that receives the force of the incoming water, is encased in the body, B, the lower cover, C, being screwed in place after the turbine has been placed in position. Secured to the face of the cover, C, is the exhaust chamber, D, into which the whirling water is discharged after expending its energy on the wheel. The central tubular shaft, E, is secured to the lower end of the turbine and extends through the bottom part of the casing, D. At the extreme end of the hollow shaft, F, the brush, G, is secured. On the upper end of the turbine casing is the small cylinder, H, in which is kept a supply of soap in chip or paste form. To the supply or feed pipe, J, is secured a handle suitable for the work in hand. This handle is hollow and split at the motor end to encircle the casing, and is pivoted at a bearing at either side. This arrangement permits the brush to be used at any angle.

The operation of the laborless water motor may be stated as follows: The water, steam or air, as the case may be, enters through the hollow handle and through the feed pipe, J, this latter being of rubber tubing to allow of free movement from one position to another. The water rushing against the blades of the turbine, A, causes the latter to revolve, the speed depending on the velocity of the incoming water. The water exhausts into the casing, D, in a swirling condition, and passes through the openings in the tubular shaft, E, and thence through the hollow shaft, F, to the cotton brush, G. To facilitate the washing operation, and where such is necessary, the soap cylinder is placed on the top of the turbine casing. By slight pressure on the handle, I, sufficient soap is pressed through the central opening in the turbine and mixes freely with the water passing to the brush. Provision is also made for drying operations by making connection at the opening, K,



WATER MOTOR WASHER.

located on the side. These laborless water motors have been designed by C. C. Howard, Toronto, Ont.

A WONDERFUL AND UNIQUE DRIVING CLUTCH

A difficulty which engineers have often experienced with regard to the electric driving of machinery and line shafting has been to start and accelerate a load or mass requiring a large starting torque without the use of special switchgear, and with a minimum starting current. For this reason many motor drives which otherwise could have been quite ideal have had to be abandoned for some alternative method, and drives which are actually in practice are proving very unsatisfactory and costly.

To overcome this difficulty, Messrs. Thomas Broadbent & Sons, Ltd., Huddersfield, have designed a centrifugal driving clutch which, for effectiveness and simplicity is quite unique. As this clutch is quite automatic it requires no further attention once it is fitted, and as there are little or no wearing parts it is practically impossible for it to get out of order. This device is particularly valuable where the electric supply authorities limit the starting current of motors to a low value, or where the machines are frequently stopped and started under load.

The function of this clutch is to enable the motor to start up unloaded, the load being gradually applied as the motor accelerates. The rate of acceleration can be predetermined when designing the clutch, and is entirely independent of the operator. The switchgear can be of the simplest form (in many cases the motor can be switched direct on to the mains without any starting resistances) and as the clutch can be designed to slip at any desired overload, other overload devices are unnecessary.

The load is applied to the motor gradually and the driven machine accelerates without jerk. As the clutch also acts as a flexible coupling it corrects slight errors in alignment and presents sudden loads or shocks being transmitted to the motor.

The clutch is eminently suitable for use with alternating-current motors of the squirrel-cage rotor type. As is well known, this is the simplest and cheapest type of motor, the only wearing parts being the bearings. Up to now, however, its poor starting torque, especially in the single-phase type, has prevented its use in many cases. This disadvantage is at once overcome by using a centrifugal clutch, and complimented switchgear with its troublesome coils, resistances, etc., is unnecessary. Belt-shifting arrangements are also done away with, and slipping and wear of belts avoided.

The clutch is quite noiseless in its action as it is perfectly balanced, has no loose parts to chatter, and is equally effective in either direction of rotation.

Many of the most prominent firms in England are now using these clutches which have proved themselves to be a great success both with regard to current consumption and cost of machinery.

Magnetized screwdrivers are useful for many classes of work, the carbon steel of which screwdrivers are made being capable of retaining considerable magnetism. A screwdriver which will retain a considerably stronger magnetism than an ordinary one, may be made from a round piece of tool steel, or preferably of tungsten steel, by simply grinding the end of a bar into the form of a very short screwdriver blade.

The Operators' Point of View

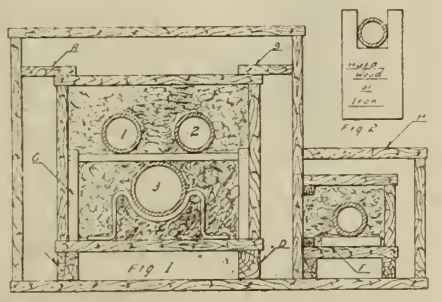
PROTECTING PIPES ABOVE GROUND

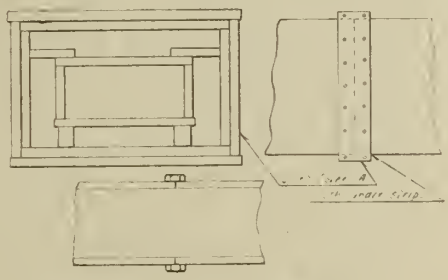
IN the section of the country where I am employed, the ground was principally stone, sometimes with only a foot or two or earth on top, often the stone comes right up to the surface.. It is a work of labor and expense to get below frost level, as much of the stone has to be drilled and blasted out. To get away from the very high cost of going below frost level, boxes such as are shown in Fig. 1 have been used with excellent results. The cost of such a box, both in labor and material, is considerable, but only a very small percentage of what the blasting process costs, for in the latter case, besides the cost of the blasting, there is the expense of carting away the stone and buying and carting earth to fill up the pipe trench, in any case, outside of the cold water pipe, the pipes have to be encased in some kind of a covering material, such as tile pipe, etc. So, even with the high cost of lumber, the ultimate cost of such boxes is not so great over the others.

I know of such boxes that have been in use for over ten years and are still in good condition.

With an outside temperature often going as low as 27 below zero, no freezings have occurred in such boxes with the tops only a few inches below the earth's surface. However, it is necessary to use considerable care in putting the boxes together, and in coating the joints and the surface of the outside box boards. In the sketch, 2, is the live steam main, 1 is the return main and 3 is a large hot water main. The inside box is held central by pieces nailed on at intervals along the box, as shown at A, B, C, D. The pipe roller support, G, is shown at Fig. 2 also; it can be made from hardwood or iron, and is fastened to the side of the box. The cold water pipe is shown in box H. The pipe can rest on pieces of wood laid several feet apart.

The inside of the small boxes are filled with dry asbestos, mineral wool, ground or broken mica, or even a light dry earth loam. Strips of cotton or other cloth are cut, soaked in an oil paint, and laid between the box joints when building them. The space between the boxes is left empty. Any knot or other hole in the boards should be covered with a piece of wood nailed on, as the efficiency of the boxes to keep out frost depends to a large extent on the tightness of the boxes . All the joints of the boards should have their edges planed smooth and straight before putting them together. The outside of the boxes, bottoms, sides and top, should receive a coating of tar, pitch or other wood preservative, otherwise the boxes will become wet after every rain and will soon rot away. I have found that pipes, 1 and 2, laid on pipe rollers,





RUNNING PIPES OVERGROUND.

and covered with some material, seldom, never in my own personal experience, move to the sides of the boxes if ample provision is made for expansion. However, it would be no difficult matter to instal some kind of a check to prevent this if desired. I may state that any water which may reach trenches here finds its way out through openings between the stone.

JAS. E. NOBLE.

MEANING OF POSITIVE POLARITY AND NEGATIVE POLARITY

By W. G. Hammond

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The terms "positive polarity" and "negative polarity" are best defined on the basis of the concept of electric potential. An electric current always flows from a point of higher potential to a point of lower potential. On this basis the positive pole, Pd (Fig. 1) or terminal of an electrical-energy-delivering device, D, is the terminal from which the electric current flows from that device to the external circuit. The negative terminal of the device, Nd, is the one into which the current flows from the external circuit. It also follows that for any energy-receiving or energy-consuming device the positive terminal Pr is the one into which the current flows from the external circuit and the negative terminal, Nr, is the one from which the current flows to the external circuit.

DRY CELLS DELIVER GREATER CURRENT WHEN WARM

By George W. Wesley

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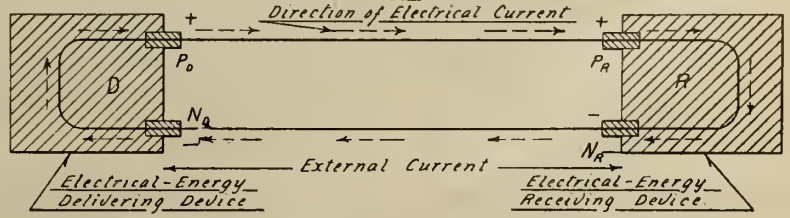
It is an observed, but a not generally appreciated, fact that dry cells will deliver greater currents when warm than when cold. Hence it is neither wise or fair to dry battery manufacturers to test a dry cell from a lot which has just been received from transit in a cold freight car. Before cells which have been shipped in barrels in cold weather are tested, they should be allowed to remain in a moderately warm room for a period of from 24 to 48 hours, so that their temperatures may become approximately 70 degrees F. before the test is made. It requires a considerable time for the cells, which were at the centre of the barrel during shipment to attain the temperature of the surrounding air.

A cell which will, on short circuit, at a temperature of 30 degrees F., produce a current of 30 amp., will produce approximately the following currents at other degrees, 20 amp.; 60 degrees, 10 amp.; 40 degrees, 30 amp.; 60 degrees, 25 amp.; 100 degrees, 35 amp. The decrease in current output at the low temperature does not imply a permanent injury to the cell, because such a cell, when again raised to normal temperature, will de-



MEANING OF POSITIVE AND NEGATIVE POLARITY

liver its normal current output.

On the other hand, dry cells should not be stored in a hot place. The heat dries them out, and hence decreases prematurely their outputs. It is, therefore, the better practice to store the cells in cold rooms, but to permit them to remain in a reasonably warm room for a number of hours before they are used or are tested for current output.

SOME CEMENTS FOR PIPE JOINTS

By B. C. Bergman

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A cement which is very popular with operating engineers for making screw joints in pipes steam tight is made of graphite and cylinder oil. Just enough cylinder oil is mixed in with the powdered graphite to convert it into a thick paste.

A cement which is satisfactory for both water and steam pipes has this composition: 4 lb. whiting, 10 lb. fine yellow ochre, 4 lb. ground litharge and ½ lb. hemp cut into fine bits. These ingredients are mixed thoroughly with linseed oil to form a thick paste. The compound is applied on the threads of the pipe and on the threaded portions of the fittings into which the pipe screws.

For ammonia piping, a cement made of litharge and glycerine is used. Sufficient glycerine is added to the litharge to provide a plastic putty. In using this cement only enough should be made at each mixing for one joint, because it sets very rapidly. It should not be disturbed after having once set.

RECONNECTING 440-VOLT INDUCTION MOTOR FOR 220 VOLTS

By B. Hermann

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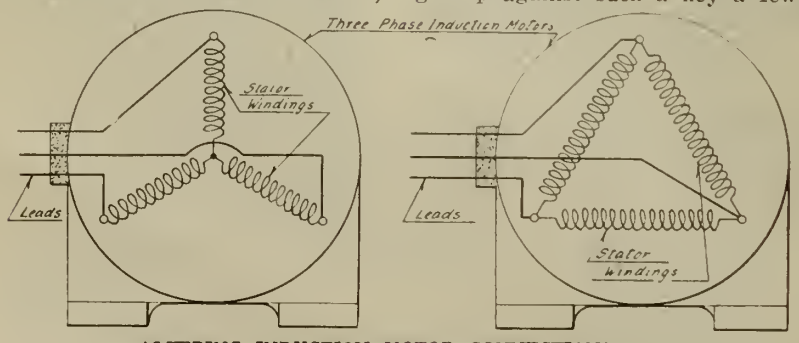
If a 3-phase, 60-cycle, 440-volt, squirrel cage induction motor has its stator coils connected in star (Fig. 1) as it probably has, it can, possibly, be made to give satisfactory service on 220 volts, if its windings be connected in delta as shown at Fig. II. If the starting torque required is great the scheme will not work. But if the starting torque is only about three-fourths of the full load torque the motor will operate and give good service on 220 volts, if it is connected as shown at II. It will then have,



ALTERING INDUCTION MOTOR CONNECTIONS.

at 220 volts, practically the same horsepower output, power factor and efficiency as it did when operating star-connected at 440.

AUDIBLE SIGNALS TO INDICATE DISCONTINUANCE OF LOAD

By Richard L. Dyke

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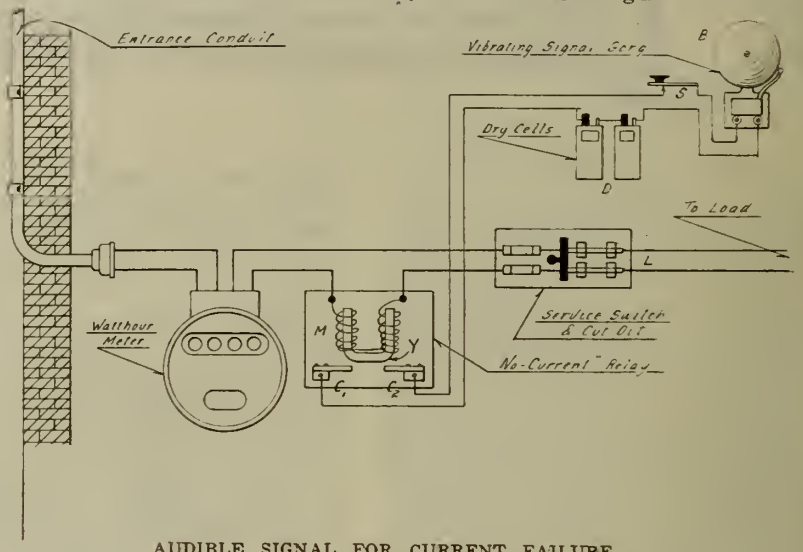
The signal will ring when a group of motors in a distant building is stopped. Fig. 1 indicates the connections. A relay, M, was made and connected to the circuit which supplies the load. When the load is taking current through the line L, the magnet coils of M have current in them and pull up the U-shaped yoke Y. But when the load is discontinued, Y drops down and makes contact to cross C_1 and C_2. This closes the electric bell circuit and causes B to ring, and it will continue to ring until switch S is opened. A large number of turns is not required on the magnet coils, M, as their function is merely to hold up the yoke Y. It is not, in most cases, necessary that the magnet coils be sufficiently strong to pull up Y because it can be raised by hand. The wire used for the magnet coils, M, must be of great enough size to carry the full-load current in the circuit.



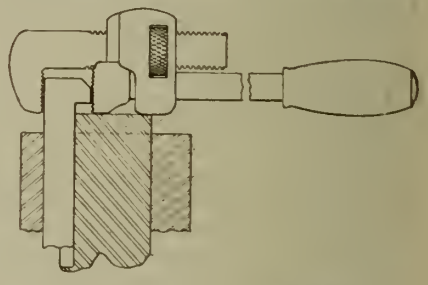
AUDIBLE SIGNAL FOR CURRENT FAILURE.

POWER PLANT KINKS

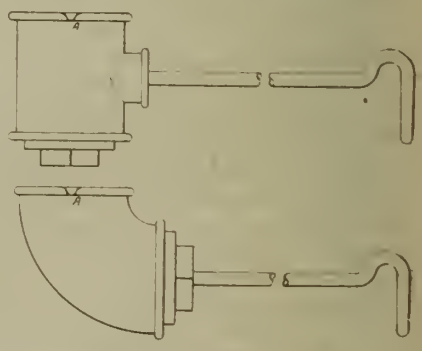
By J. E. N.

Many keys are driven in so tight that it is a difficult job to get them out. I got up against such a key a few days ago and tried the old stunt of placing a monkey wrench on to it and driving a wedge under the cut at the head of the key; however, at every heavy blow from the hammer the wrench would spring off the key head. I discarded the monkey wrench and used instead a Stilson pipe wrench as shown in the cut. This hung on like grim death until I got the key started. This is only a small tip but sometimes a fellow will fail to think of just such little things.

Another little kink is to make a babbitt pouring ladle. Fig. 2 shows such a ladle made from a 2½x2½x¾ tee, a plug being in one end, a pouring lip being filed on the top rim at A, and a piece of



REMOVING STUBBORN KEY



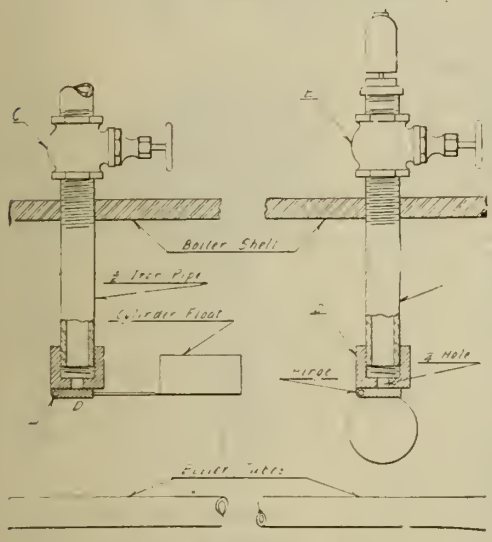
EMERGING BABBITT LADLES.

1 in. iron rod being used as a handle. Fig. 2 shows an elbow being used for the same purpose, in this case a plug is drilled and tapped to take in the rod for the handle, or a bushing the right size can be used. In either case the handle must be screwed in very tight so there will be no danger of it turning while pouring the metal.

LOW WATER ALARM

In Figs. 1 and 2 are shown a low water alarm designed by the writer. The valve, whistle and pipe are ½ inch in size. The valve, D, is a very simple affair as shown.

If a larger pipe than ½ inch is used I would suggest using the float shown in Fig. 2. It can be made any diameter required, and the longer the float and the attaching rod the greater the leverage, but care must be taken to attach the rod very firmly to the float. These floats must have enough weight with leverage to overcome the force of the pressure holding up against the small flap at D, Fig. 2. The hole in the bottom valve should be about ¼ inch, the diameter of the covering piece being about ½ inch.



LOW WATER ALARM.

The handle should be removed from the valve over the boiler. A better plan would be to lock the valve open. The sketches show everything so plain that further written description seems unnecessary.

JOHN THORN.

SUPER-POWER PLANTS IN GREAT BRITAIN

The recent decision to proceed with the super-power station scheme for electric supply in Great Britain calls to our notice what should be done along these lines on a more modest scale in certain portions of Canada.

The British plan to improve the supply of electricity throughout Britain contemplates the replacement of the numerous small stations now in operation by fewer but much larger stations supplying the extensive districts through high tension transmission networks. There will be a gain both in economy and fuel conservation and, in many cases, the quality of service will be much improved. This national electric supply operates under the supervision of five commissioners appointed by the Board of Trade; these, in turn, appoint district boards which include representatives of electric undertakings, of large consumers and of labor.

Lancashire is to be one of the first areas dealt with, the country being divided into three districts. Some of the smaller stations will probably be shut down immediately, the energy transmitted from larger existing stations being substituted. Following the building of the new super-power plants, the Commissioners will eliminate the remaining small stations and also the moderate-sized plants.

A similar situation, however, does not occur in Canada, as by far the larger portion of the capacity of our hydro-electric stations is to be found in what may be called "super-power" stations; many of them are also interconnected to allow more efficient operation.

There is, however, a portion of Canada where the absence of water power makes it necessary to supply power from steam or other fuel agencies. This area, which comprises southern Saskatchewan and adjacent portions of Manitoba and Alberta, is becoming of much importance through its rapid agricultural expansion, and its future needs should be anticipated as far as possible.

As pointed out in a report on Electric Generation and Distribution in Canada, recently published by the Commission of Conservation, adequate supply of electric energy in this section is confined to a few large centres. The smaller municipalities have installed small electric plants which are usually very expensive to operate and only give a night service. The rates which have consequently to be charged and the limited service prevent the full benefit which should otherwise be enjoyed from the various uses of electric energy. All these small plants through concerted action could be replaced by a few large and more efficient ones, each supplying a fairly extensive district by means of electric transmission lines. The cost of production would be reduced to about one-third and a better service supplied.

The example given in the above-mentioned report illustrates the possibilities in the Estevan district. A central power plant at Estevan would supply transmission lines radiating in various directions covering a total length of 150 miles. The estimated demand, based on the requirements of the near future, shows a total of some 600 h.p. outside of Estevan. As the lines would only carry a light load they could be built cheaply with light conductors and at a cost possibly not exceeding $2,500 per mile. If we allow a load factor of 40 per cent. the cost of transmission would average 2½c per k.w.h. The cost of production in the central plant would be from 2½c to 3c per k.w.h., so that the electricity could be delivered for an average of from 5c to 5½c per k.w.h. at the various small centres supplied. With a small plant, the present cost runs as high as from 15c to 19c per k.w.h. Numerous other districts, if treated in the same way, would probably show advantageous results.

ELECTRO-PLATING ON IRON FROM COPPER SULPHATE SOLUTION

For electro-plating on iron or steel from a copper sulphate solution, platers have in the past found it necessary either to give the metal a preliminary coat of nickel or to plate it with copper from a cyanide solution before transferring the object to the copper sulphate plating bath. Since the sulphate solution is much more satisfactory than the cyanide for the production of heavy deposits of copper, where these are required the plater has been compelled to maintain two different plating solutions, and to perform two distinct plating operations. The desirability of being able to plate directly on steel in the copper sulphate solution is apparent, and many persons have tried to discover a method of doing so, but until recently without success.

It has been discovered recently that by immersing iron for a few moments in an acidified solution of arsenious oxide, an adherent copper-plate may be deposited from an acid electrolyte, but no adequate explanation had been offered for this unique effect of arsenic. In this paper it has been shown that certain solutions of lead and antimony may be substituted for the arsenic dip, previous to direct-current plating of copper on iron from copper sulphate.

It appears to be impossible to obtain a perfect plate on iron from solutions of bismuth chloride by the usual methods of electro-plating, but use of the arsenic or antimony dip is attended with the same successes as in copper plating.

The successful substitution of solutions of antimony and lead for arsenic, and the application of these dips to plating on iron with bismuth, show that the beneficial effect of the arsenic dip is not due to a property peculiar to arsenic alone, but is the result of coating the iron with a metal whose potential in acid solutions is so near to that of copper that it is possible to deposit a good copper plate upon it, yet whose potential is not so far below iron that it will deposit on iron in a powdery, non-adherent form.—O. P. Watts ("Proceedings of the American Electrochemical Society.")

QUESTION BOX

(Continued from page 374)

have an efficiency of 87 per cent. The factor of safety is 5?

Answer.—The allowable working pressure equals: $60{,}000 \times .87 \times 2 \times 11\text{-}32 : 60 = 119.6$ lbs. per sq. in.

Question 59.—If 2½ in. stay-tubes are placed 10 in. centre to centre, what area will each tube support?

Answer. — Area $10 \times 10 - 4 \times 2\frac{1}{2} \times .7854 = 80.37$ sq. ins.

Question.—61. With a steam pressure of 160 lbs. per sq. in., what load is borne by each staybolt if the pitch is 7 in.?

Answer.—Load $= 7^2 \times 160 = 7{,}840$ lbs.

Question.—62. To what distance beyond the top of the upper row of tubes may the head conservatively be estimated to be supported by the tubes?

Answer.—A distance equal to one-half the width of the bridge.

Question.—63. For what reason is the furnace of a vertical boiler made of light plate and stayed?

Answer.—Heavy plates greatly retard the transmission of heat from the fire to the water.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in.	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
	Standard	Lapweld
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..		7 50
Premier, 10¾ oz.....		7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$	2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon....	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$	42 50	$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$	0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus	10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper .....$	22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

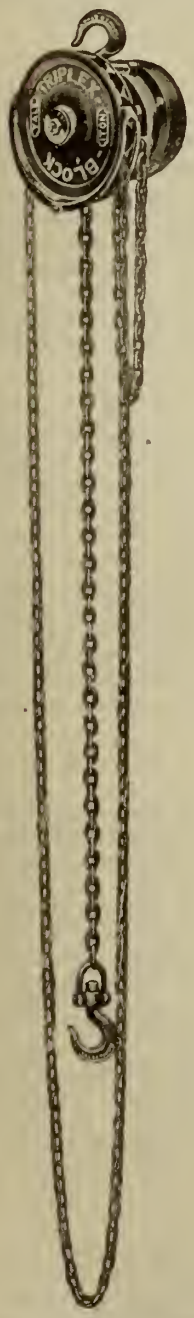
Packing, square braided .....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila....	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra. Cuts sheets to size, 1c per lb.

Hoisting with the YALE Spur-geared Chain Block is Safe, Speedy, Sure



The Yale Spur-geared Block

The peace of mind, speed and ease of operation, and reliability—all naturally result when using YALE.

The most convincing argument is the Block itself.

From Hook to Hook,
A Line of Steel.

For Sale by Machinery Supply Houses.

Send for catalog.

For factory locking equipment use a Yale Master-Key System. Write for particulars.

The Canadian Fairbanks-Morse Co., Limited

Halifax St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Saskatoon Calgary
Vancouver Victoria

Worth-While Information From Many Points

The number of German airplanes destroyed by the French aviators and the members of the Lafayette escadrille for the ten months ending October, 1917, was one hundred and twenty over the French lines, and three hundred and ninety-seven over the German lines—all total wrecks.

* * *

Shoe soles with metal coverings were made by Germans during the war—leather, cardboard, or wooden soles covered with aluminum or iron, not more than 0.01 mm. thick. The weight was the same, but they lost flexibility, became more solid and quite water-tight.

* * *

An English scientist declares that insomnia may be cured by removing excess moisture from the lungs. To put his theory into practice, he has devised a small machine for supplying warm, dry, filtered air, which the patient then breathes through a nose tube secured to the head with tape. The process is said not to be uncomfortable.

* * *

Saving controller contacts from damage by arcing is the object of a European inventor. In series with the contacts he connects hot-cathode rectifier tubes, whose heating circuit is broken by the switch arm in advance of the main circuit. The momentary interruption of the current prevents any arc formation.

* * *

The hardness of water is usually expressed in degrees, one degree being equivalent to a solution of one part by weight by carbonate of lime or other hardening salts to one hundred thousand parts of water. Wells generally contain the hardest water, 35 degrees of hardness being common. With water of one degree of hardness, the water contained in a single big tender would deposit 75 lbs. of mud or scale-making sediment.

* * *

A jackshaft or conveyor, if driven by a belt, may give a warning of its own stoppage by the use of an electric-bell wire with push button, and over it a piece of slat, held up by a spring. Place these so that if the belt comes off, part of its weight comes onto the slat, thus depressing the push button and closing the circuit. This may be used with either horizontal, vertical, or inclined belts, provided the surroundings permit the installation of wires and push-button support at suitable points. More than one bell may be wired up, each with its own circuit and its own push button beneath the slat, or several buttons may be connected through the signal lights to the same bell.

* * *

Enquiry has been made recently as to the possibility of the Mahwa tree, a native of the warmer parts of India and Burma, being cultivated in Europe. The reason of the enquiry is not a wish to introduce a tropical plant as a curiosity, but because the tree bears a flower which produces 90 gallons of 95 per cent. alcohol per ton.

* * *

A chimney has been built in the United States at Cleveland, for the Cleveland Electric Illuminating Company. The chimney, which is 163 feet high, is on top of the power house. The chimney at the top is 20 feet internal diameter, and the thickness of the wall is 10 inches, while at the bottom the thickness is 20 inches and the outside diameter is 43 feet. The weight of the whole structure is 1,200 tons, and this is supported on a concrete stage, having 12 legs reaching down through the building. The height of the stage above the basement in 105 feet.

* * *

The total number of electricity generating establishments in the United States in 1917 was 6,541, 4,224 being private and 2,317 municipal undertakings. The total primary power in 1917 amounted to nearly 13,000,000 horsepower—an increase of 70.8 per cent. as compared with 1912. Of this power about two-thirds was derived from steam and about one-third from water, the slight surplus being obtained from internal combustion engines. The total dynamo capacity in 1917 was, roughly, 9,000,000 kilowatts, 74.3 per cent. more than in 1912; while the output of energy aggregated 25,500,000 kilowatt-hours, an increase of 119.9 per cent. for the period 1907-12. It is stated, incidentally, that incandescent electric lamps are rapidly exceeding arc lamps for street lighting.

* * *

The engineer surveyor-in-chief to the British Board of Trade, in making a report on the explosion of a tube in a Babcock and Wilcox water tube boiler found that the "tube failed in the ordinary course of working, apparently through deterioration through long usage, it being one of the original tubes fitted in the boiler some twenty-two years ago. It would probably have been very difficult to have detected the defective condition of this tube before it burst, but in view of what has now happened the condition of the material of the remaining tubes should be ascertained by withdrawing some of them for a bending test.

* * *

Careful experiments as to the permeability of concrete have disclosed the fact that for heads up to 24 feet, it is impermeable for oils of low gravity. Concrete tanks for fuel storage have been built without any special precaution beyond the washing of the concrete with a rich cement mortar immediately after the removal of the forms. In some cases a solution of sodium silicate or water glass has been used.

* * *

The use of reinforced concrete for the repair of masonry bridges, which through age, excessive traffic or other causes, have decayed or been damaged, is now recognized by engineers in England as a very effective method and one which dispenses with the necessity of rebuilding. A number of England's highway bridges that for various reasons would have needed reconstruction have been made good by the employment of reinforced concrete.

* * *

That the aeroplane engine is not above ordinary humdrum work is shown by the fact that one has recently been installed in a London factory as a stand-by power unit. It burns gas instead of petrol and the cooling water is circulated through a common cast iron radiator. It is an eight-cylinder engine, surplus from the war, and at the aerial rate of living would develop 200 horsepower, but has been rated at 75 horsepower on earth to give it a reasonable length of life. The space occupied by the engine is only 8 ft. by 5 ft., by 5 ft. high, while its weight is about 800 lbs.

* * *

At Portland, Oregon, a gas container 70 feet in diameter and 75 feet high, weighing 300 tons, was moved a distance of three miles. First, it was raised 15 feet and loaded on rollers. Then it was moved four blocks through the city streets and lowered 28 feet to a dock, whence it was moved upon a pair of barges. The barges were towed three miles to a shipbuilding plant, where the tank was unloaded and raised 26 feet, moved across newly-filled ground for a distance of 2,000 feet, crossing a railroad track and placed on its new foundation. It took 71 days to complete the work.

TRADE GOSSIP

To Manufacture Fish Leather.—An American firm has been looking over the ground in Kingston, Jamaica, with a view to establishing a tannery for fish hides. The skins used would be those of sharks and other non-scaly fish.

Mjor A. G. Hutter has taken up the management of the Montreal office of the firm of Wonham Bates & Goode, Inc., New York and London, exporters and importers. Previous to going overseas Major Nutter was connected with Mussens, Ltd.

Railway Shop Busy. — The Leaside shops of the Canadian National Railway are pretty busy these days. There are about twenty locomotives in the shops for repairs besides several coaches. About 300 men are employed at present, and skilled mechanics are being taken on daily.

May Purchase Towers.—It is reported that the Nova Scotia Steel and Coal Company have started negotiations for the purchase of the coaling towers at the Halifax terminals, now the property of the British Ministry of Shipping, and also for the purchase of a large supply of coal now on the piers.

New Cable Line.—As a result of the long-felt dissatisfaction with the Pacific cable service between the U. S. and Japan, a group of Japanese business men are floating a company with a capital of about $25,000,000 for laying a new cable line. American capital will likely be enlisted as well as Japanese.

Motion to Wind Up.—A number of the shareholders of the Imperial Steel & Wire Company having made an application for the winding up of the company, Mr. Justice Kelly has adjourned the application to September 11th. In the meantime he has appointed Mr. G. T. Clarkson to make an examination into the affairs of the company.

Kingston Wants Elevators.—Kingston is going to make a bid to be the grain transhipment port in place of Port Colborne. The city council is going to urge the Dominion Government to build large elevators there. They point out that it will take two years to rebuild the elevator at Port Colborne and by that time the Welland Canal will be finished and Kingston will be the logical point for the steamers to bring their grain cargoes.

The Green Engineering Co., Chicago, announce that the firm of Bull & Swensparger have been appointed as their sales representatives in Chicago and northern Illinois territory. They will take charge of the Chicago office of the company on August 1. Mr. E. H. Bull has been connected with the Green Engineering Co. as an engineer for the past seven years. Mr. D. A. Swensparger has been a member of their sales force for the past nine years.

Halifax, N.S.—The Public Utilities Commission has granted the Nova Scotia Tramways & Power Co. permission to issue $2,000,000 in notes. The company contemplates extensions and improvements this year to its tramway lines, involving an expenditure of about $1,000,000. The proposed work will include the installation of new equipment in power house, extensions of lines, the purchase of new cars, etc.

St. Raphael, Que.—Plans have been completed by Gauvin and Lessard, engineers, 14 Cote de la Montagne, Que., for a water power development at St. Raphael for La Corporation Electrique de Montmagny. The engineers, it is reported, would like to receive prices on equipment for proposed plant, including two waterwheels with a rating of 1,100 h.p. each; head 245 feet. Also for two generators, exciters, switchboards, penstock, 8,020 ft. long, one headgate and construction of 3-phase, 55,000 volt transmission line, 16 miles long.

Trade Commissioner's Views.—The Canadian Trade Commissioner from Manchester, England, has been visiting Toronto, and has some interesting things to say anent the prospect of trade with Great Britain. He states there will be a good market for Canadian manufactured goods and raw materials in the Old Country for the next three or four years, and gave instances of orders recently placed by English firms in Canada. He mentioned a half million dollar order for confectionery placed by a Manchester firm in Canada, besides huge orders for rivets, wire nails and wire. There is a shortage of three-quarter million homes in Great Britain, and enormous quantities of windows and doors would be required.

BOILERS FOR SALE

ALL IN EXCEPTIONALLY GOOD CONDITION —17 Atlas Horizontal Tubular Boilers (Babcock & Wilcox), 60 inch by 16 feet, with Jones Underfeed Stokers; Boilers lying at Kitchener. 1 350-H.P. Erie City Boiler. 4 250-H.P. Scotch Marine Boilers with wet heads, now lying at Wallaceburg plant.

Dominion Sugar Co., Limited - Chatham, Ontari

The J. C. Wilson Mfg. Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

Makers of the "Little Giant" Turbine.

Put your water wheel proposition up to us

Western Association of Mechanical and Electrical Engineers

Edmonton District Loop No. 5

This Association would be pleased to receive correspondence from any engineers who would like to associate with us with a view of getting better conditions for the craft in general. We would also be pleased to have communications from any other society or societies of engineers who are endeavoring to secure these conditions. Address all communications to

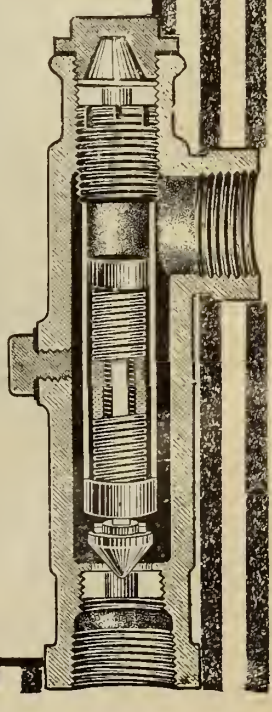
The Secretary,
Western Association of Mechanical and Electrical Engineers.
P.O. Box 991, Edmonton, Alberta, Canada.

THREE STEAM TRAPS FOR COST OF ONE!

There is no more excuse for using high-priced, cumbersome, leaky, inefficient traps of the bucket or float type than there is for obsolete, time-wasting mechanical equipment in your plant.

The Steam Trap Sarco costs about one-third the price of other traps and is a distinct advance in steam trap design.

When condensation gathers, the expansion element opens the valve automatically, allowing the water to run off. And the minute the moisture drains off the valve closes. No waste of steam.



Steam Trap SARCO

has only one moving part—no levers, gauges, packing, stuffing boxes, etc., nothing to adjust or get out of order.

And on account of its smallness you can install the Sarco in limited space where ordinary traps wouldn't fit on account of their size. Does away with digging a pit or building a platform.

Guaranteed for any given pressure up to 200 lbs. Hundreds of thousands in use.

A thirty days' Free Trial of the Sarco will give you new ideas of steam trap efficiency. No obligation. Write to-day; also ask for Booklet "J."

SARCO COMPANY, INC.

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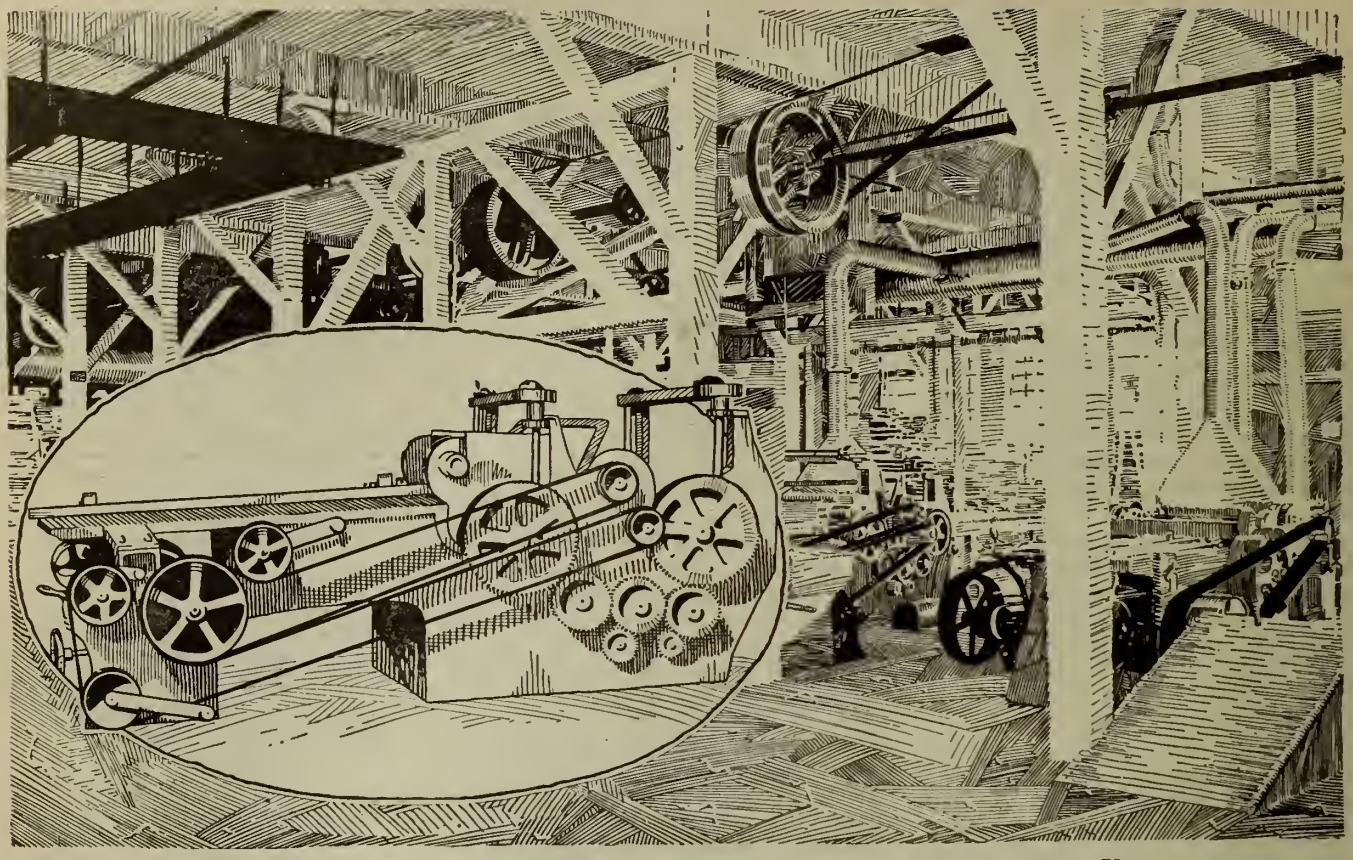
Ellicott Square, Buffalo — Majestic Building, Detroit
Monadnock Block, Chicago — Drexel Bldg., Phildelphia
and representatives in all principal cities
Canada: Peacock Bros., Montreal



Scene in the Haley Mill Showing Goodyear Extra Power Belting in Use.

Another Convert

HALEY & SON,
Lumber Merchants

Gentlemen:—

We want to tell you about the Goodyear Extra Power Rubber Belting we bought for our new mill two years ago and what great satisfaction this Belting has given us. As you are aware, we bought this kind of belting from you for the equipment of our mill **throughout,** even to planers and matchers. We were skeptical at the time about using this belting on our matchers, especially on the side heads, as that is a very trying place for any kind of a belt. We concluded we would try your rubber belting, as we thought then as a makeshift. Now it has been something over two years since we belted up our matchers with your belting and the original belts are yet on these machines and still giving good service. We thought where this belting of yours had proved so eminently satisfactory that we should tell you just as we thought about it and you know we are giving you this testimonial of Goodyear Extra Power Rubber Belting entirely at our own initiative.

Yours truly,
HALEY & SON.

GOODYEAR
MADE IN CANADA

Almost Unbelievable Power-Saving and Economy

Time and again we have found purchasers of Goodyear Extra Power Belting openly skeptical that it would live up to our promises.

Time and again they have told us not only of lower belting costs, but also of increased and faster production, time and power saved.

To-day there is no reason for any plant to buy belting on promises.

On file in our office are letters which enable you to buy belting by proof.

Records of Goodyear Belting performance.

Records of extreme long-life, which means economy.

Records of pulley-gripping, non-slip qualities which save power.

Records of work under strenuous conditions of heat, cold, damp, acids.

Records of strength and flexibility.

Records which prove that without Goodyear Extra Power Belting enough power is wasted in Canada every year by poor belts to pay a big dividend on Industry's capital.

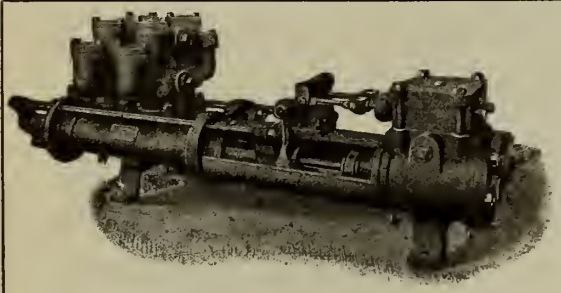
Some of this power is being wasted in your plant. Better belting, scientifically applied, will save you money. Without obligation to you, a belting man, trained by Goodyear, will call and make a record of your needs and experiences. Our recommendation will come from engineers who fit belts to conditions. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Co. of Canada, Limited

Branches: Halifax, St. John, Quebec, Montreal Ottawa, Toronto, Hamilton, London, Winnipeg Regina, Calgary, Edmonton, Vancouver

EXTRA POWER BELTING

HINTS TO BUYERS



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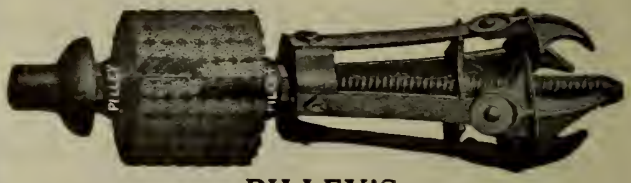
Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

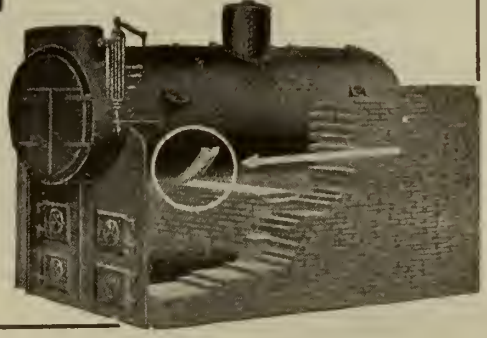
NATIONAL Boiler Girth Seam Protector

Protection means longer life and greater efficiency

If your Boiler is not Fire-cracked it eventually will be. Prevent this by putting on a National Boiler Protector. You will save cost in repairs and prolong life of the boiler. All new boilers should be protected. If your girth seam is giving you trouble at the present time, have the seam caulked up, attach one of these protectors and the seam will remain absolutely dry thereafter.

Guaranteed for one year. We make protectors for patches and all styles of boilers. For full particulars, write—

National Boiler Protector Co.
Room 24
Lombard Building
TORONTO
Main 2623



LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

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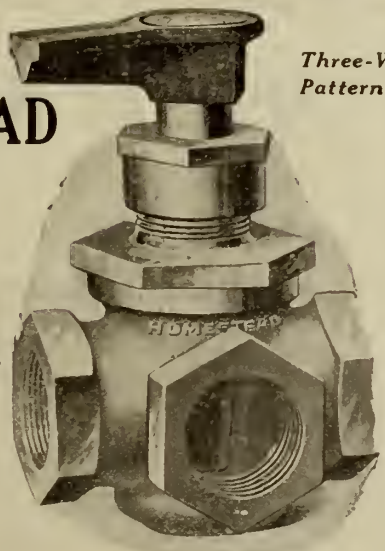
HOMESTEAD

Quarter-Turn Valves

Three-Way Pattern



Economy!
Efficiency!
Safety!

The efficient service Homestead Valves give, proves the superiority of plug cock valves over other types. Homestead Valves combine direct and unrestrained flow with simplicity and ease of operation.

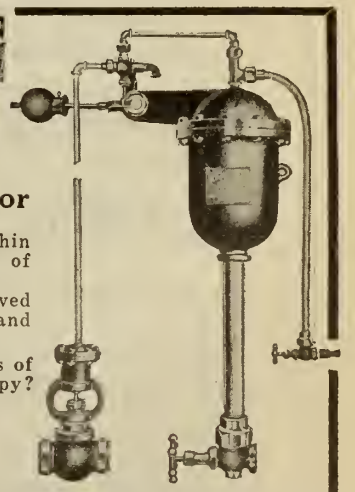
Every Homestead Valve saves its own cost shortly after installation by eliminating wastes and leakages. This is an economical feature of Homestead Valves worth considering.

The harder the service, the more the safety of Homestead Valves is appreciated. Easily stand greater pressure than that for which they are recommended.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

VIGILANT

Automatic Feed Water Regulator



The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.
Years of service test has proved it the utmost in reliability and efficiency.
Catalogue presents many points of interest. May we send you a copy?

The CHAPLIN-FULTON MFG., CO.
28 Penn Ave., Pittsburgh, Penn.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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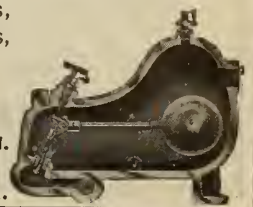

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No. 146 N. 7th Street, PHILADELPHIA, Pa.

Structural Steel and Steel Plate Work

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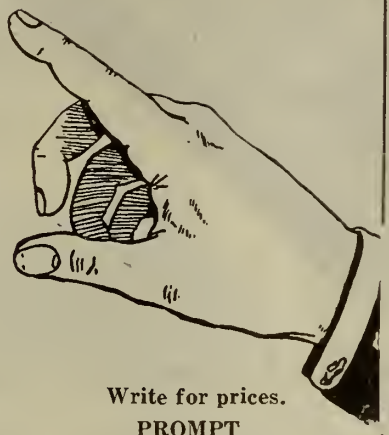
Gate Steelwork
Power House Steelwork

MacKinnon Steel Co. Limited



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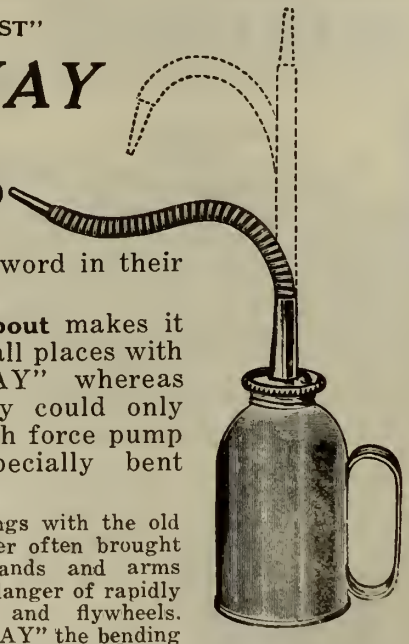
OILERS



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Babcock & Wilcox, Ltd., Montreal.
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Babcock & Wilcox, Ltd., Montreal.
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Johns-Pratt Co., The, Hartford, Conn.
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The Secret of the Strikes

Most Canadians are asking "What is the cause of the 'Great Unrest' "? Is it the fault of labor—or of capital?—or is it the result of German propaganda? Do you know of the real reason for the labor disturbances in Canada, and elsewhere? Are YOU thoroughly familiar with the ins-and-outs of the plans which threaten a world-wide "tie-up?" This is something that should be understood by every Canadian. And every Canadian should read "The Secret of the Strikes," by Lieut.-Colonel J. B. Maclean in the August issue of MacLean's Magazine. It is brimful of startling and authoritative information regarding this great problem. Read it carefully. It starts on page 33, August MacLean's.

"The Lecturer At Large"

Stephen Leacock is one of the continent's greatest humorists. "The Lecturer at Large" is one of the best humorous sketches that he has written. It is made up of what he terms "a few painful reminiscences of the platform" in the course of his lecturing up and down Canada. Get your family around you and read the sketch aloud—it's a rare treat.

Other Big Features

"A Party in the Making." By J. K. Munro. Illustrated by William Casey. An article on the political situation, giving a great deal of inside information with reference to recent developments at Ottawa.

"Solving the Problem of the Arctic." By Vilhjalmur Stefansson. The fifth instalment of his story of the five years' explorations that he conducted for the Dominion of Canada.

"The Unspoiled Country." By Harold C. Lowrey. A descriptive article of a part of Canada which is little known to Canadians generally, Temagami.

"Petite Simunde." By Arthur Beverley Baxter. Illustrated by E. J. Dinsmore. A charming romance of the war. The author will be remembered favorably for his "Mr. Craighouse of New York, Satirist."

"The Seven Blue Doves." By W. A. Fraser. Illustrated by Charles L. Wrenn. The fifth of the Bulldog Carney series and in some respects the best. It is a mystery story.

"His Majesty's Well-Beloved." By Baroness Orczy. Illustrated by C. F. Peters. The second instalment of this splendid romantic novel of the colorful era of Charles II.

The Month's Vital Question

Turn to page 34, August MACLEAN'S, and you will find timely and interesting information regarding the High Cost of Living—a problem of large proportions.

The Review of Reviews

Here are a few of the articles chosen as the best published during the past month in all magazines:—Britain Winning Supremacy of the Air; Has Japan Two Governments?; Kaiser Employed Famous Beauties; The New Triple Alliance; Mammoth Animals in Alberta.

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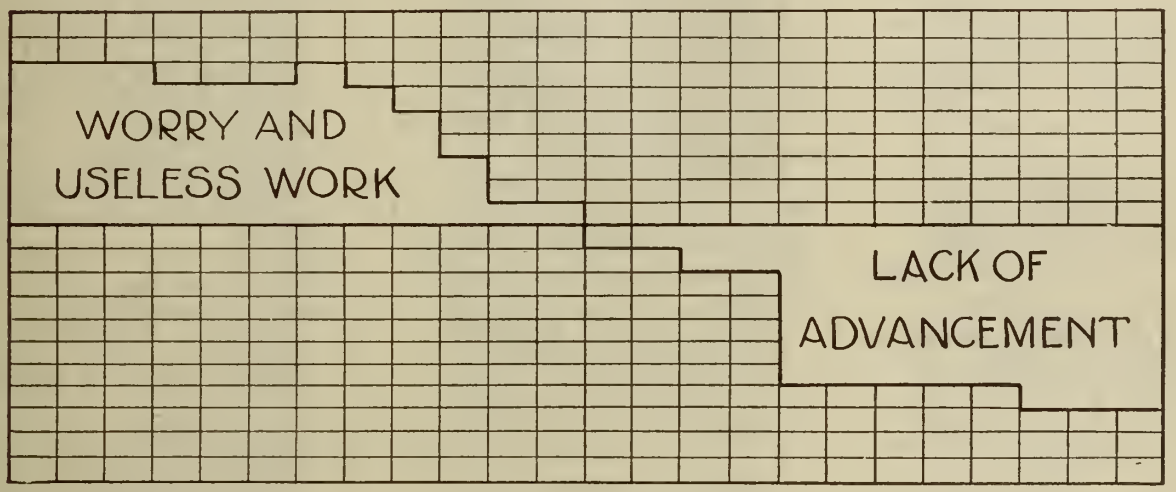

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Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. J. Philip & Sons, Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd.
St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Company, Limited, Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
S. F. Bowser Company, Limited, Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Lanrie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
S. F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.

PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Limited, Toronto, Ont.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

REGISTERING MEASURES
S. F. Bowser Company, Limited, Toronto, Ont.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

RECORDING INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.

ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.

SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.

SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTER LININGS
Beveridge Paper Co., Montreal, Que.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

SPROCKETS, COMPENSATING
Morse Chain Co., Ithica, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal
Cole, Ltd., Geo. W., Toronto,

Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Mason Regulator & Engineering Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
S. F. Bowser Company, Limited, Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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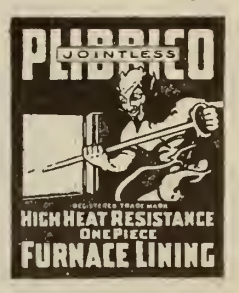

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All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

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When Writing Advertisers Please Mention Power House.

THIS IS TO SHOW YOU HOW
"Cole" Return Traps Save Your Fuel

ATTENTION, MR. ENGINEER:

Does your plant operate under these conditions? Just study this diagram a few minutes and we will explain to you how a "Cole" Return Trap System **saves your fuel.**

Don't you think this is rather an expensive method of handling your condensation? Warming up the outside air and damaging your drains, sewers, walls, etc.

Note the overflow from the tank. See the steam and vapour escaping to the atmosphere.

Look at the cold water jet cooling the hot returns as they enter the tank. This is all loss. Why can't this loss be avoided?

We can avoid this loss for you with our "Cole" Return Trap System. How? Let us explain.

You will note the average temperature of the returns in this case is about 266° F. The boiling point of water at 100 lbs. gauge pressure is 338° F.

The difference of the temperature of the returns at 266° F. and 338° F. at 100 lbs. gauge pressure is 72° F.

The difference in temperature of feed water at 160° F. to which we have cooled the returns down in order to enable the pump to lift the water and 338° F. the boiling point is 178° F. a clear loss of 106° F., or nearly 11% of the heat.

By putting it directly into boiler as hot as we can get it a "Cole" Return Trap saves this loss and handles the water into the boilers without robbing the boilers of steam to do it.

We will assume we have an ordinary Duplex steam pump pumping out of hot well. We all know a steam pump will not lift "real" hot water owing to the vapour in the suction pipe destroying the vacuum as fast as it can be created by plunger of pump. A pump's best work is to develop a horsepower at an expenditure of at least 120 lbs. of steam per hour, equal to 4 boiler horsepower. This 4 H.P. is wasted to the air when it might otherwise be doing useful work.

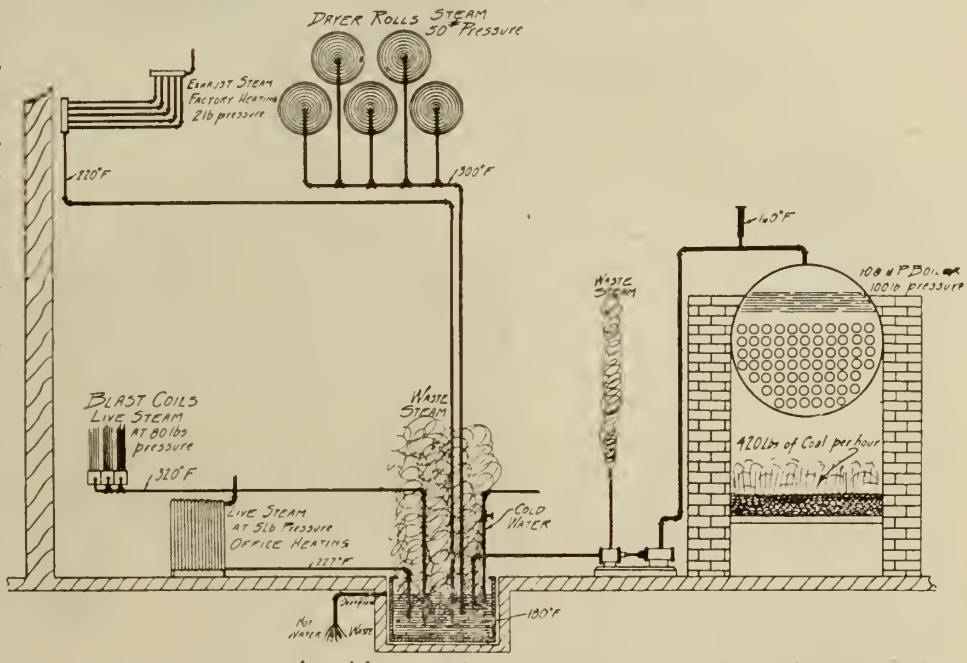
"Cole" Return Traps save all losses in condensation. With a simple installation of "Cole" Return Traps the water would be discharged directly back into boiler as hot and as quickly as it forms, to replace the steam going out of the boiler.

A Steady Water Line.—We would be getting pure distilled water back into our boilers, thereby greatly reducing scale formation, and saving as much useless work in boiler cleaning and much money for compounds and repairs.

We would be saving the cost and maintenance of boiler feed pumps, and also a considerable amount of fuel in making steam.

The Saving. By the installation of this equipment, you would appreciate the saving in your fuel consumption, your labor, and worry, as a "Cole" Return Trap needs a minimum amount of attention or upkeep. You would forget you had a "Cole" Return Trap installed owing to its smooth operation, no pounding of check valves or other objectionable noises, no packing of plungers, valves, etc. No attention to lubricators.

The Cost is nothing as compared to the saving effected with a good return trap system, in a plant operating under anything like this condition.

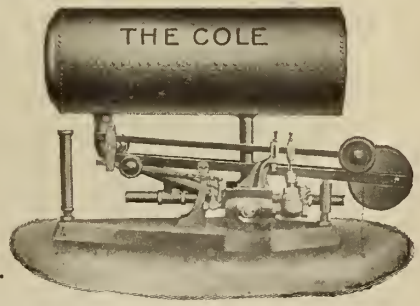


The savings effected would pay for such an equipment in a very short time, and as long as the plant operates the return trap system returns its cost over and over again to the owner.

Are you interested in the betterment of your plant conditions, Mr. Engineer? If so, let us help you.

Show your employer by your own practical engineering knowledge that you can save him money by the installation of a "Cole" Return Trap system suited to your requirements. He will appreciate you for it. He will know you are keeping in advance of the other fellow, by trying to modernize his steam plat and cut down his fuel bills. How about it, Mr. Engineer?

Write us for any information you require on the Cole Return Trap.



Stop the wasteful Steam Plants. Install "Cole" Return Traps. There is credit and increased wages in it for you.

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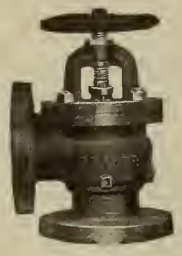
More Data to Come.

In our next ad. we will illustrate other conditions which obtain in steam plants, and which you should be aware of, where constant losses are occurring, and which only need pointing out to the Factory Executive to have them corrected.

We have Bulletins, which contain interesting information to enquirers generally, and you should have them.

Write us for any further information on the "Cole" Return Trap.

Morrison's "BEAVER" VALVES



"Beaver" Angle Valve
Iron body, bronze mounted.

"Beaver" Check Valve
Iron body, bronze mounted.

"Beaver" Globe Valve
Iron body, bronze mounted.

"Beaver" Check Valve.
Iron body, bronze mounted.

"Beaver" Non-return Stop and Equalizing Valve.
Iron body, bronze mounted.

"Beaver" Check Valve.
Bronze.

"Beaver" Angle Valve.
Bronze.

"Beaver" Check Valve.
Bronze.

"Beaver" Globe Valve.
Bronze.

The valve and seat can be furnished metal to metal regrinding, or with renewable copper disc. The seats are renewable and are fitted with set screws to prevent their working loose when the valve is in operation.

Particular attention is called to our improved joint between the body and yoke, the machined faces of the double spigot preventing any possibility of the gasket blowing out.

The stuffing box gland being made of bronze offers a non-corrosive surface for the stem and also prevents the gland breaking when the stuffing box is being packed.

Beaver valves have full area throughout.

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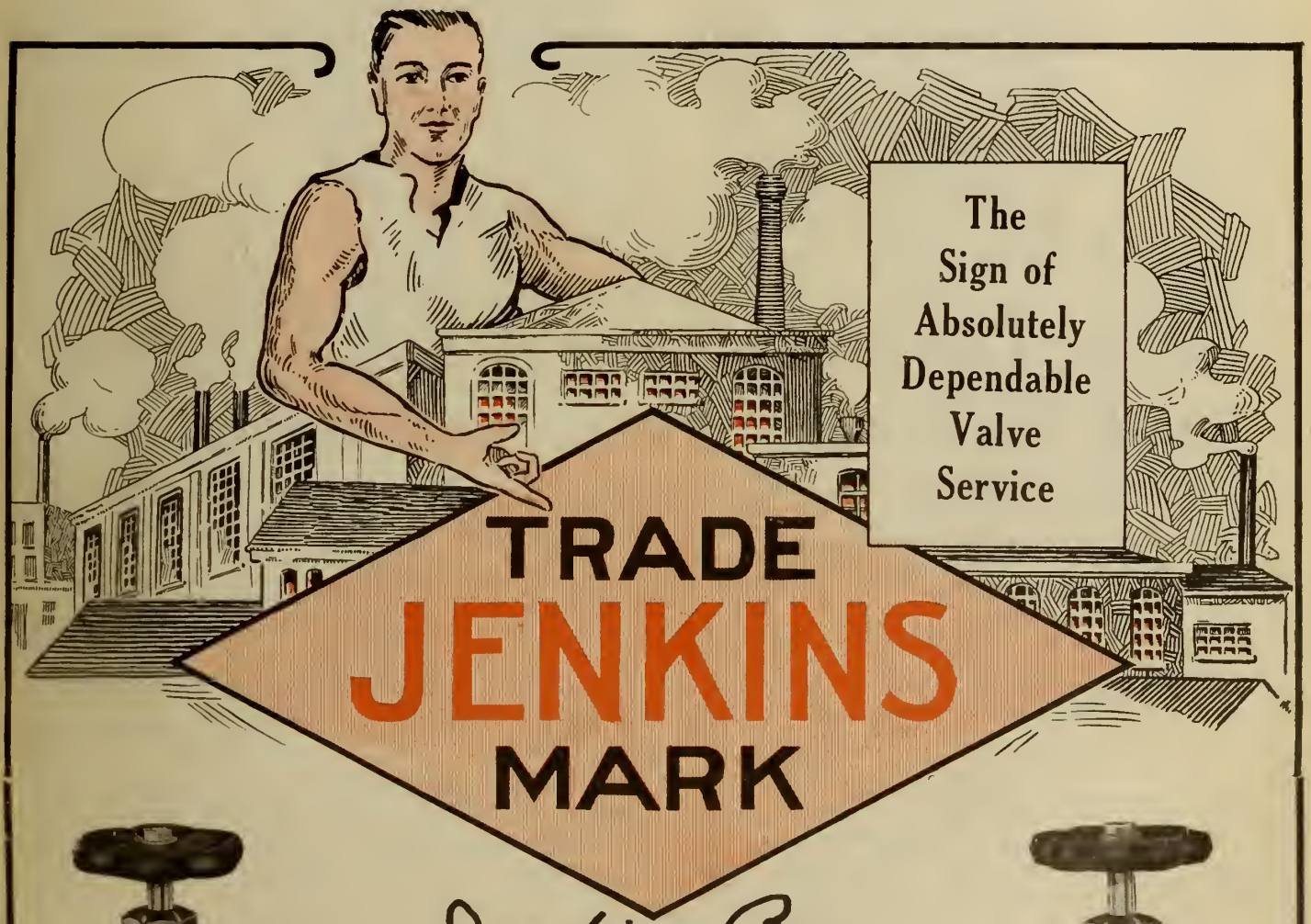

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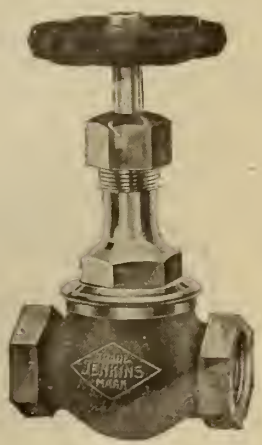
IT'S the power house engineer who has every-day experience that has learned to appreciate what the DIAMOND TRADE MARK means on GENUINE JENKINS BROS.' VALVES. He has seen Genuine Jenkins Bros.' Valves on the job, year in and year out—he knows they are made to successfully meet the severest tests valves may be put to.

The Jenkins Diamond, the distinguishing mark of unvarying service, is on the body of all Jenkins Bros.' Valves—Brass, Iron and Cast Steel. These include types and sizes to meet all requirements; Globe, Angle Cross, Check, Combination Stop and Check, Blow-off, Whistle and Gate Valves in stationary or traveling spindle patterns.



STOCKED BY FIRST-CLASS DEALERS EVERYWHERE.

Catalogue No. 8 Free on Request

TRADE JENKINS MARK Jenkins Bros

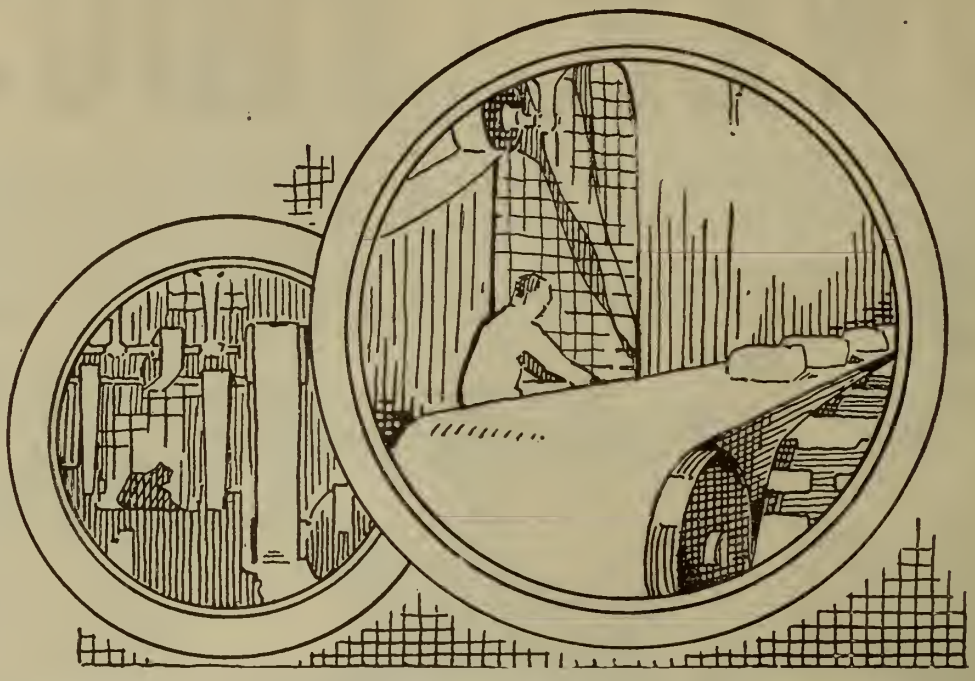
Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street, Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingswa London, W.C. 2, England

TRADE JENKINS MARK Jenkins Bros



How Dominion Rubber System Belting Service Helps Belt Users

For more than fifty years we have specialized in the making of belting and the solving of problems in transmitting power and conveying materials economically.

We maintain a staff of belting experts for the sole purpose of helping Canadian Manufacturers to "speed up" production by cutting belting costs and eliminating power wastage.

These experts will, without charge, analyze your transmission and conveying equipment in its entirety and will recommend changes only where they are necessary to increase the efficiency of that equipment.

You are under no obligation to us in availing yourself of this service — the only return that we request is that you purchase Dominion Rubber System Belting when you have been convinced that the changes recommended by our engineer will be beneficial.

This special service is available through any of our branches.

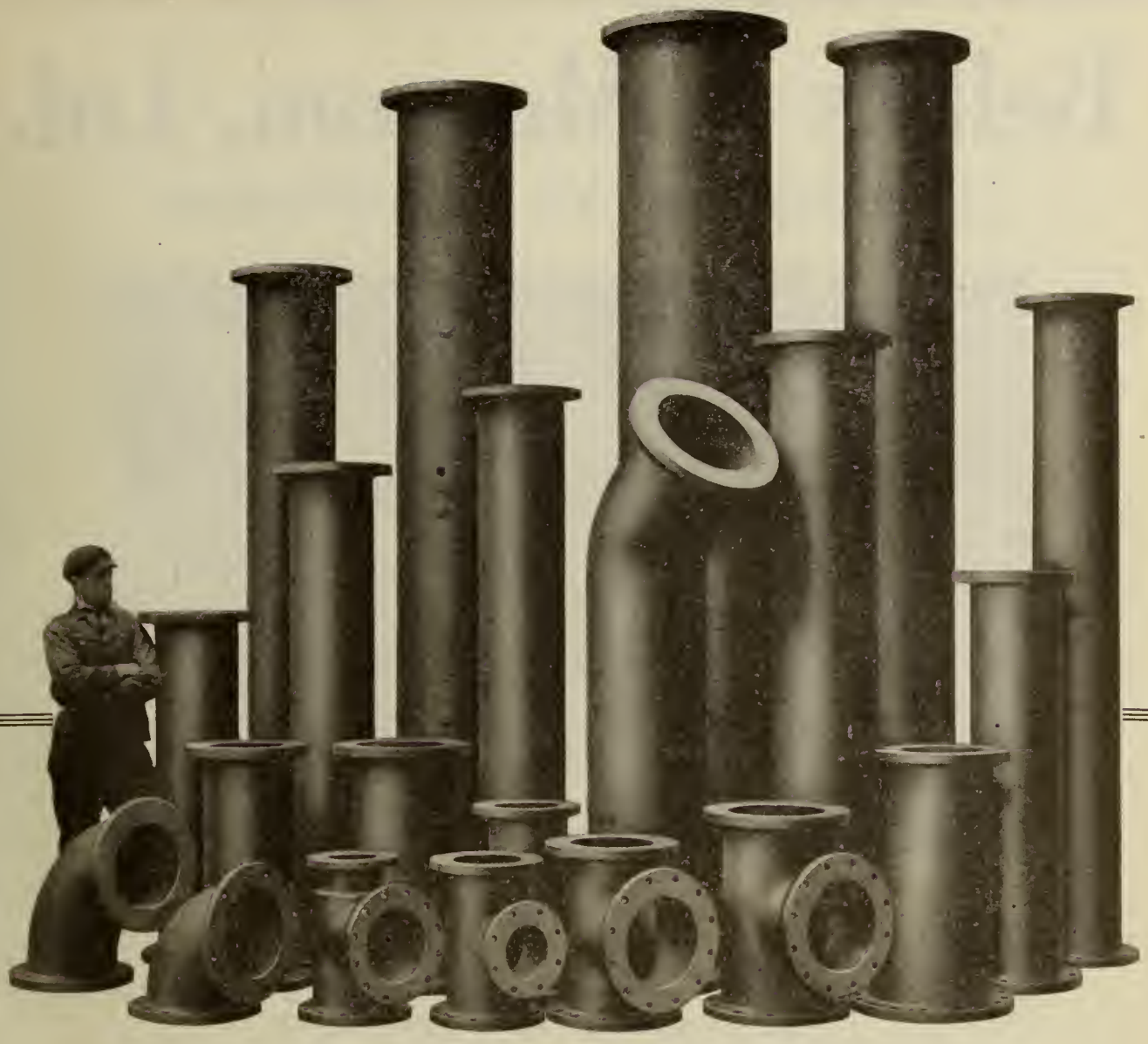
CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Makers of Dominion Hose, Packing and Industrial Rubber Goods and Dominion Tires, the GOOD Tires for every Purpose.

Phone, wire or write the one nearest to you and let us prove to you that the kind of service we have given to Canada's largest industries and the kind we want to give to you, means more than just selling better belts.

Service Branches:

Halifax	St. John	Quebec	Montreal
Ottawa	Toronto	Hamilton	London
Kitchener	North Bay	Winnipeg	Fort William
Brandon	Regina	Saskatoon	Edmonton
Calgary	Lethbridge	Vancouver	Victoria



CASTINGS IRON and BRASS

These cast iron pipes ranging in size up to 24 in. in diameter and 14 ft. long, are representative of a large order of piping and fittings recently supplied the Brantford Water Commissioners.

The recent additions to our foundry have put us in a better position than ever before to supply your casting wants.

We supply grey iron castings up to 20 tons, also Brass, Bronze and Aluminum castings, either rough or finished.

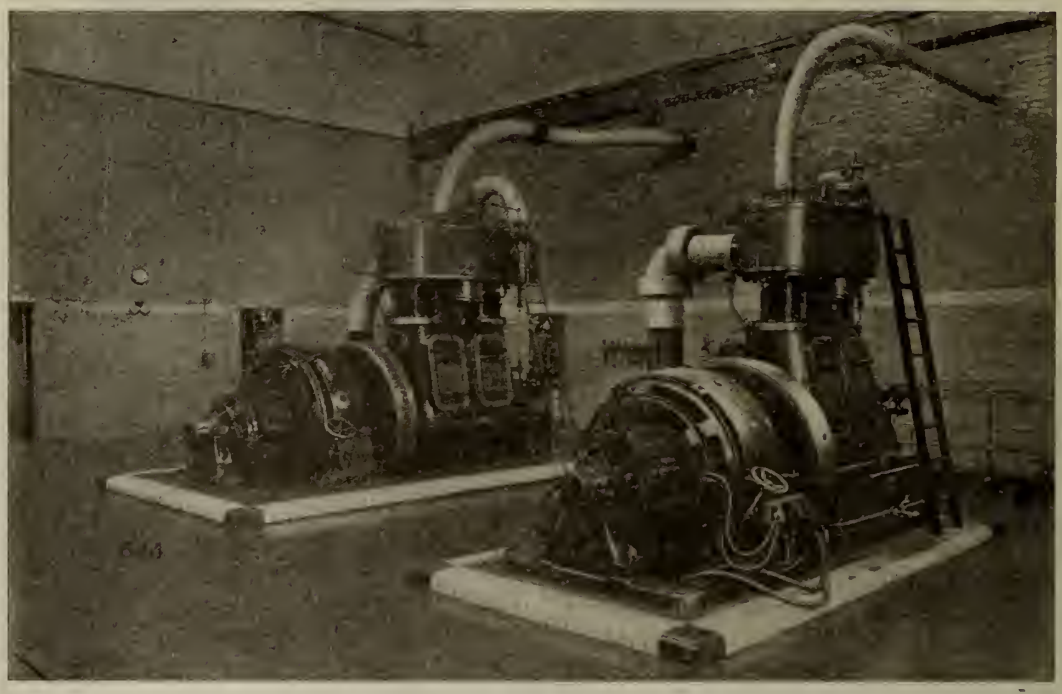
You can be sure of their strength, smoothness and uniformity of texture, as we analyze all materials to insure a perfect product. The work is turned out true to pattern and readily machined.

The Waterous Engine Works Co., Limited

BRANTFORD : : CANADA

Belliss & Morcom, Ltd.

Engines and Air Compressors



Belliss Engines at McGill University Power House

Steam and Exhaust Turbines
Diesel Engines, Air Compressors
Condensing Plants, Steam Engines

Heanan Refuse Destructors
Air and Water Coolers
Dynamometers

Paterson Water Softening Plants

Centrifugal Pumps

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

POWER HOUSE, September 5, 1919, Vol. XII., No. 14. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 112, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

PLAY SAFE

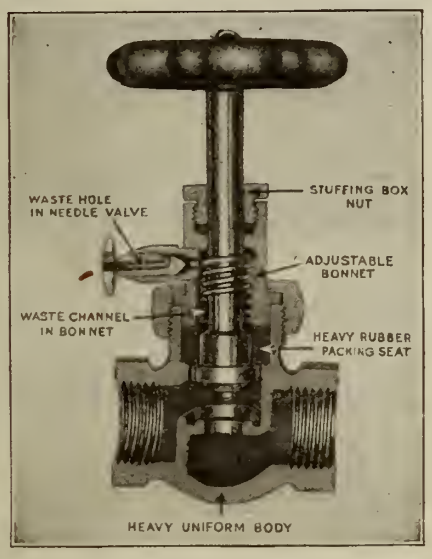


Plate A 840
Jenkins Disc Globe Valve

The whole steam system will be dubbed wrong if a faulty valve is installed, no matter how good the other fittings are.

The sanitary engineer cannot afford to have his good work reflected upon, by so small, yet so important, a factor of the work.

Make sure that the valve is right above everything else.

"Emco" valves are fitted with special high heat resisting "Radium" discs which last a lifetime.

They are registered in all provinces of the Dominion, our ordinary line being approved for 175 lbs. working pressure. All goods are thoroughly inspected and tested before they leave our factory.

Send for our catalogue. Specify "Emco" valves from your jobber or order direct from us.

EMPIRE MANUFACTURING COMPANY Limited
London and Toronto
CANADA

TALBOT

Contra-Flow Steam Boilers

(Equipped with Crude Oil Burners)

Reduces Steam Cost

The cost of operation is cheaper than any known power product.

Require one-seventh the space of the ordinary boiler.

No brickwork is necessary.

Feed water and fuel burners are automatically controlled to adjust the boiler to varying demands for steam.

Tubes easily replaced under high steam pressure.

1-1000 H.P. Boiler in stock, immediate delivery.

May we send you the full details?

Canadian Manufacturers and Sales Office:

Montreal General Tool Co., Limited

675 Notre Dame, Maisonneuve
MONTREAL, QUE.

HOMESTEAD Quarter-Turn Valves

Full Pipe Area

No Obstruction

Smooth Passage

Opened by Quarter Turn

No Pressure Loss

Homestead Quarter-turn straightway Valves offer practically no resistance to flow, and cause no pressure drop. Seatless in construction—no scoring or wear under pressure. No bottom nut or other adjustment necessary. Homestead Quarter-turn Valves have replaced Globe and angle valves in thousands of plants on steam, water, air, gas, oil, acid and other pipe lines.

Let your plant be next

Homestead Valve Manufacturing Co.

HOMESTEAD, PA.

"Be Sure The JEFFREY Improved Carrier is Included in the Budget"

says the Chief Engineer

"You know that ever since the war started what a hard time we've had to keep men in the power plant. You see they did not like the hard, dusty job of wheeling ashes and with the opportunity of having easier work and better wages, you can't blame them for getting out.

"The tremendous job of reconstruction is continuing to create a great demand for labor. Another point to consider is that we are planning to overhaul the power plant completely. I am sure the JEFFREY Carrier will prove one of the best economies we have ever installed."

"By the way we should have Catalog No. 210-4 describing the Carrier on file here. I'll write for a copy to-day."

THE

Jeffrey Mfg. Co.

Canadian Branch and Warerooms

MONTREAL
CANADA

Handle it Mechanically

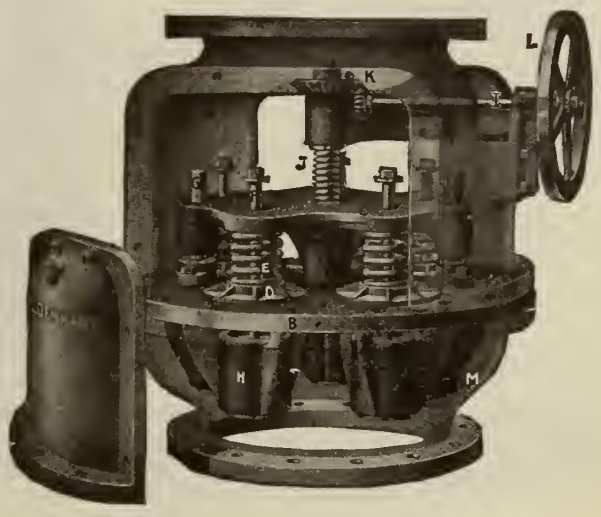
"DID YOU SEE IT AT BRANTFORD"

Some Pointers regarding the Cochrane Multiport

THE COCHRANE MULTIPORT

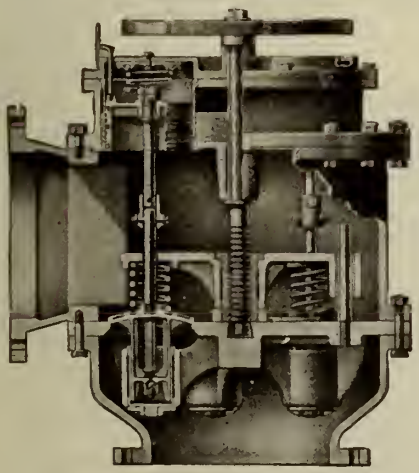
Is an improved Safety Valve
for the Exhaust Steam System

A UPPER CASING, having two removable doors, providing easy access to disks for regrinding, and to springs for removal, etc.
B VALVE PLATE, carries dash pots which guide and cushion the valves, and which are bored simultaneously with seats, insuring alignment.
C PRESSURE PLATE, motion limited to prevent exceeding a predetermined pressure.
D BRONZE VALVE DISKS. Cast integral with dash pot plungers.
E NICKEL-PLATED STEEL SPRING. Can be changed if a different back pressure is desired.
F BRASS LIFTING SPINDLES. Serve to lift disks off seats when exhausting free to atmosphere.
G BRASS SLEEVED GUIDE POSTS for pressure plate.
H DASH POTS. Bronze lining secured by nut on bottom.
I STEEL SHAFT for revolving bronze spindle; not required in horizontal form.
J BRONZE SPINDLE for raising and lowering pressure plate.
K BRONZE GEARS, not required in horizontal form.
L ADJUSTING HAND WHEEL. Valves are also arranged for control from distance by chains, extension shaft, hydraulic pressure, electric motor, etc.
M LOWER CASING.



Interior View, Fig. 1,000, Cochrane Multiport Safety Exhaust Outlet Valve.

WHEN used in back pressure service, it protects piping, radiators, feed water heaters, cooking kettles, absorption ice machines, low pressure turbines or other appliances, against abnormal rises in pressure whenever the amount of steam supply from the engine exceeds the ability of the exhaust system to condense or otherwise dispose of that steam.



Section of Cochrane Multiport Flow Valve for use in connection with Mixed Flow Turbine. Prevents condenser vacuum from backing up into the engine exhaust line and drawing in air through leaks, etc.

COCHRANE MULTIPORT VALVES for Vacuum Service are installed between engines or turbines and condensers. They serve not only to protect against abnormal rises in pressure, but they also provide a convenient and natural channel for the escape of steam during non-condensing operation. They are thoroughly water-sealed to prevent the entrance of air into condensers.

The main idea in designing the COCHRANE MULTIPORT has been to secure absolute safety by providing a number of channels of escape for the steam, so that the chances of all becoming inoperative at once are infinitesimal, at the same time doing away with the excessive list and severe hammering upon the seat inseparable from heavy single-disk valves.

In accomplishing this object, we have taken advantage of the opportunity to make the valve easily adjustable, that is, by varying the position of the pressure plate the tension of the springs may be adjusted for any back pressure desired. Where installed in connection with heating and drying system, it is thus often necessary to carry the maximum back pressure only for a few hours in the morning, while at other times the steam consumption of the engine is reduced by lowering the back pressure. With nearly all other valves, this is utterly impracticable.

The introduction of the pressure plate and spring principle into back pressure valve design also enables us to make the valves strictly foolproof, that is, it is impossible to overload or tamper with the valves, since the limited travel of the pressure plate determines the maximum back pressure. Inasmuch as there are no moving parts directly connected to the disks extending outside of the valve casing, overweighting, tying down or accidental obstruction are eliminated, likewise sticking through over-tightening of glands.

The method of control also makes it convenient to install appliances for operating the valves from a distance, as by means of a long shaft, a chain and sprocket wheel, hydraulic pressure, or by electric motor. That is, it is not necesasry to climb a ladder or to go up on the roof in order to change the back pressure, if you have a MULTIPORT. In atmospheric service, it is sometimes convenient to be able to open and close the valves from the switchboard, which can be arranged for with this type of valve.

In vacuum service, these valves offer perfect facilities for throwing over from non-condensing to condensing operation, especially in connection with reciprocating engines, since the engine may be allowed to exhaust through the valve until the moment when the main gate valve between the exhaust line and the condenser is opened, upon which the small disks will seat immediately without allowing an inrush of air thereby avoiding all danger of losing the vacuum and of having to prime the condenser over again. COCHRANE MULTIPORTS are built for all situations, that is, vertical pipes, horizontal pipes and angle pipes.

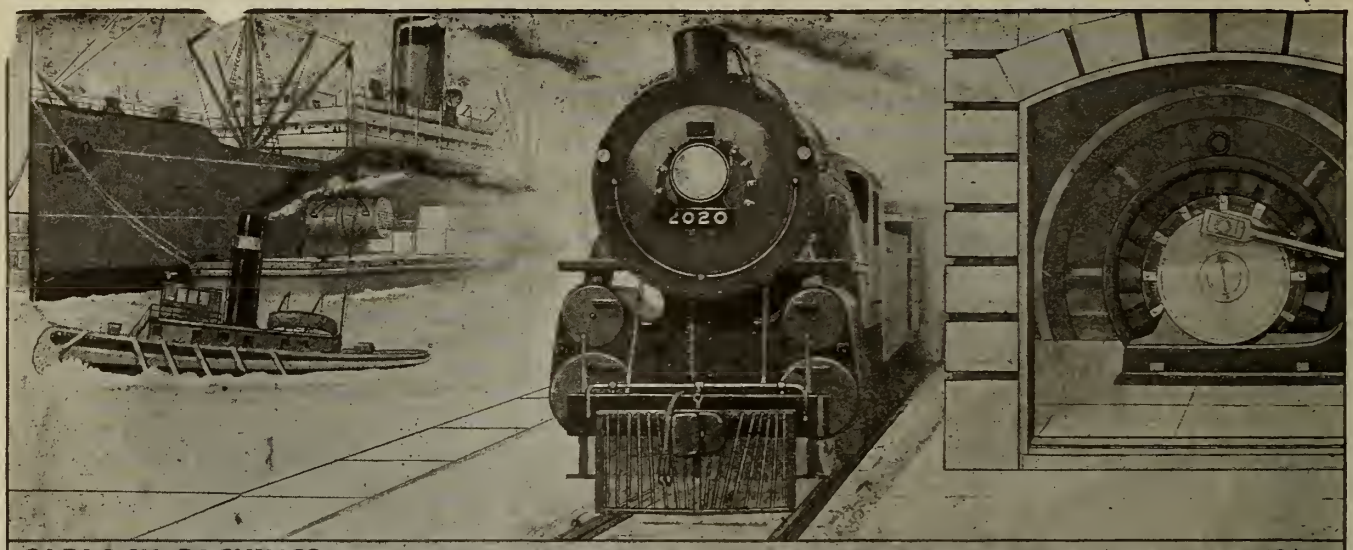
Special types of COCHRANE MULTIPORTS are supplied for preventing the vacuum from mixed flow turbines reaching back into the engine exhaust line, with consequent impairment of vacuum due to the drawing in of air through leaks in the engine exhaust piping, through piston rod packings, etc.

ASK FOR BULLETIN 601

CANADIAN ALLIS-CHALMERS

HEAD OFFICE: TORONTO LIMITED

Branch Offices: Montreal, Quebec, Halifax, Ottawa, Hamilton, London, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton Nelson and Vancouver



GARLOCK PACKINGS ARE USED EXTENSIVELY BY THE GREATEST RAILWAY AND STEAMSHIP LINES AND IN THE LARGEST STATIONARY POWER PLANTS THROUGHOUT THE WORLD

In the Three Great Branches of Steam Engineering

Where speed and economy are paramount, where a hot rod or a blown out gasket might mean a schedule broken or contract lost,

GARLOCK PACKINGS

are used generally. Under the most trying conditions of service Garlock Packings have proved their superiority. Let us suggest a cure for that rod or joint that "won't stay packed." We invite you to submit your packing problems.

The Garlock Packing Company - Hamilton, Ont.

Branches:

Montreal, Quebec - - -	409 Shaughnessy Building
Toronto, Ontario - - -	404 Continental Life Building
Winnipeg, Manitoba - - - - -	Galt Building
Calgary, Alberta - - -	211 Eighth Avenue West

JOHNS-MANVILLE Mastic Flooring

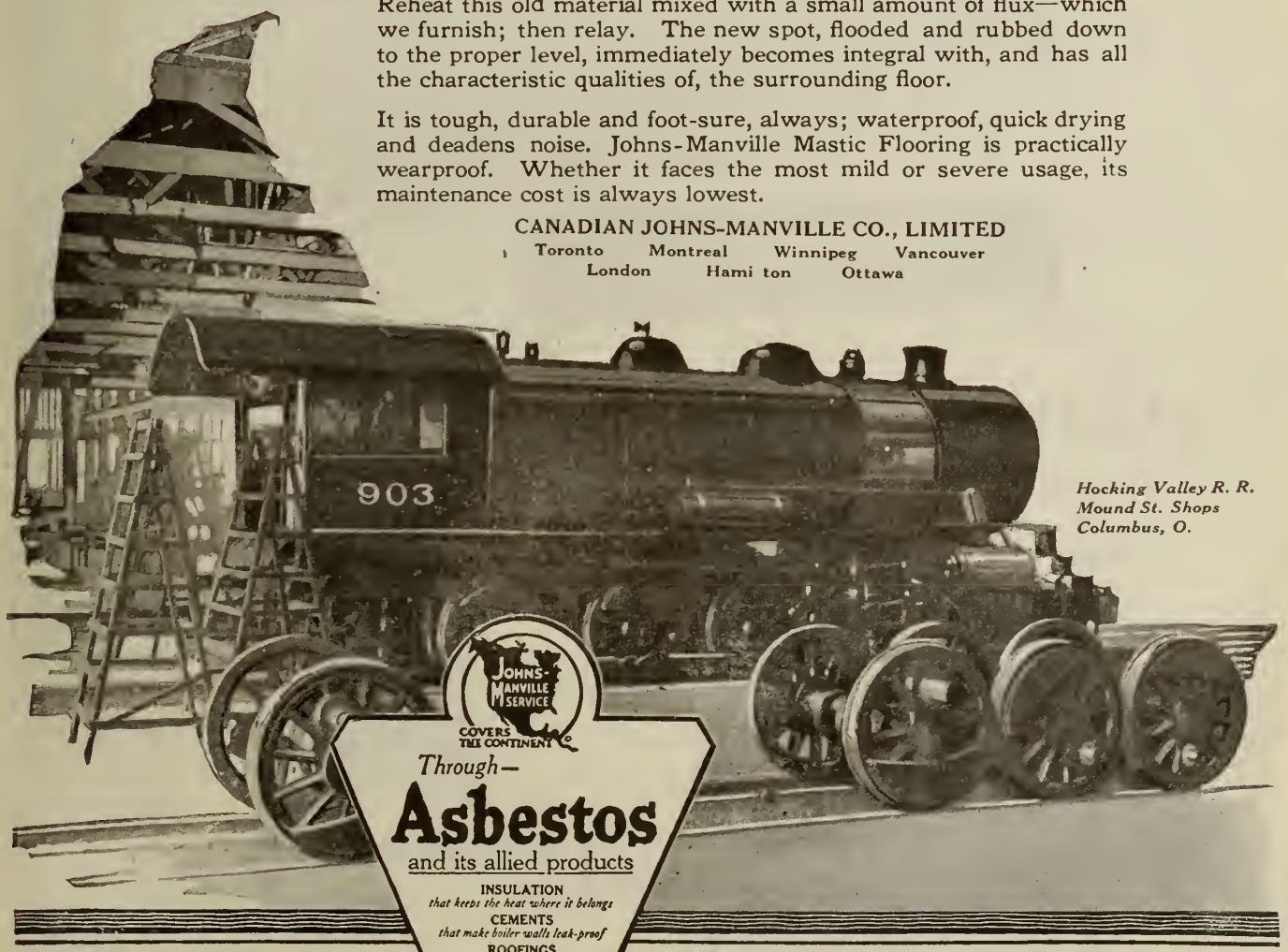
Floors that resist time and tons

GOOD flooring is never bought on the basis of price alone. Other things, more important, must be considered. For instance, *maintenance cost.* Common flooring materials, such as concrete, wood, or asphalt, require frequent, costly repairs, and results are seldom satisfactory

Johns-Manville Mastic Flooring is "made to fit" any conditions and gives longest wear. Easily and quickly repaired—at little cost. When repairs are needed—simply cut out the worn or damaged section. Reheat this old material mixed with a small amount of flux—which we furnish; then relay. The new spot, flooded and rubbed down to the proper level, immediately becomes integral with, and has all the characteristic qualities of, the surrounding floor.

It is tough, durable and foot-sure, always; waterproof, quick drying and deadens noise. Johns-Manville Mastic Flooring is practically wearproof. Whether it faces the most mild or severe usage, its maintenance cost is always lowest.

CANADIAN JOHNS-MANVILLE CO., LIMITED
Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa



Hocking Valley R. R.
Mound St. Shops
Columbus, O.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

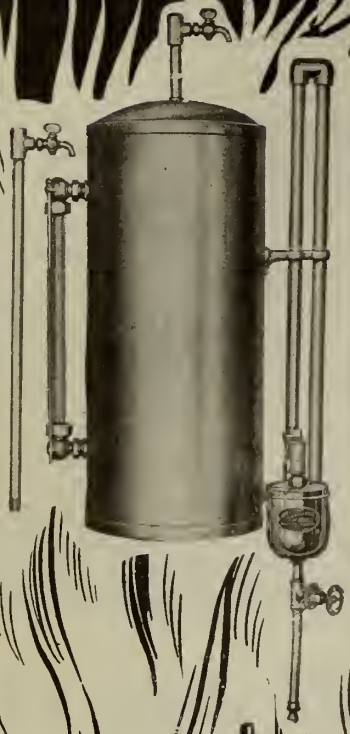
Asbestos

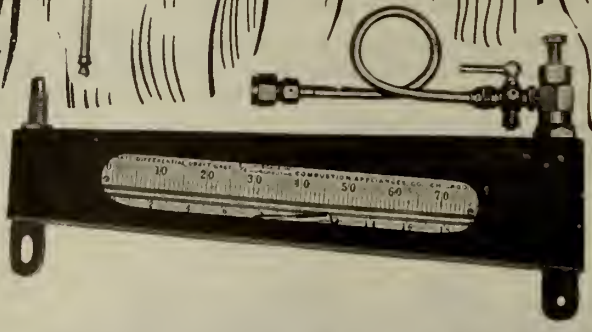
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE Serves in Conservation

Lower the Cost of Steam





Hays CO_2 and Draft Recorder

More Load with Less Fuel

Hays Combustion Apparatus puts this condition within easy grasp of every power user.

It is a friend of the fireman and a very profitable investment for the plant owner. Shows at once if draft is proper—if there are holes in the fire—if settings are leaking—if firing periods are improperly timed and other causes of fuel waste.

Hays Combustion Apparatus effects a huge fuel economy because our engineers make it a point to install the type of Hays Equipment that is best adapted to your individual conditions.

Write for our booklet. It tells how easy it is to get more steam from less fuel.

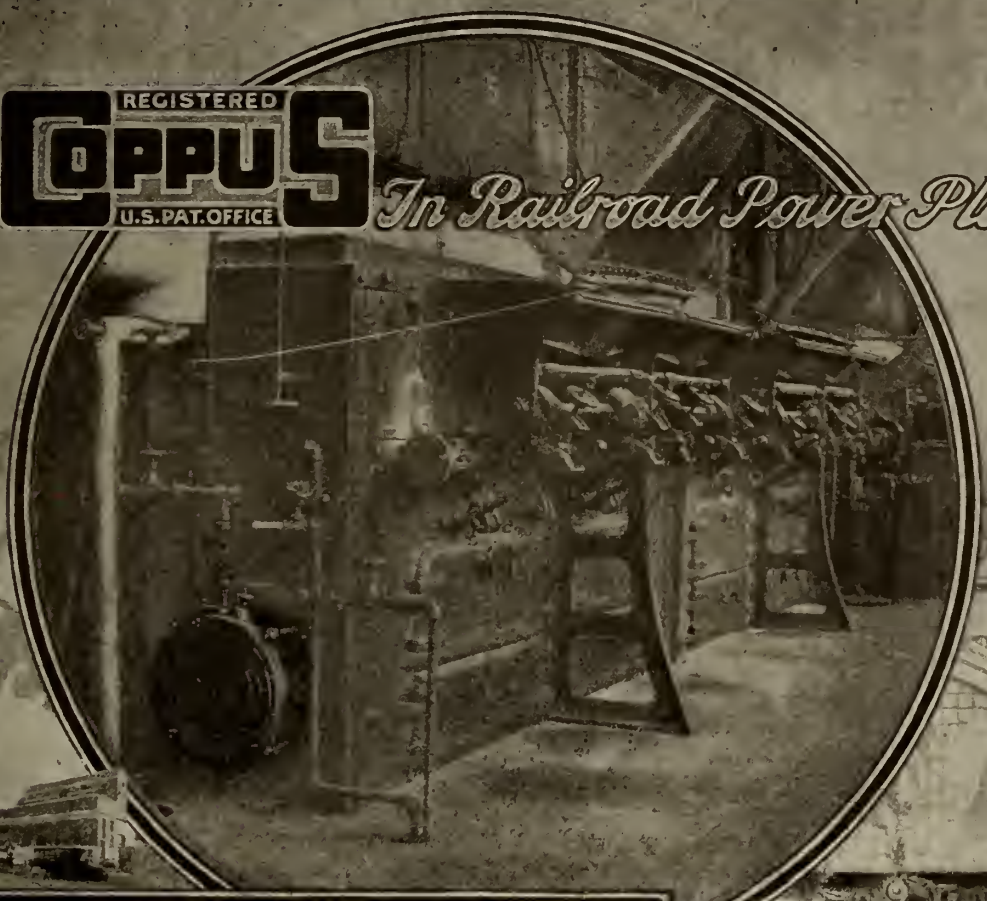
The Jos-W-Hays Corporation

Michigan City
Indiana
U.S.A.

Stephen H. Payne, 30 Church St., New York, Canadian Representative

REGISTERED COPPUS U.S.PAT.OFFICE

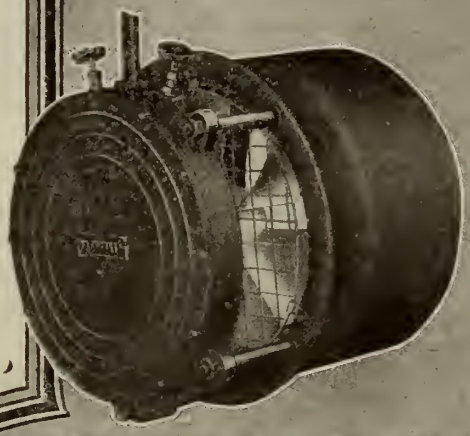
In Railroad Power Plants



Railroads are sticklers for efficiency. Equipment approved by them must produce results—save money—earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers **pay.**

Every one of this big battery of blowers—one of which is shown above—has cut coal costs—reduced labor charges—and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peak loads quickly—and burn cheap fuel.

COPPUS Blowers **pay a profit** to the Central Railroad of New Jersey. **They can do as much for you.** Why not put them on the job? Catalog H-14 will show you how *"COPPUS Equipment can save you money."*



THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfgs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbines

341 Park Ave., Worcester, Mass.

Agents for Montreal: Mason Regulator and Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Bldg.

COPPUS TURBO BLOWER

LINDE

Modern

Refrigerating and - - Ice Making Machinery for all purposes

100 ton Linde Refrigerating Plant in Operation.

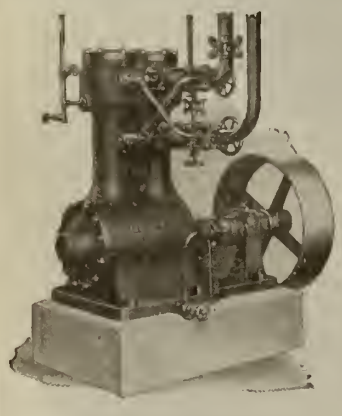
Leading Canadian firms use Linde Refrigerating Equipment. There's a reason. Linde machines possess indisputable constructional advantages, combining as they do the best of the generally accepted features of design along with certain LINDE features not seen in any other make of refrigerating machinery. Thus LINDE equipment is more economical and more efficient.

The Linde Canadian Refrigeration Co., Limited
37 St. Peter Street, Montreal, Que.
Toronto Winnipeg Vancouver

Makers of Quality Refrigerating Machinery Since 1896.

This Linde Plant was made in Canada

There's a Linde System for Every Need.



Ice-making and Refrigerating Machinery

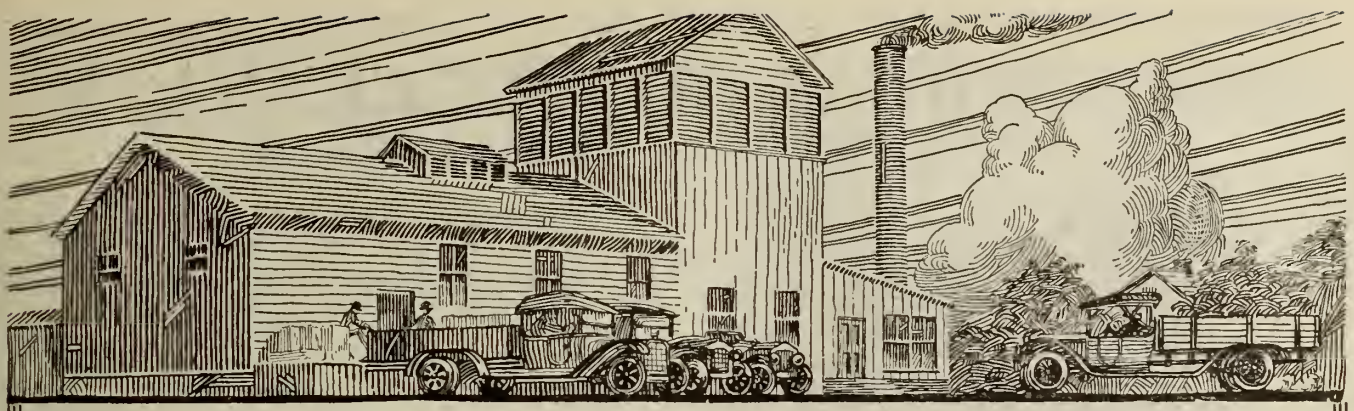
Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin



THE ICE MAN'S HARVEST

As the farmer's returns from the soil are based and computed on the quality and amount of seed sown, so the ice manufacturer's harvest is based on the quality and size of Ice Making plant operated.

For the farmer nature insures the harvest while FRICK Ice making equipment guarantees the ice man profitable returns.

The QUALITY, DURABILITY and *EFFICIENCY* of *FRICK Refrigerating* and Ice Making Machinery are never questioned. Superior Since 1882. Ask any user—"He knows."

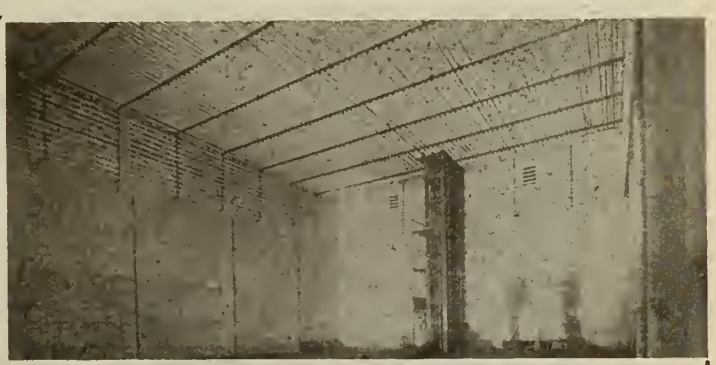
Ask for a copy of our list of users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Are Leaky Walls, Floors and Ceilings Making Trouble for You?



5400-ton ice storage room of the City Ice & Storage Company, Kansas City, Mo., equipped with 130,880 board feet of Nonpareil Corkboard Insulation.

Trouble in maintaining the temperature of refrigerated rooms is too often blamed on the refrigerating machine when the real cause is inefficient insulation.

There may be nothing startling in this statement of fact; but, if such conditions prevail in your plant, what are you going to do about it? Are you satisfied to put up with all the annoyance that flows from leaky cold rooms; or have you had enough of this kind of trouble to convince you that it should be stopped?

So successful has Nonpareil Corkboard Insulation proven in preventing the escape of refrigeration from cold rooms that scores of owners have used it to supplant the insulation with which their plants were originally equipped. Changes of this kind are expensive, to be sure **—but not nearly so expensive as operating a plant with insulation that doesn't insulate.**

If you want to go down deep into the details of this product—if you want to know all the "whys" and "wherefores," send for the free book, "Nonpareil Corkboard Insulation."

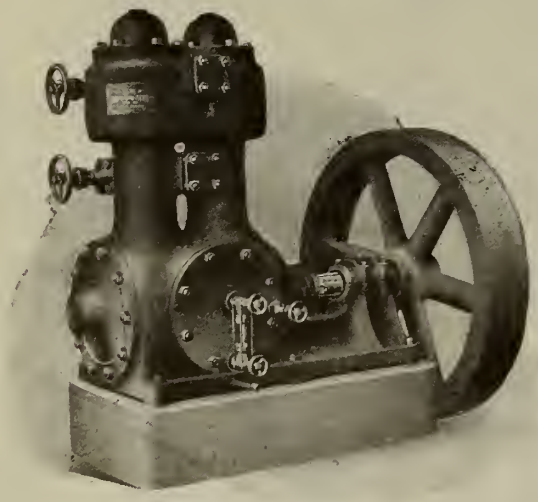
Armstrong Cork & Insulation Company, 504 McGill Building, **Montreal, Que., Canada**

Nonpareil Corkboard Insulation

For Cold Storage Rooms

MECHANICAL REFRIGERATION

SAVES MONEY :-: HELPS BUSINESS



"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively

YORK, PA., U.S.A.

Canadian Representatives

Canadian Ice Machine Company

WINNIPEG 85 Lombard St. | TORONTO 82 Chestnut St. | MONTREAL 324 Craig St. West | CALGARY 605 Second St

In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant,* as we find *them substantially made* and the *insulation perfect.* We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant.* We would not be warranted in throwing out the doors but would like the type hardware you supply."

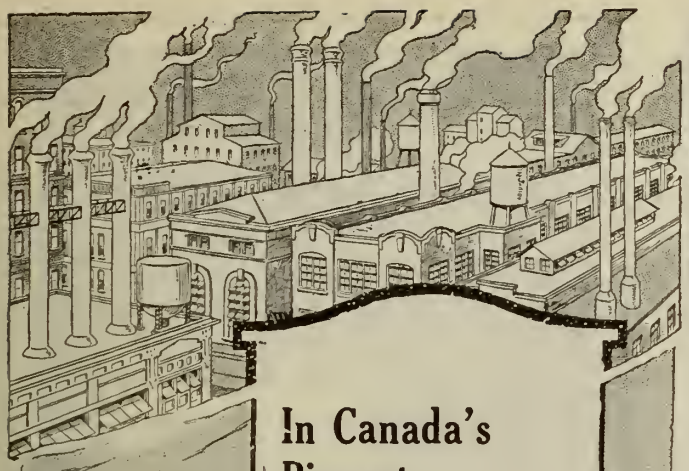
THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you,* in use at both plants, *have been in every way satisfactory,* and we think the *Jamison door is the best on the market.*"

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, M.D., U.S.A.



In Canada's Biggest Industries

Where absolute certainty must be counted upon at all times, no chance can be taken with equipment.

In the big industries, especially must every detail be efficient—the blow-off valve as well as the boilers, pumps and engines.

So, when the big Canadian corporations such as the following instal Yarway (formerly the Simplex) "Seatless" Blow-Off Valves, their choice becomes an endorsement of the very highest character.

Canadian Explosives Co., Ltd., have 11.
Dominion Iron & Steel Co., Ltd., have 20.
Canadian Pacific Railway Co., have 24.
Bathurst Lbr. Co. have 8.
Montreal L., H. & P. Co. have 24.
International Eng. Wks., Ltd., have 13.

And there are many others. With the Yarway (formerly the Simplex) "Seatless" Blow-Off Valve there can be no sudden opening and closing to injure tubes; the operation is simple, certain and safe; the valve does not leak; it requires but little attention, as there are no weak places such as seats or discs to cut and scar; even the packing lasts for years. You can verify each of these claims by testing the Yarway on one of your boilers for 60 days. Return it if not satisfactory.

Write to-day, stating size of line, and whether screwed or flanged, angle or straightway.

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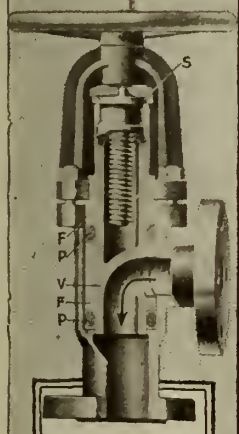

Operation: In closing valve shoulder "S" on plunger "V" engages the lose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

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Seatless Blow Off Valve
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Twelve eight-retort RILEY UNDERFEED STOKERS as installed under twelve 625 H.P.B. & W. boilers at the Port Morris Station of the New York Central R.R. Co.

One feature alone of the Riley Stoker—its moving grates—is worth a dozen skilled operators. Even the most skilled would find it impossible to keep the fuel bed free from holes and clinkers without dropping the efficiency by opening the fire doors.

The Riley Stoker moving grates distribute the fuel—keep the fuel bed open and porous—clean the fires—and discharge the ash and refuse. All done efficiently and economically without the attention of the operator.

It is this kind of money-making and man-releasing machinery that pays dividends, not only for the central station but for the industrial plant.

Your plant may offer large opportunities for saving. Investigate today. Complete details of the Riley Stoker construction are illustrated and described in Catalog HR-9. Copy on request.

For information on the Murphy Automatic Furnace for smaller boilers see advertisement in last issue or send for Murphy Catalog HM-9.

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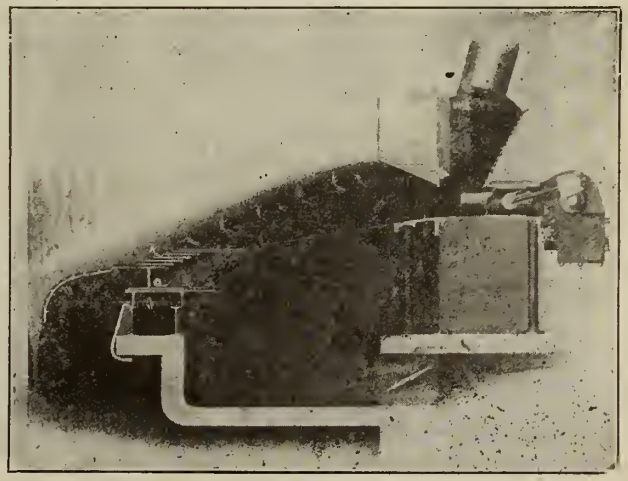

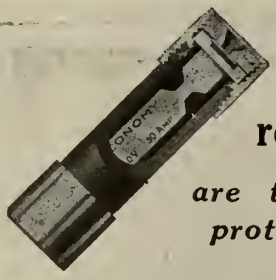

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Manufacturers in Canada of
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Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Power Machine				No. of Blade for Hand Frame	
	Light Machine	Medium Machine	Heavy Machine	Extra Heavy Machine	All Hard	Flexible or Soft Back
Light Angles Channels Tee Iron Ornamental	116					52
Heavy Angles Channels Tee Iron	116-B					250
Light Structural	116-B					250-B
Heavy Structural	114					250-B
Steel and Iron Pipe Conduit and Brass Pipe	116					252
Solid Stock Cold Rolled Machine Steel	114					250 250-B
Tool Steel Cast Iron	114					
Brass	116					
Sheet Metal and Tubing Less than 18 gage, Over 18 gage						258 252

Numbers above are those given in the S

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The Right Way

Follow the chart. There's never any question then about what blade will do that job of cutting easiest, quickest — and cheapest. And remember this — uniformity is one of the strongest points of Starrett blades. Send for Catalog No. 21 "CD" and Chart "CD".

42-960

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COMBINED
CO_2 AND TEMPERATURE RECORDER

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Does your fireman know how much fuel he is wasting? Do you know?

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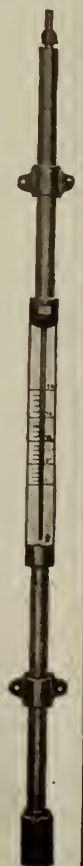
Get more Steam per pound of Coal and reduce your annual fuel consumption.



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Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

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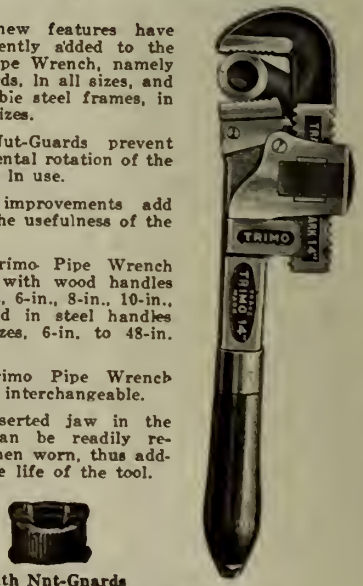

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These valves are without question the highest grade standard valves that have ever been offered to the Canadian trade. Each valve is subject to unusual tests for strength and general service. These tests are greatly in excess of the actual service demanded. Provincial authorities have registered for 175 lbs. pressure on this valve.

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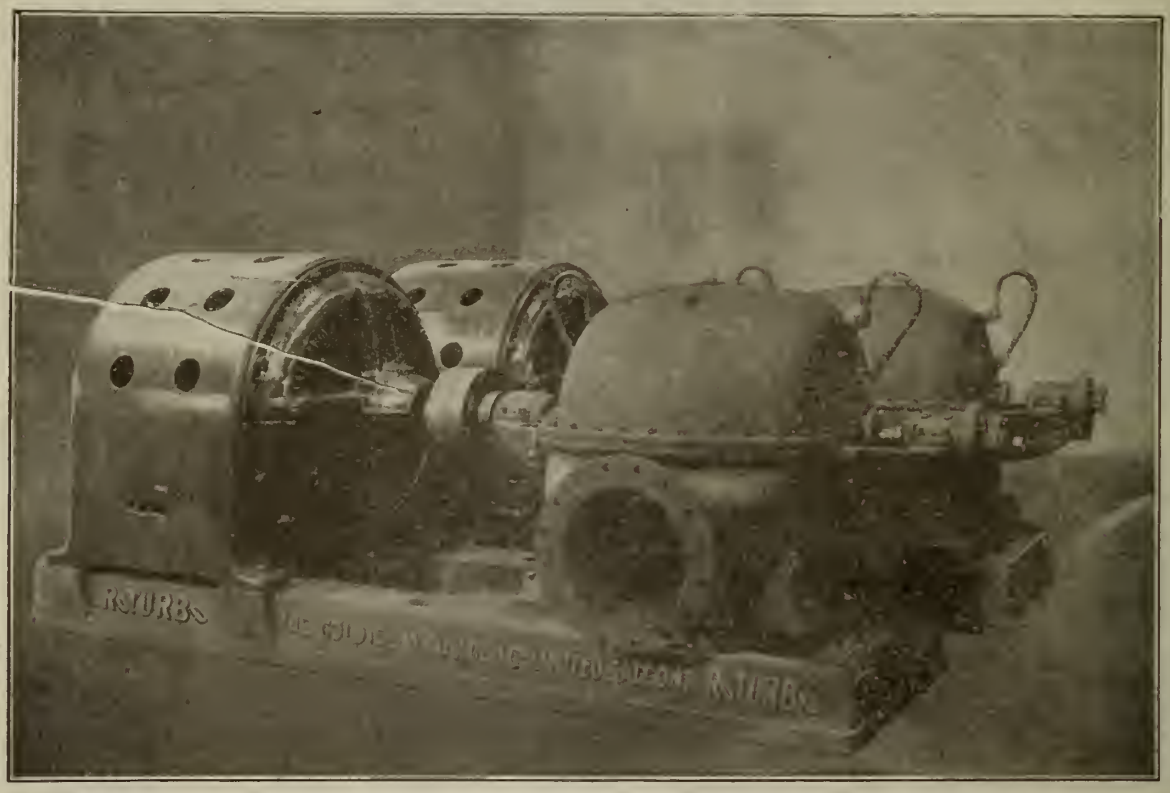
The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed by us for the Windsor Water Works at Windsor. Ont.

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POWER HOUSE

Established 1907 Published Semi-monthly

Low Cost Hydro Power in Winnipeg

Interesting Facts and Figures Relating to One of Manitoba's Hydro-Electric Developments—The Winnipeg Electric Railway Develops Power at a Very Economical Figure

THE accompanying illustrations and drawings show the construction of the Winnipeg Electric Railway power plant which, with the Kenora and city of Winnipeg Municipal Hydro-Electric stations, form the most important developments in Manitoba to-day. The report of Chief Engineer J. T. Johnston, of the Dominion Water Power Branch of Ottawa, Canada, on the Winnipeg River power and storage investigations is of special interest, particularly on the possible power concentrations.

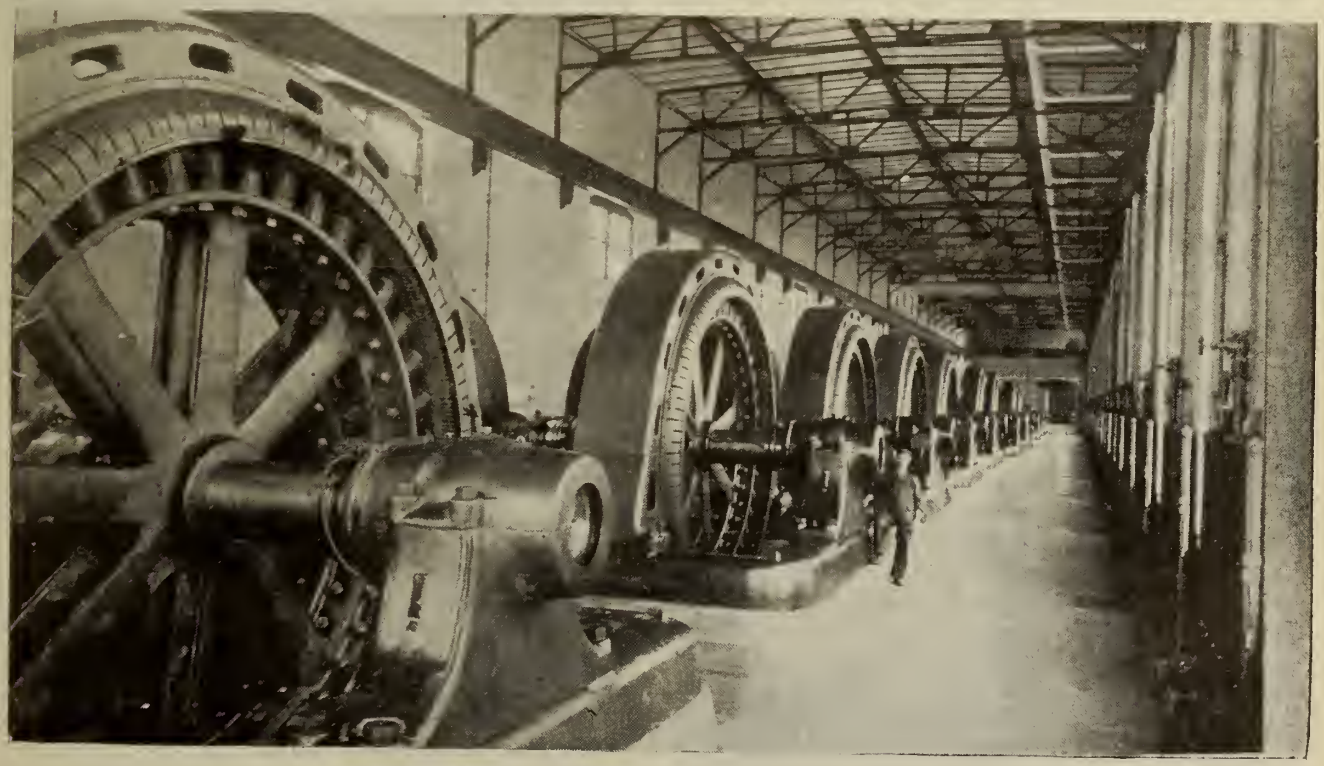
The following remarkably low figures are of interest as to the estimated cost of operation of the seven proposed power developments in Manitoba of Hydro-Electric power placed on the low tension switchboards in the power stations. It is pointed out that a consideration of the total costs shows the following: The total final output of the seven proposed developments is 313,500 horsepower at a total capital cost of $24,547,000, that is, an average cost of $78.30 per horsepower, or $42.80 per horsepower based on machinery installed, the mean annual cost being $5.48 per horsepower based on power output.

The detail estimates of the annual costs per horsepower of the seven Canadian developments are as follows:

	Per h.p. on basis of installation.		Per K.W. hour 100% load factor	
	12,000 Sec. ft.	20,000 Sec. ft.	12,000 Sec. ft.	20,000 Sec.ft.
Pine Falls	$ 5.05	$4.47	0.122	0.108
Du Bonnet Falls	15.04	5.54	0.116	0.102
McArthur Falls	7.24	6.40	0.166	0.136
Lower Seven Sisters Falls	.....	5.47	.....	0.132
Upper Seven Sisters Falls	.....	5.58	.....	0.138
Upper Pinawa	7.11	7.11	0.159	0.159
Slave Falls	5.70	5.21	0.131	0.117
Mean (based on power output)	$ 5.48	$4.21	0.130	0.118

It is stated that no consideration has been given to the cost of transmitting the developed power to the present industrial market, the reason being the uncertainty as to the use to which the power developed at the various sites will be applied. Undoubtedly in some instances the power will be used industrially directly at the site, either for pulp grinding or in connection with one or more of the various electro-chemical processes which are now coming to the front.

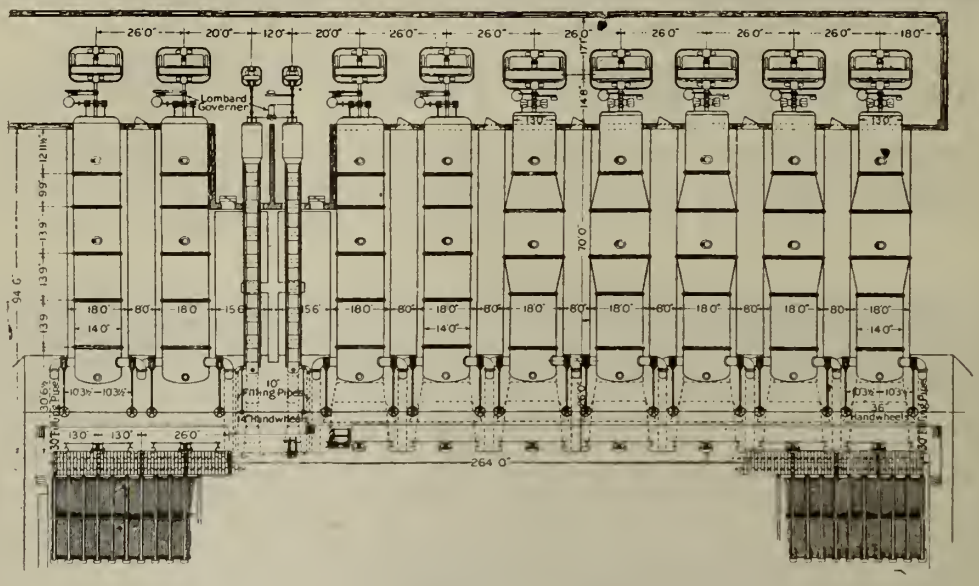
The entire reach of the river in Manitoba above Lac du Bonnet was more or less affected by the head-and-tail waters of, and the diversion conditions resulting from, the two existing undertakings. The river reaching below



INTERIOR VIEW OF POWER HOUSE SHOWING GENERATORS.

Lac du Bonnet was undisturbed by existing structures, and offered full scope to development along maximum advantageous lines.

What was probably the first power installation on the Manitoba reach of the Winnipeg river was undertaken some forty years ago at Pine Falls. The river as a whole does not lend itself to small developments, and it is only by taking advantage of particular local opportunities that such developments are even feasible.

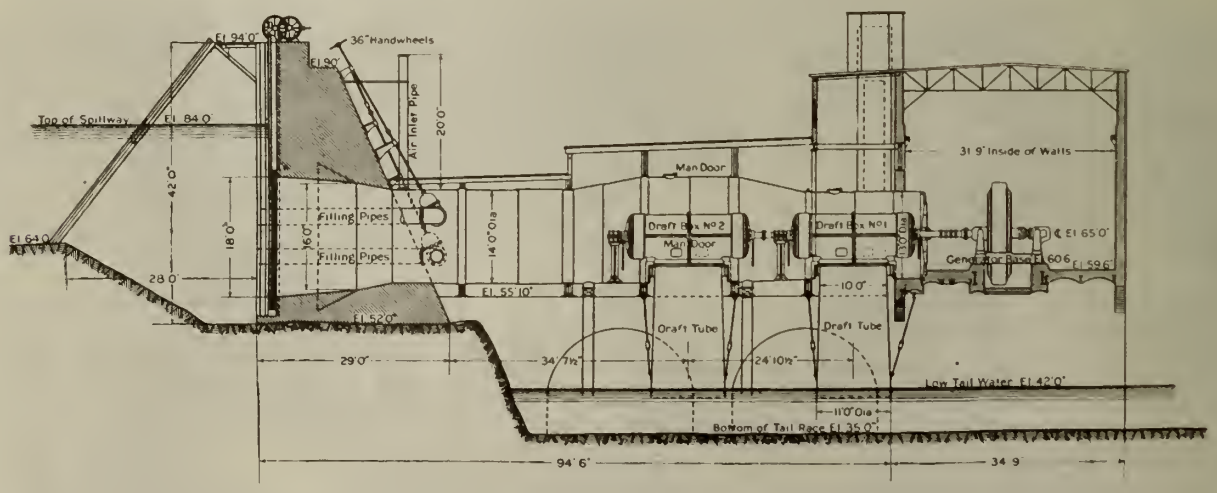


SECTIONAL PLAN

Scale of feet

At Pine Falls advantage was taken of the rock and shore formation on the left river bank to blast a power raceway for the purpose of carrying the head water level to a lumber and shingle mill located some 900 feet below. A head of about 9 feet was available. No diversion dam was constructed in connection with the head-race, the natural shore line providing of itself all the facilities which were necessary in this direction. The first large hydro-electric development constructed in Manitoba was that undertaken by the Winnipeg General Power Company on the Winnipeg River. The Winnipeg Electric Railway Company was incorporated a decade ago and amalgamated the interests of the Winnipeg General Power Company with those of the Winnipeg Electric Street Railway Company. This latter company operated the street railway system of Winnipeg, and also distributed power for domestic and industrial use, supplying the same from a steam station located in the city.

The site selected for the construction of the plant is located on the Pinawa Channel about 59 miles in a direct line from the city of Winnipeg. The general scheme proposed called for the diversion into the Pinawa Channel of a portion of the Winnipeg River flow, by means of diversion weirs across the main channel, and the concentration and development of a 40-foot head. The site of the power station is 7 miles distant from the village of Lac du Bonnet, which at the time of construction gave the nearest railway connection. The city of Winnipeg tramway line now runs within 4 miles of the station. The construction of the plant required the installation of a ferry at Lac du Bonnet, where the river is somewhat less than a mile in width, and the construction of a traffic road.



TYPICAL SECTION OF INTAKE DAM, PENSTOCK & POWER HOUSE

There are three diversion weirs which cross the main and secondary channels of the Winnipeg River at the head of the Pinawa channel. The main weir consists of a 1,379-foot concrete capped, rock-fill structure, with crest at elevation 105.5 company's datum, or 897.44 water power survey datum, connected with the river banks on either side by concrete spillways with crests at 879.44, bringing the total length of the main weir up to 1,652 feet. This

rock-fill section is not entirely water-tight, but fulfills the purpose for which it was constructed, that is, raising the water level above to a sufficient elevation to divert the necessary flow down the Pinawa.

There are two secondary weirs, one of timber, length 120 feet, crest at 896.94 and the other concrete, length 535, crest at 995.94, spanning two secondary channels, complete the diversion system. The discharge down the Pinawa to the plant is governed by a control dam, consisting of eighteen 9-foot and one 13½-foot stoplog sluiceways, with sills at elevation 881.94. Above the control dam and the diversion weirs there is a pondage area of approximately 5,800 acres, extending up stream to the foot of Slave falls.

The head-race from the control dam to the power station pond some 2½ miles below follows a somewhat winding route, which in places has been extensively improved, widened and straightened by excavation. The current is rapid, and the water surface, which above the weirs varies from elevation 898 to 901, drops to elevation 881 in the pond above the power dam. The tail-race presents conditions largely similar to those in the head-race, and the water finally rejoins the main river in Lac du Bonnet, about 13 miles below the station.

The power station is located on the west bank of the channel. The power house is 330 feet in length, 32 feet in width and 29 feet 9 inches from generator floor to top of roof truss. The generator floor is at elevation 851.44, with the bottom of the tail-race at 826.94. The intake dam is placed 95 feet upstream from the upstream

DOWNSTREAM SIDE OF POWER HOUSE AND TAIL RACE.

side of the power station, the water being led to the turbines through 14-foot steel penstocks housed for protection against frost, and with their entrances guarded by the customary gates and racks. The transformer house lies to the north, and is an extension of the power house, having a length of 176 feet, width 53 feet, height 36 feet 9 inches. The entire building is of fireproof construction, being built of brick and structural steel throughout.

The water power equipment consists of nine main units, four 2,595 h.p. and five of 4,788 h.p., and each unit consists of four horizontal inward-flow runners mounted in pairs and located longitudinally in the penstocks. The draught tubes drop vertically into the tail-race, with the water seal at elevation 832.69. The tubes are direct connected to the generators, and are equipped with Lombard governors. The electrical installation consists of four 1,000 k.w. and five 2,000 k.w. revolving field, 60-cycle, 2,300-volt, three-phase generators. The smallest machines run at 200 and the larger at 180 revolutions per minute. The generators are guaranteed to operate at full load at 95.5 per cent. efficiency. Excitation is provided by two 100 k.w., 125-volt, direct-current machines coupled to two 200 horsepower McCormick turbines, and operating at 600 revolutions per minute; and by two 175 k.w. 125-volt exciters coupled to three-phase 2,300-volt induction motors, operating at 514 revolutions per minute.

There are fifteen transformers provided which raise the voltage to 60,000 for transmission to Winnipeg. The Winnipeg Electric Railway also is provided with both

DAM DURING WINTER WEATHER.

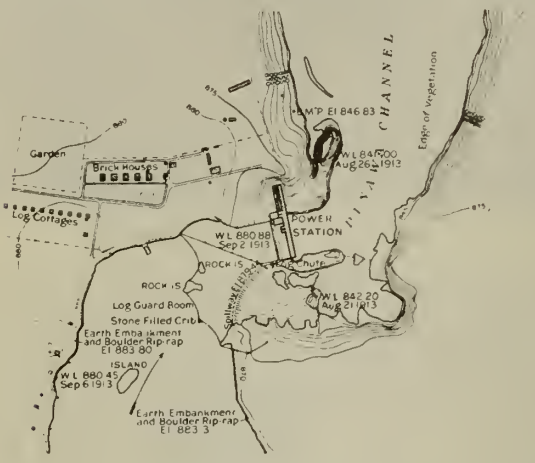
steam and storage battery plants operated in conjunction with the Pinawa station. When hydro-electric power was first used in Winnipeg, all electric light and power was supplied from a steam plant on Assiniboine Avenue, in Winnipeg, owned by the Winnipeg Electric Street Railway Company. This plant had a capacity of about 5,000 brake horsepower. Later the capacity of the Assiniboine Avenue power house was increased by 1,000 horsepower and an auxiliary steam plant of 12,000 horsepower capacity was constructed at Mill Street adjoining the company's main substation. Then the company built a storage battery house adjoining the Mill Street substation, and installed a 5,000 ampere hour storage battery, and the Mill Street station is now capable of producing 16,000 horsepower, and the Assiniboine Avenue plant approximately 60,000 horsepower and at certain seasons of the year all of the steam power and the storage battery plant is in use and operated to capacity.

Chief Engineer Johnston places the total power available for distribution in the city in the neighborhood of 45,000 horsepower. A free spillway, curved in plan, and 429 feet in length, with crest at elevation 879.44 crosses the old river bed along what was previously the crest of a natural fall, and connects with the left bank. Low earth embankments with top at elevation 883 are located on either bank. All headworks are constructed to withstand a pond level of 882. The head available for power purposes varies considerably, depending on the season and the flow in the channel. The original crest of the spillway was at elevation 875.67 and this was raised to its present elevation, 879.51, by the placing of tiers of timbers along

POWER DAM FROM HEADWORKS.

the crest while the average head available at the plant is 39 feet.

Regarding the transmission of this power it may be stated that the entire output of the station is transmitted to Winnipeg at 60,000 volts, over a 65-mile duplicate line which is supported on standard steel towers, 40 feet high and placed at 500-foot intervals. It crosses the main Winnipeg River with a span of 760 feet, on 72-foot towers, and the Red River with a span of 1,100 feet on 105-foot towers. The power is delivered to substations and distributed in the cities of Winnipeg and St. Boniface, the towns of Transcona, Stony Mountain,



GENERAL LAYOUT

Scale of feet

and Stonewall, and a dozen rural municipalities and also is supplied in bulk to the West Selkirk municipal plant.

On account of the fact that with a properly-controlled run-off the surplus flow passing over the diversion weirs and down the main channel can be profitably developed on the Seven Sisters reach, a study of the flow in the Pinawa is necessary to properly operate the plan, and also of the actual flow conditions since the plant was placed in operation is of considerable importance. As a result of the adverse ice conditions which occur during the winter season, and which produce sudden and considerable changes in the flow, and also from the fact that, until recently, no continuous systematic effort was made to secure a full record of the discharge, a determination of past conditions of flow at all seasons is a matter of considerable difficulty.

There has been a metering station established by the field staff of the Dominion Water Power Branch immediately below the control dam, and continuous records have been secured. This, combined with the existing gauge records provides a fairly accurate rating for summer conditions. In order to secure winter flow information it was necessary to rate the plant and to carefully study and utilize the load records. While the final collation and reduction of the results secured is not yet completed, sufficient has been accomplished to indicate that the 8,000 cubic feet per second which has been utilized throughout this report as the flow necessary to properly operate the plant is amply sufficient for the requirements of the present installation. The discharge frequently exceeds 8,000 cubic feet per second and there is generally a considerable automatic discharge over the free spillway.

Water Softening By Chemical Means

By Treating the Water Before It Enters the Boiler.—The removal of scale-forming components from water by chemical means, whether before or after entering the boiler, is accomplished by converting the calcium and magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing down, filtering or sometimes by settling. Lime and soda ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution. These are no longer soluble in the water after removing the carbon monoxide, and therefore separate from it. In a similar way the sulphate scale is removed by its conversion to insoluble carbonate by the soda ash.

The Lime-Soda Process.—There are in current use in power plants practically only one lime-soda process, of which there are two varieties, differing chiefly in the temperature of the water when treated. In all essential respects the two varieties are similar. The treatment consists of adding to the "raw" water softening agents in carefully controlled amount, which must agree with the composition of the water, mixing these thoroughly within the water, and permitting sufficient time to elapse for the separation of the "sludge" before the water is fed to the boiler.

In the case of the "hot-continuous" process, this separation is effected more rapidly, which permits of less storage capacity than in the case of in the cold-continuous. In all cases, though, it is of the utmost importance to provide sufficient storage space to allow the sludge to be completely deposited before the water is fed to the boiler: otherwise the partially completed softening process will be completed within the heater, and the purpose of the treatment will be largely defeated. Another advantage of the hot process is that it expels the air from the water and so reduces the corrosion.

The Zeolite Process.—This is entirely unlike the processes described above, and, unlike them, gives a water of from the softener and replaces it by the calcium and magnesium which had caused the hardness of the water. The hard water simply flows over the permutit packed in a cylinder or is forced up through it and flows from it with all scale-forming material removed. After a time the softener must be regenerated by allowing a solution of salt to flow over it, restoring its original composition and activity. The "Permutit" process is a well-known efficient variety of the zeolite treatment.

Advantages and Disadvantages of Zeolite Process

The construction and operation of this softening equipment is extremely simple, and, as already stated, water of zero hardness is furnished. On the other hand, in the case

GENERAL KEY PLAN

Scale of miles

of water to a high degree of temporary or carbonate hardness there is a correspondingly large amount of sodium salts introduced into the water, so that foaming is liable to occur (as is liable to occur when softening water of a similar composition by means of boiler compounds). In such cases the following modified form of the zeolite process is used.

The Lime Zeolite Process

In this an intermittent or continuous tank equipment, as described already under the lime-soda processes, is connected through a filter to a zeolite softener. Only lime is used in the tank, the soda compound being secured from the zeolite. The filter is placed between the tank and the zeolite softener to avoid any sludge coating the permutit particles and so impair its efficiency.

The Strength of Screws, Bolts and Nuts

In His Memorandum to the Manchester Steam Users' Association the Author Gives Some Interesting Data Regarding These Much Discussed Items of Mechanical Design

By C. E. STROMEYER

In my last year's Memorandum I mentioned that this subject was receiving consideration, but, with the exception of the few failures which have occurred in the meantime, no practical enquiry into this subject had been carried out. The subject was dealt with in a paper read at the Spring Meeting of the Institution of Naval Architects. It was there shown that very slight irregularities in the shapes of screw threads, and more particularly in the relative pitches of screwed bolts and nuts, could produce very serious local stresses at the roots of the threads, stresses which were found to be far more intense than the overall tension stresses in the core of the bolt. It was also found that the finer the threads the intenser the local stresses, and that, contrary to the generally accepted view, a bolt with a fine thread and, therefore, with a relatively large core is no stronger than a bolt with a coarse thread. In fact, this conclusion is almost self-evident, if, as an extreme case, we look on the bolt head as being a nut with microscopically fine threads welded together in order that they may not become disengaged. Of course the corner between the bolt and the imaginary nut would be a mathematically sharp one, and, as is well known, a sharp corner is very weak because, as would happen if a microscopic thread had actually been used, all the shearing stress is concentrated close to the corner. It follows that a bolt with a microscopically fine thread is a very weak structure. The other extreme case is a bolt with such deep threads that it has no core, a mere cork-screw. Such a bolt would also have very little strength; but there is some intermediate ratio of depth of thread to diameter of bolt for which the strength is a maximum.

Unfortunately, this maximum has a comparatively low value, being about one-third of the strength of the shank of the bolt measured over the threads. This, no doubt, accounts for the comparatively low stresses which are allowed in bolts. For instance, the permissible stresses on boiler shell plates between the rivet holes reaches 13 000 lbs. per square inch, and still leaves an ample margin of safety, whereas 10,000 lbs. on the cores of bolts, or about 7,500 on the shank of a bolt is considered fairly high. In reality the local stresses at the roots of the threads, combined with the longitudinal pull of 10,000 in the core, works out at about 20,000 lbs. per square inch, and it is probably only due to bolt materials being very plastic, and the threads being very small structures and, therefore, capable of adjusting themselves, that nominal stresses of 10,000 lbs. corresponding to actual local stresses of 20,000 lbs. do not result in failures.

These local stresses can be greatly intensified by making the pitch of the nut finer than that of the bolt and this malpractice is a not uncommon one. Most bolts have their threads cut with dies, and when these get blunt they tend to lengthen the bolts while they are cutting and compressing them. Then also large bolts and nuts are turned in lathes, and when these have seen much service, the leading screw has become more severely worn near the headstock where the nut would be turned than further off where the bolt thread would be turned. The result seems to be that many large nuts have finer threads than their bolts. The result is that when these bolts are loaded, it is only the threads near the lower end of the nuts which carry the load, and the severe resulting local stresses combining with the longitudinal pull, which is also a maximum at this level, produce very severe stresses; so intense indeed that no simpler means for breaking off a bolt end could be devised than using a hard steel nut with a relatively fine thread and wrenching off the bolt end.

Conversely a very marked reduction in the stresses near the lower level of the nut can be effected by making the nut thread of a slightly coarser pitch, say one-tenth per cent., than that of the bolt. When the nut is screwed on and a pull applied, the bolt will at first rest only on the upper threads of the nut, and gradually, as the load is increased, the bolt lengthens and more and more threads become engaged until all the threads are offering a fair share of resistance. It is of course no easy matter to produce absolutely correct pitches, but seeing that irregularities do occur, and that relatively fine threads in the nuts are dangerous, it would be an advantage to aim at not allowing the bolt thread pitch to exceed a certain limit, and also not allowing the nut thread pitch to fall below this limit.

Some insight into the nature of the stresses which occur in bolts and nuts is afforded by the following short modified extract from the paper previously referred to.

The depths of the nuts are assumed to be equal to the cores of the bolt. The numbers in the table, express the resulting stresses at the roots of the threads in the bolts in pounds per square inch for every 10,000 lbs. stress in the unreduced shank of the bolt.

No. of Threads per Core	Bolt and Nut Thread Pitches are equal		Nut Threads are 1-1000 coarser than Bolt Thread Pitches	
Diameter.	Bottom of Nut	Top of Nut	Bottom of Nut	Top of Nut
8	30,800	5,700	17,400	21,600
16	29,700	3,500	13,400	22,500
32	33,400	1,900	11,500	27,500

When the pitch of the nut thread is finer than that of the bolt, the maximum stresses at the roots of the threads are approximately given by the formula—

$$s = 4\sqrt{[T.Z.D. \div 2h \times (T \div 3E + 1/p)]}$$

where T is the tension in the core of the bolt of the diameter D. The depth of thread is h, E is the modulus of elasticity, say about 13,000 tons per square inch, and Z is the shearing modulus of elasticity of the threads, say 1,000 tons per square inch. The ratio of excess pitch of bolt thread over nut thread pitch is 1/p. The above formula does not apply unless 1/p is larger than 1-1000. For a tension stress T of 6.5 tons per square inch the value of T/3E is about 1/6000. We may therefore write—

$$s = 4\sqrt{[T.D. \div 2h \times (1/6 + 1000/p)]}$$

Let 2=65 tons, h/D=1-16 and p=1/1000, then s=31.2 tons per square inch, to which shearing stress a portion of the 6.5 ton tension stress has to be added.

If 1/p, the discrepancy between the pitches, should be 4/1000, which was actually the case with a boiler stay-bolt which failed, the shearing stress would be nearly 60 tons per square inch. No wonder, therefore, that this 2½ in. bolt should have failed while its nut was being screwed up.

Doubtless many similar cases occur in practice, but comparatively little notice is taken of them, they being attributed to bad material or carelessness on the part of the workmen. The faulty shape of the threads and pitches seems never to be suspected. However, as this subject deserves the very closest study, it is hoped that cases of broken bolts either of boilers or engines will be mentioned to me for the purpose of fuller investigation.

One reason why it is desirable to look very closely into this matter is the growing practice, started by American automatic tool makers, to supply mild steel which will mill easily. This steel con-

tains a large percentage of sulphur. Unfortunately phosphorus is frequently also present in large percentages, and then the bars are very brittle. Quite recently all the screwed stays of a new locomotive boiler had to be removed on account of their brittleness, and other loco boilers having screwed stays from the same steel-maker are constantly breaking their stays.

Drilling and Trepanning Tests of Various Qualities of Steel.

Letter	Relative Drilling Revolutions	Relative Trepanning Forces	Sulphur per cent.	Remarks.
O	0.96	1.21	0.010	Pure high carbon steel.
R	1.26	1.11	0.014	High phosphorus.
S	1.13	1.20	0.014	High phosphorus.
L	1.36	1.34	0.022	High phosphorus and nitrogen.
P	1.26	1.13	0.023	
N	1.26	1.06	0.026	
M	1.10	1.02	0.031	
BB	1.17	1.12	0.032	
W	1.09	1.00	0.034	
T	1.15	1.18	0.035	
Z	0.92	1.14	0.036	
J	1.13	1.00	0.043	High copper.
G	1.04	0.94	0.046	High copper.
V	1.02	0.98	0.047	
F	0.91	1.08	0.048	Very high phosphorus, also copper.
E	0.92	0.91	0.053	High phosphorus and copper.
K	1.01	1.01	0.056	High phosphorus.
B	1.07	0.78	0.057	
C	1.01	0.84	0.060	High carbon.
Q	1.04	1.04	0.060	High nitrogen and copper.
X	0.93	0.94	0.061	
H	0.94	0.79	0.062	High phosphorus and nitrogen.
A	1.07	0.92	0.078	High copper.
U	0.85	1.13	0.083	
D	0.71	0.89	0.193	Very high sulphur.
Y	1.06	0.05	0.031	High tenacity silicon steel.

The above-mentioned new stays contained 0.06 per cent. sulphur, 0.09 per cent. phosphorus, which is already rather high, and .020 per cent. nitrogen, which is very high and suggests that the steel maker had been using a large percentage of Bessemer scrap.

Some time ago, Mr. Dempster-Smith of the Manchester Municipal College, kindly carried out some drilling and trepanning experiments on samples of steel plates of which the chemical analyses and other tests will be found in my pervious notices. As there was a marked blunting of the tools after drilling or trepanning a few holes, a standard sample of steel was drilled for comparison both before and after drilling two test piece holes.

In table 11. the first column contains the distinguishing letter of the sample. The second one contains the relative number of revolutions of the drill per inch of depth of hole drilled, the load on the drill being constant. The third column contains the relative turning force for enlarging the drilled holes to a given size by trepanning, the rate of feed being constant. The fourth column contains the percentage of sulphur, and the fifth one contains remarks about the other impurities.

It will be noticed that sample L with only 0.022 per cent. sulphur offered a maximum resistance of 1.34. Sample D with 0.193 per cent. offered a minimum resistance of 0.71 and 0.89, say 0.8 mean. In other words, the increased percentage of 0.171 per cent. sulphur reduced the cutting resistance by 40 per cent. In view of this very great machining advantage offered by sulphur steels, efforts should be made to make them more reliable than they are at present. They seem to have been tried for motor chains, because blanks made from them punched very easily, but the experiment is said to have proved a failure.

Rules For Measuring Heating Surface of Boilers

The true heating surface of a tube is the side exposed to the hot gases, the inner surface in a fire tube boiler, and the outer surface in a water tube boiler.

Take All Dimensions in Inches

Rule for finding the heating surface of vertical tubular boilers: Multiply the circumference of the fire-box by its height above the mud-ring. Multiply the combined circumferences of all the tubes by their length, and to the sum of these two products add the area of the lower sheet. From this sum subtract the cross-sectional area of all the tubes and divide the result by 144; the resulting figures are the number of square feet of heating surface.

Rule for finding the heating surface of horizontal tubular boilers: Multiply one-half or two-thirds of the circumference of the boiler shell (depending on the amount of boiler surface that is exposed to the hot gases) by its length. Multiply the combined circumference of all the tubes by their length. Add these two products and divide the sum by 144; the resulting figures are the number of square feet of heating surface.

To find the square feet of heating surface in a tube, multiply the circumference of the tube by its length in inches, then divide by 144.

To find the circumference of the fire-box, tube, tube sheet or boiler shell, take the diameter of the tube, fire-box, tube sheet or boiler shell, that is, whichever it happens to be you want the circumference of, and multiply it by 3.1416.

To find the area of the fire-box, tube, tube sheet or boiler shell, take the diameter of the tube, fire-box, tube sheet, or boiler shell, that is, whichever it happens to be you want the area of, and square it (that is, multiply the diameter by itself). For instance, if the diameter of a tube is 3 inches, to square it you would multiply it by itself, 3, which would equal 9 inches, and then multiply the square of the diameter by 0.7854.

It is a general practice among manufacturers to rate boilers on the basis of 10 sq. ft. of heating surface per horsepower for water tube boilers and fire tube boilers and 7½ sq. ft. of surface for Scotch Marine boilers. These heating surfaces as specified are considered capable, under normal operating conditions. of evaporating 34.5 lbs. of water per hour from and at 212 degrees. However, this does not mean that this is the limit of the amount of water that this amount of heating surface will evaporate.

When the boiler is rated at a stated horsepower it is not to be understood that the boiler is in any state of strain when developing more than its rated capacity, that is, the horsepower. Broadly stated, the evaporating capacity of a certain amount of heating surface in a well designed boiler, that it is capable of producing, is limited only by the amount of fuel that can be burned under the boiler.

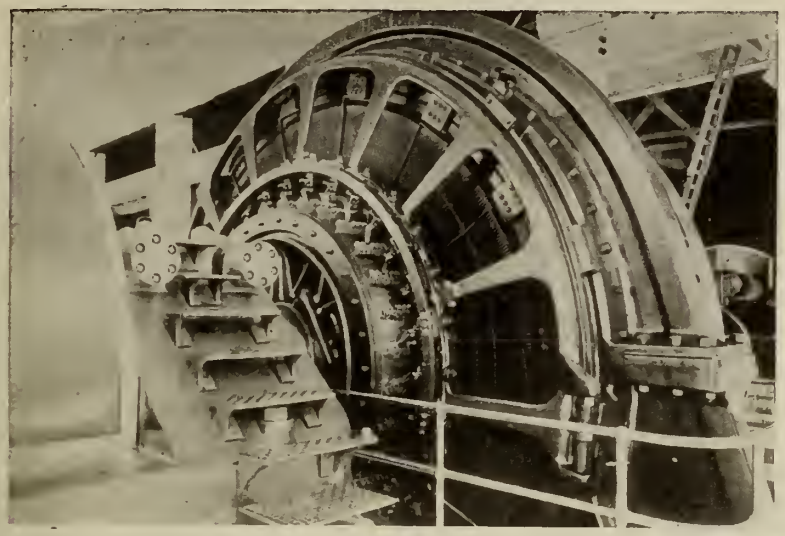
While this statement tends to lead you to believe that the question of capacity that can be secured in a boiler is simply one of making an arrangement by which sufficient fuel could be burned under a definite amount of heating surface to generate the required amount of steam. there are certain limiting features, structural and otherwise, in a boiler to be taken into consideration against the advantage of high capacity developed from a small heating surface.

The maximum capacity of a boiler expressed in boiler horsepower is given in terms of per cent. above the manufacturer's rated horsepower (by manufacturer's rated horsepower is meant the horsepower that is given for the boiler in the manufacturer's catalog, or, the horsepower the manufacturer rated his boiler at, when he sold it).

That the aeroplane engine is not above ordinary humdrum work is shown by the fact that one has recently been installed in a London factory as a stand-by power unit. It burns gas instead of petrol and the cooling water is circulated through a common cast iron radiator. It is an eight-cylinder engine, surplus from the war, and at the aerial rate of living would develop 200 horsepower, but has been rated at 75 horsepower on earth to give it a reasonable length of life. The space occupied by the engine is only 8 ft. by 5 ft.. by 5 ft. high, while its weight is about 800 lbs.

* * *

An English scientist declares that insomnia may be cured by removing excess moisture from the lungs. To put his theory into practice, he has devised a small machine for supplying warm, dry, filtered air, which the patient then breathes through a nose tube secured to the head with tape. The process is said not to be uncomfortable.



The Making of Commutators

The First of Several Articles Descriptive of Commutators and Their Troubles. This Article Deals With Their Construction

By W. F. SUTHERLAND

ONE of the most important features of direct current machinery is the commutator. In some respects it may be looked upon as a necessary evil for no other part requires such care in design, for the securing of proper commutation, and no other part is so liable to give trouble. When properly designed and

FIG. 1—MICA AND COPPER ROUGH MILLED READY FOR ASSEMBLY.

cared for, however, the commutator need be given but little attention and functions very well.

Materials of Construction

In essentials, not including brushes and current collecting devices, there are but three parts to a commutator, the current-carrying bars, the insulation and the supporting rings or spider.

Somewhat at variance with popular belief copper, so universally used, is not altogether chosen for its electrical conductivity but also on account of its high heat conductivity. Occasionally the design of the bar is such that electrical conductivity becomes a requirement demanding attention but in the great majority of cases if the requirements imposed by adequate heat conductivity are met with, electrical conducitvity becomes of secondary importance.

High speed machinery and the offsetting of wear as well as the securing of a uniform quality necessitate in most cases the use of rolled or drawn copper in place of castings for bars. A high elastic limit is especially desirable in view of recent advances in high speed commutator work for turbo-blowers, direct current turbo-generators, etc. In order to obtain a high elastic limit hard-drawn copper is used and for the most extreme requirements the hard-drawn copper is put through several subsequent rolling operations. Hard-drawn copper commutator bars should never be exposed to such temperatures as will anneal the copper. Temperatures above 250° C. seriously affect the elastic limit of copper, while at temperatures above 400° C. the elastic limit is greatly reduced.

Since a commutator is built up of many bars of copper it is necessary that these bars be made very accurately to gauge not only at both the thicker and thinner drawn edges but also in the centre. A difference at either of the edges will result in the bars building up into a commutator either larger or smaller in diameter. Differences in size at the centre of the width of the bar

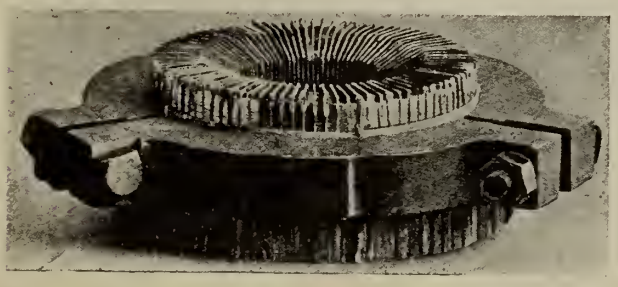


FIG. 2—COMUTATOR ASSEMBLED READY FOR BORING OUT.

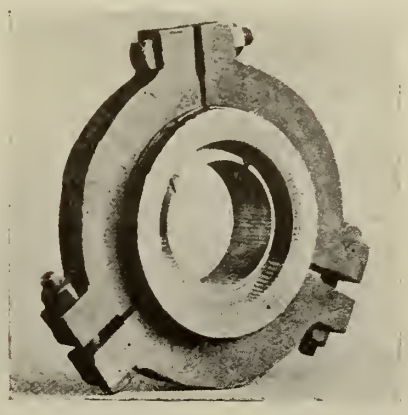


FIG. 3—COMMUTATOR FINISHED, BORED AND ENDS FACED.

arise in the process of drawing. The central part of the bar draws more readily than the edges and the cross-section of the bar, therefore, becomes instead of a wedge with straight sides, a wedge with concave sides.

Insulation

Various materials have been used in commutator construction but in all cases, in commutators of any size, mica is universally used. Fibre and molded insulation are used quite extensively in commutators of smaller sizes. Mica is perhaps the only material which combines the qualities of electrical resistance, equal wear with copper

and resistance to heat in a degree satisfactory to the manufacturer of direct current apparatus.

High mica has been the source of much trouble in the past and to-day is frequently the cause of faulty operation. Many micas are entirely unsuited for commutator construction and the only two which have been

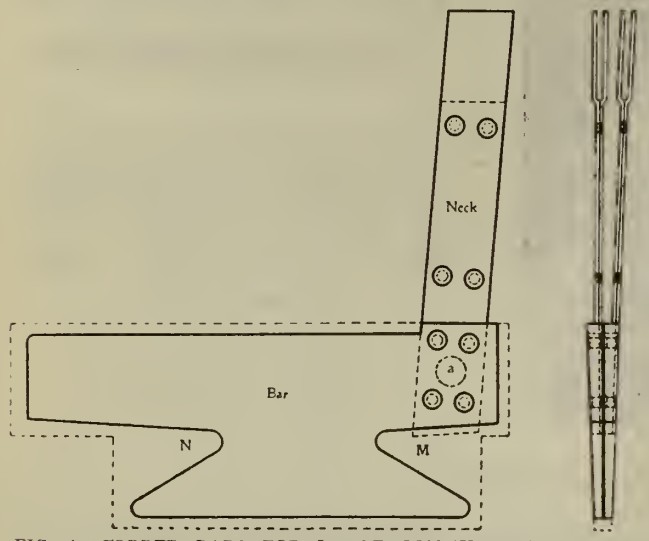


FIG. 4.—COPPER BARS FOR LARGE COMMUTATOR. THE DOTTED LINES INDICATE ORIGINAL SHAPE BEFORE BEING TURNED.

found to give uniformly good results are the Green Ceylon and the Canadian amber mica.

In the manufacture of commutator strips or insulation the naural mica is split up into five flakes and is united under pressure into a sheet of uniform thickness by means of a band, shellac in many cases. One-thirty-second of an inch is about the usual thickness for this strip material.

The bonding material used in built-up communtator mica must not be used in excess or some of it will be exuded in building up the communtator when it is baked. This baking process, as it is commonly termed, is not made either to get rid of moisture or an excess of bonding material in the insulation, but only serves to adjust the mica strips to the inequalities in the copper. If this is not done in the process of manufacture adjustment will take place when the machine is placed in service and loose bars may result, or at least, the commutator will need tightening up.

The vee ring or the insulation on the ends of the commutation bars is built up from mica in much the same manner as the strip insulation and this also needs to be heated when in final position.

The principle of adjustment of built-up mica to inequalities in the metal surface depends on the fact that when the bond is sufficiently softened, built-up mica will flow under pressure. The temperature usually reached in this baking process is about 125° to 150° C. for a shellac bond.

Mechanical Details

The supporting members which carry the commutator bars are usually made of cast iron, cast steel in the larger sizes, or brass in the smaller sizes where economy of space is of importance. Steel forgings are also used by some firms and make a very strong construction. Care is usually exercised by the manufacturers to see that sound material is used.

Building

The copper bar used for the segments is cut approximately to length and the rough bars are milled nearly to the size they will have in the finished commutator. The mica strip is also milled or otherwise cut roughly to size but is made slightly larger than the copper bars. In medium sizes before the commutator is built up a copper bar or neck is brazed to each segment for connection purposes, but in the smallest sizes and in most railway motors, where the neck is short, the segment and neck are in one piece, the mica strip extending to the top of the neck.

FIG. 6—MICA INSULATION FOR COMMUTATORS AND SHOWING THE VARIOUS STEPS IN MAKING A VEE RING
Photo Courtesy the General Electric Co.

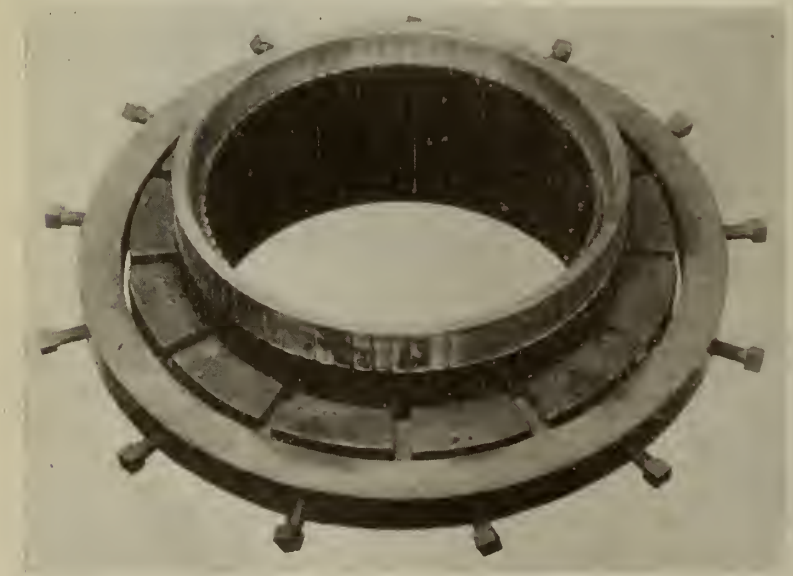


FIG. 5—COMMUTATOR IN RING, PARTIALLY TURNED. NOTE THE ARRANGEMENT OF THE BLOCKS AND SET SCREWS.
Photo Courtesy the General Electric Co.

In large commutators drop-forged copper bars are used. Fig. 4 shows a commutator segment for a large machine. The method of joining the bar and neck is shown clearly. This neck consists of two strips of copper fastened together with rivets and also securely riveted to the bar with countersunk rivets. Afterwards the neck and bar are brazed together and the whole finished off smooth. The dotted lines in this illustration represent the original form of the bar before turning.

The commutator is built up by placing the segments on end, side by side in the form of a circle with neck at the bottom and placing the mica strips between the copper segments. The clamp shown in Figs. 2 and 3 serves to tighten the assembly together, and after it is in place and drawn tightly home the commutator is baked in an oven, the clamping ring being tightened from time to time.

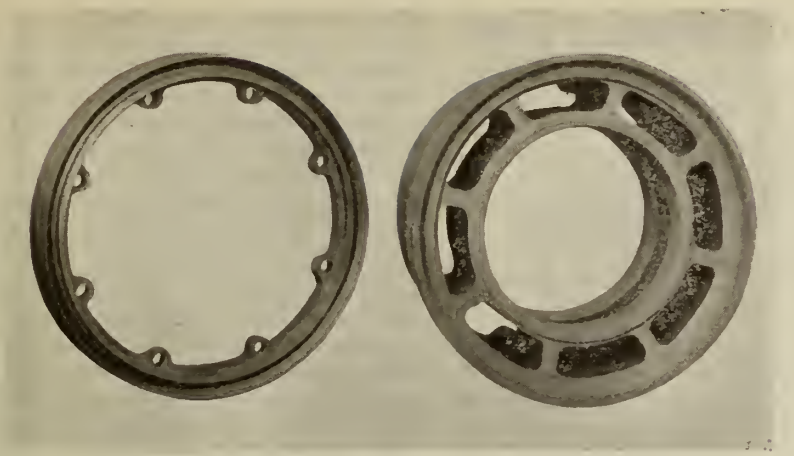


FIG. 7—COMMUTATOR SHELL AND CLAMP RING.
Photo Courtesy General Electric Co.

After the commutator is baked it is allowed to cool and is then machined as is shown in Fig. 3, the dovetails being cut and the inside surface trued up.

The iron or steel bushing is then placed in position with its insulating vee ring of mica and the steel vee or clamping ring also with its insulation placed in position. The whole assembly is then drawn up tight, the outer ring removed and the outer surface machined off.

In the building of larger commutators much the same practice is followed as for smaller ones. The commutator is built up on a circular horizontal surface plate. An iron block is clamped vertically on top the plate near the outer edge to act as a support for starting the row of bars. The copper segments are then set up side by side, with the necks at the bottom and projecting outwardly. A heavy movable block is used to keep the segments in an upright position while building. When the required number of segments have been built up to form a complete circle the whole is loosely bound with rope or tape and the mica sheets placed between the segments. When the commutator bars are very heavy and thick, the mica sheets must be built up with the bars. When the copper and mica are all in place binding rings are clamped about the bars to hold them together. Strips of fibre are used underneath the binding rings to protect the copper.

When the rings are adjusted in place they are supported upon wooden blocks and the mica and bars are evened up by driving against the fibre strips. The bars are set perpendicular by making the edges of the mica strips parallel to a straight edge set perpendicular to the surface plate.

When all the bars are properly set the screws in the clamping rings are tightened and the commutator is ready to be baked. In the baking process the commutator is placed upon a large iron block having a circular hole in the centre. The inner surface is lined with sheet iron to prevent the flame from carbonizing the shellac in the mica strips and heat is supplied by gas flames. During the baking the set screws in the binding rings are occasionally tightened and any excess shellac forced out. When the shellac is thoroughly dried out the commutator is then carried to a boring mill, where the inner surface is machined off. The mill is operated at a high rate of speed and air is sometimes used to blow the turnings from the work. Both ends are also faced off and the commutator tested for short circuits.

FIG. 8—LARGE COMMUTATOR IN PROCESS OF ASSEMBLY.

If one should be found it may be due to particles of copper making a connection between adjacent bars, in which case the connecting copper is cut away by a sharp tool; or it may happen that the trouble is in the mica below the surface. To remedy this it is necessary to remove sections of the clamping rings and to replace the faulty mica with new. After a thorough test the inner surface is sandpapered smooth and shellaced, after which the commutator is ready to be mounted upon its supporting spider. The outside surface is then machined off either when the armature is wound and connected up or, in the case of larger machines, separately in a boring mill.

It is estimated that there are between four and five million acres of land in the United Kingdom which might be planted with timber. Of this amount about one-fourth should be planted during the next forty years, according to the Forestry Bill, which has passed the second reading. This amount would put the country in a position to subsist without imports of timber for three years.

* * *

According to the "Iron and Coal Trades' Review," the Lens coal pits are flooded to the ground level, and at the lower level mines the water is flowing out over the ground, threatening flooding of the countryside. The Mining Society of Lens estimates that it will take eighteen months to pump out the water, and that the working of the coal in the higher seams cannot be resumed until the end of 1920. The complete restarting of the mines of Lens and Lievin will take at least ten years. The powerful pumps required have been on order for a considerable time. They will be operated electrically, from an electrical supply taken from the generating station at Harnes.

* * *

Sir Dugald Clerk, in a paper read before the North-east Coast Institution of Engineers and Shipbuilders, points out the well-known fact that the efficiency of the Diesel engine is largely due to the high compression ratio of 12 or 14, the compression ratio with the gas engine being usually seven, although the author states that "from the results of prolonged experience it may be taken that for explosion gas engines the extreme practicable compression ratio is 10 to 1, and the maximum probable brake thermal efficiency is 39 per cent.

* * *

The author remarks that there appears to be only one method open to increase the heat economy in an internal-combustion engine in a practical way, and that is by using regeneration of heat in some form. If in large installations the steam were used in a high-efficiency Parsons steam turbine, requiring 10 lb. of steam per b.h.p. hour, 25 per cent. could have been added by steam expansion to the brake power obtained by internal-combustion.

MICHIGAN had a dozen buggy factories ten years ago, but now only one. Gasoline is pushing the old gray mare off the map.

The Properties and Uses of Colloidal Fuel

NO problem in America during the recent war reached a more acute stage than that of maintaining a sufficient supply of fuel oil and petroleum derivatives, and among the various problems taken up for study by the Submarine Defence Association was that of securing a smokeless fuel—logically essential to effect concealment for a ship lying just below the horizon, but so often self-betraying because of the telltale trail from its funnel. In the various researches were included trials afloat of powdered coal. This fuel commended itself mainly because of the very complete combustion which could be secured, and exhaustive tests were made aboard the U.S.S. Gem. During preliminary trials attempts were made to burn the powdered coal by first firing oil in conjunction with pulverized coal through separate feeds, and from these tests spring the suggestion to combine fuel oil and powdered coal, so that they they might be fed simultaneously to the oil burners.

Being familiar with the oil industry and with the efforts previously made to evolve a colloidal fuel, and knowing of the availability of certain coals in Europe, where oil is scarce, Mr. Lincoln W. Bates, chairman of the Submarine Defence Association, turned his attention to devising coal-and-oil mixtures, because he believed that an oil-saving fuel could be reached in that way. The first results of trial combinations of coal and oil, made in the autumn of 1917, were instructive and gratifying, but they were not satisfying. Nevertheless, the investigation gave promise of practical use, although neither the oil nor the coal employed was then up to the United States Navy or the British Admiralty standards. A special search was next undertaken for the purpose of discovering a "fixateur" which would render the composite sufficiently stable when oil and coal up to official standards were employed. New supplies were obtained and diverse experiments were conducted with continually better results. After a six months' struggle and many trials, by December of 1917, it was found that certain chemical ingredients incorporated in the admixture created a molecular state wherein the coal content would not settle out at service temperatures. Three months later the work of the laboratory was so far successful that the time for demonstration had arrived.

Many oils are readily available in their natural state for mixing with coal to form a colloidal fuel, while others require slight transformations to effect this, but all varieties of coal are suitable for incorporating with oils. These include, besides the usual anthracite and bituminous coals, lignites and even peat. The low-grade European kinds may be used pulverized, when they could not be used advantageously as coal alone. The salient point is the B.Th.U. content. A coal so low in thermal units as to leave the B.Th.U. value of the colloidal composite much below that of oil alone might not be worth while, except under the extreme stress of a war-time emergency. Another important factor affecting the actual heating efficiency of coal-and-oil combinations is, of course, the amount of ash left on complete combustion.

In all practical coal-and-oil mixtures it is necessary to prepare the coal by pulverization, an art which has been largely developed within the past few years. It is now possible to pass more than 90 per cent. of the pulverized coal through a screen of 300-mesh, i.e., 90,000 holes per square inch. This fine subdivision enables the coal and oil to be stabilized when suitably treated. It has been established both ashore and afloat that "any solid fuel which, in a dry pulverized form, has two-thirds of its content combustible, is suitable for steam generating purposes." All coals may be pulverized. Also inferior grades such as anthracite culm, rice, dust and "slush," as well as bituminous and lignite slag, screenings, etc., can be burned in pulverized form. Coal cokes and crude oil coke, charcoal, and pulverized wood may be incorporated in colloidal fuel and give good results. To obtain satisfaction from these sources of carbon, however, they should be dried and milled so that the surface or free moisture will not exceed 1 per cent. It is reported authoritatively that: "The total cost for preparing pulverized coal properly in a suitably equipped drying and pulverizing plant will range from 15 to 45 cents a ton, depending upon the capacity of the plant."

Of course, the crux of a satisfactory colloidal fuel is stabilizing the coal in the oil. There are only four ways yet known to increase the stability of a coal-and-oil mixture. One is to subdivide the coal to such fineness that a chemical combination between coal and oil particles takes place. This would be a true colloidal mixture. Another way is to thicken the viscosity of the oil so that sedimentation of the coal powder is delayed. A third is to introduce "fillers" of light particles, which would act as nuclei for flocculation, but which by reason of their buoyancy would operate to reduce sedimentation. The products obtained by any of these alternatives are either too expensive or impracticable for storage, or are not acceptable for daily use. By means of a fourth method it is now possible to introduce into the mixture of oil and powdered coal a fixateur which produces a colloidal fluid having the desired properties. The fixateur which has been developed has in its mixture certain characteristics, readily obtainable, which prevent sedimentation for a long period of time. The nature of this fixateur cannot be disclosed at present. The fixateur need constitute but 1 per cent. of the composite—only 20 lb. in a ton, and no doubtful process or industrial problem is involved in its preparation.

With the character of a proper fixateur established after much research, mixtures of coal and oil so stabilized were tested in a practical way under rigorous condition aboard the U.S.S. Gem. For this purpose fuel oil complying with the specifications of the United States Navy was supplied, whilst of the coal 99.7 per cent. passed through a 100-mesh screen, 98 per cent. through a 200-mesh screen, and 85 per cent. through a 300-mesh screen. The calorific value was determined to be 13,974 B.Th.U. per pound. The calorific value of the mixture can be grasped from the accompanying table:

In the report upon this colloidal fuel it is stated: "The results obtained under standard conditions with the Parr calorimeter show that up to 30 per cent. coal replacement the composite has equal calorific value per unit volume. The composite used was not the most favorable possible; it had a higher fixateur content—2.5 per cent.—than is necessary for stabilizing, while the coal used was not of the highest grade available."

Fuel	Per pound, B.Th.U. fd.	S.G. fd. 25°/25°	Per unit, volume relative heat units
Heavy crude fuel oil	18,330	.900	16,497
Same oil and 20 p.c. soft coal without fixateur	17,307	.968	16,753
Same oil and 25 p.c. hard coal without fixateur	16,390	.995	16,308
Navy oil, No. 1	18,669	.924	17,297
Same oil and 30 p.c. coal with fixateur	17,023	1.035	17,619
Coal	13,974	....	.....

Regarding the spraying and atomizing of the colloidal fuel, numerous laboratory tests were made. The results are thus summed up: "While it is not possible to make on a small scale a satisfactory trial of the burning and heating properties of the fuel, it is possible to test its capacity for being sprayed and atomized. For this purpose it is sufficient to have a reservoir of the fluid connected to a compressed air line with gauge, and, on the other hand, to an oil burner or atomizer. For our experiments we used an air injector oil burner, with about ⅛ in. nozzle, regulated by a cone valve, and having a by-pass for injection of the atomizing air current. This air was supplied by a shunt from the main line, and provided with an independent pressure gauge. The fuel was heated to nearly 158 deg. Fah. in a reservoir, which corresponded to a preheater in an oil-burning installation. Quite effective spraying was obtained with a pressure of 70 lb. to 80 lb. on the reservoir and with from 20 lb. to 30 lb. in the air shunt."

At first sight, it might seem that a mixture of a fuel oil of ordinary B.Th.U. value with a coal of a lower B.Th.U. value per pound would make a composite having a reduced B.Th.U. value per unit of volume when compared with fuel oil alone. Such a result, however, is not the case if good grades of coal be used. Of course, there would be a deficiency in the colloidal fuel if coals of relatively low B.Th.U. value were employed. According to the findings of the Submarine Defence Association, we have this interesting fact: "Assuming a volume of 3 cubic feet of colloidal fuel, of which 2 cubic feet would be oil and 1 cubic foot pulverized coal. The fuel oil weighs approximately 58 lb. per cubic foot, and the heat value, for example, is estimated at 19,000 B.Th.U.'s per pound. Therefore 2 cubic feet will contain 2,204,000 B.Th.U.'s. One cubic foot of solid coal weighs approximately 80 lb., and, assuming an average B.Th.U. value of 14,500, one cu. ft. of coal would contain 1,160,000 B.Th.U.'s. Therefore a combination of the two fuels, oil and coal, and in the ratio of 2 of oil to 1 of coal, would contain 3,364,000 B.Th.U.'s, or 1,121,333 B.Th.U.'s per cubic foot, as compared with only 1,102,000 B.Th.U.'s per cubic foot of oil. The heating values will vary directly, according to the B.Th.U. value of the coal and the oil."

Pulverized coal in a dry state weighs only about 35 lb. to 38 lb. per cubic foot, according to the gravity of the coal and to the degree to which the coal has settled. There are, however, no voids in the coal when mixed with the oil, and hence it must be taken as a solid. Colloidal fuel can be made of a great many grades of coal and oil, rendering available in numerous cases fuels heretofore looked upon as undesirable. Colloidal fuel made with pressure-still residuals —such as oil, wax tailings, crude oil coke—is a success. From these residuals an ashless fuel is prepared so low in sulphur that it will command a premium because of its value in making high-grade alloy steel. The Submarine Defence Association, in response to the wish expressed by the Admiralty, extended its research to coal tars. It is possible to announce confidently that it is entirely practicable to blend petroleum oils and coal tars and so stabilize the mixture that the powdered coal, pulverized coke, and asphaltic substances will not be precipitated, but, instead, will produce a stable liquid fuel that can be shipped, piped, and stored. This means that countries without oil, like Australia, France, Italy, and England, may themselves produce quite half of the substances needful to the making of a satisfactory liquid fuel.

It has been found entirely practicable to hold suspended in oil for months running from 30 per cent. to 40 per cent. of coal. The average size of the coal particles is many times that of the graphite particles in lubricating compounds. It is possible to combine in a stable liquid fuel about 45 per cent. of oil, 20 per cent. of tar, and 35 per cent. of pulverized coal, thereby replacing more than one-half of the oil now used, while securing equal, if not greater, heat values per barrel, not to mention a considerable saving in cost.

Regarding the nature of the fixateurs and the process by which they are incorporated with the oil and coal, it will have to suffice at present to say that the fixateurs and treatments produce a state in which the settling force of gravity, operating upon the particles somewhat agreeably to Stoke's Law, is overcome by peptization, absorption, Brownian movement, electrical factors, and chemical and physical phenomena, including such as obtain in the case of colloids and metals. The exception, however, is that in the composite fuel many of the particles are above colloidal size.—"The Engineer."

SURFACE CONDENSING PLANT TEMPERATURES

When tuning up surface condensing plants it is highly desirable that, having a good vacuum, the hotwell water temperature should be kept as high as possible consistent with that vacuum, and a little trouble taken to regulate the cooling water supply to suit the load on the condensing plant will be amply repaid.

There should not be more than 10 deg. F. difference between the hotwell water temperature and the theoretical temperature:

Vacuum	Theoretical Temperature
20	161.28° Fahr.
21	166.83° Fahr.
22	151.97° Fahr.
23	146.55° Fahr.
24	140.42° Fahr.
25	133.32° Fahr.
26	124.89° Fahr.
27	114.34° Fahr.
28	100.05° Fahr.

A difference of more than 10 deg. F. indicate either (a) air leaks in exhaust main; (b) inefficient air pump; or (c) if vacuum is high too much cooling water passing. There should not be more than 18 deg. to 30 deg. F. difference between hotwell temperature and the cooling water discharge temperature. A high difference indicates either (a) an excess of cooling water, or (b) a dirty condenser. The former is shown by low hotwell temperature, the latter and more usual by high hotwell temperature. A low vacuum with a high temperature in both hotwell and circulating water discharge shows that insufficient circulating water is passing, and may be due to centrifugal pump running at wrong speed, or to its impeller being worn.

It should also be remembered that, although steam turbines require as high a vacuum as can be obtained, in order to obtain the best results as regards coal consumption, reciprocating engines generally give their best results with about 25.5 in. to 26 in. vacuum, the hotwell temperature being kept up as near as possible to the theoretical temperature.

INTERNATIONAL MACHINERY EXPOSITION ANNOUNCED

Announcement of the International Machinery Exposition to be held in Grand Central Palace, New York City, has been made by the Merchants' and Manufacturers' Exchange of New York. This is to be one of the most advanced steps made in the machinery industry since the war ended ,and will be a permanent affair. October 15th is scheduled as the opening date, at which time it is expected that hundreds of machines will be in actual operation on the floor. The exposition will occupy 50,000 square feet of floor space, in the high structure, which is the largest exposition building in the world and will include a most comprehensive display of modern engines, lathe milling machinery, planers, drills, screw cutters, presses, boring, can-making, wood-turning machines, etc. The Merchants' & Manufacturers' Exchange, which operates Grand Central Palace, is owned and controlled by the Nemours Trading Corporation, of which Alfred I. duPont is president. It has nineteen branches and 3,000 selling agencies throughout the world, and is one of the most remarkable organizations of the sort in existence. The Merchants' & Manufacturers' Exchange will operate eight permanent industrial expositions in the Palace on the eight upper floors of the 12-storey building. The four lower floors will be used for temperary exhibit, such as the annual automobile show, motor boat, flower show, etc.

Visitors at the Internationl Machinery Exposition will also find the other expositions in this building of considerable interest, included among them are the International Factory Appliance Exposition, International Mining Machinery Exposition, International Farm Tractor and Implement Exchange, and International Exposition of Mining Industries, etc. The advantages of this great world trade clearing house are obvious. Manufacturers will have their exhibits side by side, affording easy comparison. Interchange of ideas and the opportunity to observe what is new and improved in machinery, will be of decided benefit to all who are connected with the industry. Then, too, familiarity with the implements and machinery of one industry so often leads to appreciation of their applicability to another.

Lloyd L. Warfield is manager of the Machinery Exposition and will be assisted by an able staff. Fred W. Payne is general manager of the Merchants' & Manufacturers' Exchange, and has general supervision of all of the expositions. Inquiries should be addressed prior to Sept. 15th to Suite 421, 405 Lexington Ave., New York City, and after that date to Grand Central Palace.

Using Pulverized Coal as a Boiler Fuel

The Following Paper Read Before the Detroit Meeting of the A.S.M.E. Gives Some Interesting and Useful Data Relative to the Use of This Fuel

By N. C. HARRISON

THE peculiar conditions as they exist to-day, on account of the war and for other reasons, such as the gradual disappearance of sources of fuel, like natural gas, and the shortage in the supply of crude oils, which have become of too great value for ordinary fuel purposes, have compelled those interested to consider the possibility of the adoption of pulverized coal as a fuel, to replace their present methods of operation. Pulverized coal was first used in the United States about 26 years ago for the economical burning of the cement rock in the rotary kilns of the portland-cement industry.

Pulverized coal was first applied successfully for economical reasons in connection with the burning of portland cement. The growth of the portland-cement industry also had a great bearing on the development and use of pulverized coal, in that, it is in this industry that pulverizing machines were brought to the present high state of development, for in the manufacturing of cement in the neighborhood of 1,100 lbs. of raw materials, clinker and coal must be ground to produce one barrel of portland cement weighing 380 lbs. As there are a hundred million barrels of portland cement made in this country annually, these figures will give one a reason why pulverizing machines have been so highly developed during the last few years. Fine grinding of the raw material means reduction in the quantity of fuel required and also makes possible the highest quality of the finished product, so far as the chemical analysis or combination is concerned. Fine grinding of the clinker means increased strength for the reason that the hydraulically active units in cement are in direct proportion to the percentage of fine or impalpable powder in the finished product.

The application of this form of fuel has been gradually taken up by engineers connected with other industries, who have speedily recognized its value to such an extent that the steel industry to-day is using in the neighborhood of two million tons of pulverized coal annually in various types of furnaces such as open-hearth, heating, puddling, soaking pits, continuous-heating, reheating, annealing, forging furnaces, and furnaces of practically every description where heat is required.

The copper industry is using between one and two million tons per year in ore-roasting furnaces, reverberatory and copper-melting furnaces of all types. Large amounts of pulverized coal are used in rotary kilns (other than the cement industry) for the desulphurizing and roasting of various grades of ores; for nodulizing blast-furnace flue dust so as to make available products heretofore very expensive to recover; for burning lime to oxide of lime for use in open-hearth furnaces; for burning dolomite for open-hearth furnaces; and for the calcining (or driving off of CO_2 gas and water of crystallization) of various minerals, from which are obtainable such commodities as plaster of paris, stucco, potash, etc. A total of approximately ten million tons of pulverized coal are burned annually in the United States in the above industries.

A still further and very important development is now going on, which will, when it attains its growth, require more pulverized coal than probably all of the other industries combined, and that is in its application to locomotives, particularly in the West. This application is now being developed. There is still another field in which enormous quantities of this fuel will be used and a field in which we are all concerned, and that is in the generation of power in stationary power houses.

Practically any coal can be burned in pulverized form with a proper furnace and burning equipment. Each application, however, must necessarily be governed by the quantity of the fuel available in the district in which it is made. Generally speaking, however, the coals which would give the most satisfactory results would be those in which the ash content would be less than 10 per cent., the volatile averaging between 30 and 40 per cent. and the fixed carbon between 40 and 50 per cent. The sulphur content should be low, although coal with a sulphur content running as high as 4½ to 5 per cent. is being burned in pulverizing form under boilers without any detrimental results. The ash should have a high melting point. These statements, however, are tentative, as most excellent results have been obtained from all sorts of coals, differing widely from the ideal analysis stated.

It is very apparent that the development in this method of burning coal has brought coals, from which heretofore very inefficient results have been obtained, within reach of a great many consumers. For instance, from Texas to Edmonton, Alberta, the country is underlaid with various grades of lignites, low-grade mineral coals with high moisture content and of such a nature that the ash would melt or flow down on the grates, thereby preventing the highest efficiency from being obtained. They are of such a nature that their use in gas producers is not very satisfactory, so that until the development and burning of these coals in pulverized form was an assured success these coals were not used in as large quantities as is now possible. The largest deposits of lignite and mineral coals appear to be in the Northwest awaiting future development when proper means are at hand for obtaining the highest possible economy from their combustion, and the location of these large deposits will now be of great value to the districts in which they are located.

Around steel plants there are large quantities of waste fuel such as coke breeze. This fuel is being used to a certain extent on some forms of grates, with forced draft, but it can be burned in pulverized form under boilers for the generation of power, and possibly in the open-hearth furnaces for making steel. In the anthracite field there are large quantities of coal daily pumped back into the mines, which coal is a result of the washing and crushing operation, for bringing the coal to commercial sizes. I understand that eight to ten million tons annually of this silt are allowed to be pumped back into the mines to fill up old workings.

A number of the coal companies are now carefully investigating the application of pulverized anthracite or low volatile coals with a view to using this waste coal in pulverized form so as to obtain power for its use, making available coals of higher grade for the market, which they are firing at the present time. A very successful installation of this kind is in operation at Lykens, Pa.

The above statements have been of a rather general nature so as to bring out forcibly the fact that coal in pulverized form is going to become one of the most important fuels. The results thus far obtained have shown that with installations properly designed and installed, that from an operating standpoint it is not only a desirable fuel but one which will eventually become necessary on account of its economy.

What is Pulverized Coal?

The average man will tell you that pulverized coal is coal ground to a powder. Any coal which is ground or powdered from his point of view is pulverized coal. From a technical standpoint pulverized coal is that coal which is properly dried, crushed and pulverized so that the product contains the highest percentage of impalpable powder. Merely powdering coal does not fulfill the requirements. Coal must be pulverized so that at least 95 per cent. will pass through a 100-mesh sieve having 10,000 openings to the square inch, or in terms of dimension 95 per cent. must

be less than one two-hundredth of an inch cube.

The average person does not fully realize to what a high degree of fineness it is possible to reduce the coal today by pulverization. The finer the coal is pulverized the more efficiently it can be burned and the more readily it will be diffused when mixed with the air for combustion and fed into the furnaces. A cubic inch of coal pulverized so that 95 per cent. will pass through a 100-mesh sieve will contain over two hundred million particles, none of which will be greater than one one-hundredth of an inch cube, and a large percentage will be less than one six-hundredth of an inch cube. A cubic inch of coal has a superficial area of 6 sq. in., but the combined area of these multitudes of small articles shows that when the coal is ground to above mentioned degree of fineness the superficial area will increase to nearly 30 sq. ft. or an increase in area of approximately 700 times. This increase in area permits perfect and instantaneous combustion. Its rapidity depends directly upon the surface exposure. This is one of the reasons for the grinding.

Pulverizing certainly does not change the nature of the coal. We do, however, change the form of the coal to a certain extent in pulverizing it, in that we change it from a solid into a fuel having liquid properties. As the coal is pulverized it is mixed with air, and when handled in the conveyor it flows like water; when fed to the furnaces it is more or less like a gas, and the furnaces must be designed to burn a gaseous mixture.

Description of a Coal-Pulverizing Plant

A pulverizing plant consists of three main units: a crusher, a crushed-coal drier and a pulverizer. The number of each one of these three main units will depend on the size of the plant. The coal is dumped in a track hopper and conveyed by either a belt or apron conveyor into hopper, feeding single-roll coal crusher, or where slack coal is at hand, direct to elevator pit. After being crushed to about one inch in diameter, it passes by gravity to elevator pit, where it is taken by bucket elevators to the drier storage bin. Automatic weighing scales may be installed if desired before the drier storage bin. Magnetic-separator pulleys are also installed, where a belt conveyor is used from the track hopper to remove iron or steel scrap in the shape of nuts, bolts, pick-points, wedges and such foreign matter, which would interfere with the pulverization.

From the drier storage bin the coal passes to a coal drier. This drier must be of a size to deliver the required quantity continuously, thoroughly dried. The drier is heated either by hand-firing on grates, or by pulverized coal, so arranged in either case to avoid igniting the drying coal. The cylinder of the drier is rotated by power, either a small motor or line shaft being used. The dried coal falls from the drier through a chute into the pit of an elevator. In this chute the coal passes over another magnetic separator to remove any final pieces of metal which might be left in the coal and which were not caught on the magnetic separator spoken of above.

This elevator carries it to a storage bin set aloft for supplying the pulverizer. By spouts and gates the coal is permitted to enter the pulverizer as desired. This pulverizer grinds the coal to the fineness required. From the pulverizer the coal is conveyed in various ways to the pulverized-coal bins. With the type of mill used at our plant, it is carried by spouts from the mill to the pit of an elevator, which carries it aloft to the screw conveyor, which feeds the pulverized-coal bins. In another type of mill the fine pulverized coal is conveyed by suction fan from the mill to a cyclone separator, properly located over the pulverized-coal storage bins, or over the screw conveyor to the pulverized-coal storage bin. This separator will allow the coarser particles to fall back to the mill, to be reground, while the fine dust passes to the storage bin. No fine-dust elevator is necessary with this mill.

These pulverized-coal storage bins are of a capacity proportional to the service and hold a supply in excess of the amount required in the intervals when the grinding is not going on. Thus the mills may supply in eight to ten hours all that the furnaces may use in 24 hours, by making provision therefor.

If the pulverizing plant is located within 200 ft. of the furnaces and the furnaces are of large capacity, these storage bins are located directly at the furnaces. But if there are numerous small furnaces located at a considerable distance from the pulverizing plant, we then locate the above storage bins at some central point and convey from these points to the various furnaces by means of one of three methods: first, screw conveyor; second, in a mass by means of compressed air; third, in suspension in a current of air. We now have the pulverized coal at the furnaces ready for use.

Costs of Pulverizing Coal

The cost of the operation of pulverizing coal depends upon four items: first, the amount of moisture that must be expelled from the coal before pulverizing; second, the cost of labor; third, the cost of coal delivered at the pulverizing plant; fourth, the cost of electricity. Table 1, issued by a pulverized-coal engineering company, gives the cost of pulverizing plants, including buildings, and costs of pulverizing coal in plants of capacity from 10 to 250 tons per day. These figures include all costs, except interest and depreciation, in the pulverizing plant proper, and deliver the dust from the top of the last elevator to the screw conveyor, which feeds the pulverized-coal storage bins.

TABLE 1. COSTS OF COAL-PULVERIZING PLANTS AND COSTS OF PULVERIZING COAL PER TON NET.

Tons daily	Total cost pulverizing per ton, dollars.	Cost of plant including building, dollars	Labor, hours	Labor, cost per ton, dollars
10	0.56	31,000	10	0.30
20	0.51	31,000	20	0.25
30	0.49	31,000	30	0.23
40	0.49	31,000	40	0.23
50	0.39	37,000	26	0.13
60	0.39	37,000	30	0.13
70	0.39	37,000	40	0.13
80	0.39	37,000	40	0.13
90	0.39	37,000	46	0.13
100	0.34	45,000	34	0.09
110	0.34	45,000	37	0.09
120	0.33	45,000	40	0.08
130	0.33	45,000	44	0.08
140	0.32	50,000	45	0.06
150	0.32	50,000	47	0.06
160	0.32	50,000	50	0.06
170	0.32	50,000	54	0.06
180	0.32	50,000	57	0.06
190	0.30	62,000	48	0.04
200	0.30	62,000	51	0.04
210	0.30	62,000	53	0.04
220	0.30	62,000	56	0.04
230	0.30	62,000	59	0.04
240	0.30	62,000	61	0.04
250	0.30	62,000	63	0.04

Data on which Table 1 is based.

Labor rate: Millers, 30 cents per hr.; drier firemen, 20 cents per hr.; common labor, 20 cents.

Cost of drier fuel: 6 cents per net ton, based on 7 per cent. moisture. Coal at $5 per ton delivered.

Evaporation: 6 lb. per lb. of coal burned or 26 lb. of coal per ton.

Repairs: 7 cents per net ton. This includes whole pulverizing plant, all machinery.

Power has been based on 12.7 cents per ton pulverized, and a consumption of 17 h.p.-hr. per ton pulverized at 1 cent per kw.-hr. or about $54 per h.p. per annum.

We have taken from Table 1 figures relating to those plants having daily capacities approximately the same as our plant, and by changing labor rates to correspond to our rates have recomputed these figures as given in Table 2.

Table 3 shows actual costs at our plant, and these are slightly higher than figures given in Table 2.

Open-Hearth and Metallurgical Furnaces

The development and use of pulverized coal in this country has been primarily due to its application in the cement industry and its gradual application to other types of metallurgical furnaces. Marked economies, and in some cases increased production, have been obtained from this fuel and within the last few years it has been applied very

TABLE 2 COSTS OF PULVERIZED COAL PER TON NET.

Tons daily	Total cost pulverizing per ton, dollars	Labour hours	Labor, cost per ton dollars
80	0.45	40	0.19
90	0.45	46	0.19
100	0.38	34	0.13

Data on which Table 2 is based.

Labor cost: Millers, 40 cents per hr.; drier firemen, 35 cents per hr.; common labor, 35 cents.

Cost of drier fuel: 6 cents per net ton, based on 7 per cent. moisture. Coal at $5 per ton delivered.

Evaporation: 6 lb. per pound of coal burned or 26 lb. of coal per ton.

Repairs: 7 cents per net ton; this includes whole pulverizing plant, all machinery.

Power has been based on 12.7 per ton pulverized, and a consumption of 17 h.p.-hr. per ton pulverized at 1 cent per k.w.-hr. or about $54 per h.p.

Cost of pulverizing will naturally vary according to local conditions.

successfully to various kinds of heating furnaces, including forging, continuous-heating, busheling, puddling and open-hearth furnaces. Pulverized coal is being used on continuous-heating furnaces with very gratifying results. It is also being used as a fuel for soaking pits and promises to be used more extensively on this type of heating furnace in the future.

One of the first applications of pulverized coal to the various types of metallurgical furnaces was made by the American Iron & Steel Manufacturing Co., now the Bethlehem Steel Co., Lebanon, Pa., at whose plant this form of fuel was successfully applied to heating, busheling and puddling furnaces, this being practically the first attempt to apply it to the iron and steel industry. Taking into consideration the knowledge obtained from the experience at the above-mentioned plant, and also that obtained from other installations, it has been found that furnaces can be successfully operated by various methods of applying this fuel. Each type of metallurgical furnace presents different requirements as to the kind of burners to be used. Probably the greatest recent development in its use has been as a fuel for open-hearth furnaces and boilers.

Boilers

Many engineers who attempted to burn coal in pulverized form obtained unsatisfactory results, and concluded it was "impossible." In many of the earlier trials to burn pulverized coal under boilers the usual method was to install coal-feeding devices of some kind in the furnace as it stood, with the result that the fire bricks melted down and the tubes were plastered with unconsumed carbon, ashes and soot. So destructive were the results that we can hardly blame those making the tests from arriving at the conclusion they did. How close some were to success was not fully realized. Conditions were not ripe. To-day, results are being obtained that are of sufficient importance to warrant careful investigation and consideration.

For the proper combustion of coal under boilers, there are five main points which must be given serious consideration, otherwise the burning of this fuel will not be a success. These five points are:

a Coal fineness
b Size of combustion chamber
c Necessary air opening
d Proper damper regulation
e Clean tubes

Coal fineness. The pulverized coal should run about 96 per cent. through the 100-mesh screen and about 85 per cent. through the 200-mesh screen. If it runs below 80 per cent. through the 200-mesh screen, we notice particles of carbon flying through the air inside of the combustion chamber, and these particles are not completely burned when the gases reach the tubes, and will then deposit themselves on the tubes. Also, these heavy particles in the pulverized-coal mixture will sometimes settle on the bottom of the combustion chamber and will soon build up in the shape of stalactites. This accumulation will continue to build until the bottom of the combustion chamber continues to be raised, until it comes in contact with the flame. These built-up particles will then fuse into a solid mass, which, in a very short time, will cause a shut down of the boiler to dig this fused mass out. It is, therefore, necessary, for the successful burning of this pulverized fuel under boilers, to have this coal as finely pulverized as possible.

Size of Combustion Chamber. Before installing, or considering the use of pulverized coal under boilers, we must first make a study of our boiler-house installation and know at exactly what rating we wish to operate these boilers, considering any peak load which may develop. We must then design our combustion chamber large enough to take care of the maximum loads which will be developed from our boilers at any time. After this maximum rating has been determined, we then figure our combustion chamber of a cubical capacity equivalent to approximately 50 cu. ft. per lb. of coal burned per min., or approximately 2½ cu. ft. per h.p. developed by boiler. If we decide to run this boiler at 150 per cent. of this rating and design our combustion chamber accordingly, the efficiency will not be decreased perceptibly if the boiler is run under this 150 per cent. rating, but if we develop over a 150 per cent. of the rating, we run into serious difficulties. We have to admit more coal and air to the boiler to develop the greater rating, consequently we need more combustion space, but not having this combustion space, the flames impinge on the brick work and cut it away very rapidly. Also, combustion is not complete at the time the gases strike the bottom row of tubes and consequently the gases will pass up the stack unburned. Efficiency is then decreased. If the gases are not completely burned by the time they reach the first row of tubes, they will not burn later on in the boiler. The size of the combustion chamber should also be so designed that the velocity of the gases should not pass through this combustion chamber at a speed of more than 6 ft. per sec. The mixture of air and coal entering the combustion chamber, as stated above, should be at as low a pressure as is possible to bring this mixture in in suspension; or, in other words, breathe it in.

TABLE 3. COSTS OF PULVERIZING COAL PER NET TON AT THE ATLANTIC STEEL COMPANY.

	Cost per ton.
Daily Output 80 Tons per Day.	
Labor	$0.22
Repairs	0.19
Power	0.134
Drier coal	0.0218
Total Cost	$0.5658
Daily Output 90 Tons per Day.	
Labor	$0.195
Repairs	0.19
Power	0.134
Drier coal	0.0218
Total Cost	$0.5408
Daily Output 100 Tons per Day.	
Labor	$0.176
Repairs	0.19
Power	0.134
Drier coal	0.0218
Total Cost	$0.5218

Total coal pulverized Jan. and Feb., 1919 ..... 5275 tons

Power: 17.9 k.w-hr. per ton pulv. at ¾ cent ..... $0.134 per ton

Labor: 1 man 16 hr. at $0.40 ..... $ 6.40
2 men 16 hr. at $0.35 ..... 11.20

Daily cost $17.60

(= $0.22 for 80 tons output, $0.195 for 90 tons, $0.176 por 100 tons.)

Drier coal: Cost of drier fuel 2.8 cents per ton, based on 2.62 per cent. moisture. Coal at $5 per ton, 6 lb. evaporated per lb. of coal burned or 8.7 lb. per ton of coal pulv.

Repairs: Total repairs for Jan. and Feb... $1412.16
Credit 409.69

Charged $1002.47
(= $0.19 per ton pulv.)

Proper Air Openings. The pressure at which the pulverized coal is admitted to the furnace is as low a pressure as can be used to carry this fine coal in suspension, and is, I should say, about half an ounce pressure at the nozzle. In some installations the coal falls by gravity from the variable-speed screw conveyor, located on the bottom of the pulverized coal bin, into a fan air line which carries it into the furnace and also supplies the necessary air for combustion. Some few openings are placed in the front wall of the boiler to give any additional air which may be needed, and a few may also be placed on the side walls of the boiler to protect the brickwork at times.

In other installations the amount of air necessary to convey the coal into the furnace varies, acording to the rate at which the boiler is being operated. The balance of the air to burn the coal properly is admitted through adjustable air openings in the front, sides and bottom of the combustion chamber. These openings are made adjustable and are placed on all sides of the combustion chamber to take care of the various grades of coal which may be used in the boiler plant. By properly observing the combustion in this chamber, by a little experience the fireman knows at exactly what points to give more, or less air needed for combustion.

Damper Regulation. In order to give the proper velocities of gases passing through the combustion chamber, it is necessary that we have very accurate damper regulation to take care of the various load conditions which the boiler is to supply. The damper should be so regulated that we should practically have a balanced draft inside of the combustion chamber and only a slight vacuum in the first pass, while at the damper itself we do not want more than 0.10 to 0.15 in. If we have more vacuum than this, it pulls our gases through the combustion chamber too fast, causing them to be unburned before reaching the first row of tubes and will then build up very fast on the outside of these tubes. This very small draft needed at the base of the stack will allow us to operate boilers using pulverized coal with stacks of about 30 to 35 ft. in height.

Clean Tubes. In order to get the

maximum evaporation from any boiler it is necessary that the tubes be kept clean, both inside and outside. The keeping of the tubes clean inside is a question of the proper quality of water and has nothing to do with pulverized coal. The keeping clean of the outside of the tubes is very necesary with the use of pulverized coal as a fuel, and they should be blown by means of mechanical soot blowers at least every six hours, and oftener if it is necessary. Also, once every 24 hours by means of a hand-lance steam jet we should blow the bottom of the first row of tubes. These are the tubes in which the gases come into contact first after leaving the combustion chamber has been properly constructed and if they are blown regularly as needed. But if they are not blown regularly this material builds up and accumulates very fast and in time will become fused and cannot be blown off.

Another item which might have been included in the five main points above, and might have been called the sixth point, is the removal of ash which deposits at the bottom of the combustion chamber. As spoken of above, this ash should be removed at regular intervals, which intervals will be determined by the amount of ash in the original coal. If we do not remove this ash regularly, it will build up until it comes in contact with the flame, when it becomes fused and has to be dug out. But if removed at regular intervals, it can be easily raked out with ordinary boiler-room ash rake and will not consume more than half an hour per 24 hours, and will not interfere with the operation of the boiler while this is being done.

The following are some advantages of pulverized coal as a fuel for boilers over stokers:

(a) Muhc wider variation in the quantity of the coal usable is obtained when burning coal in pulverized form. Practically any and all grades of coal can be burned in this form with economy. No stoker will satisfactorily handle all grades of coal. Therefore the use of pulverized coal will largely overcome most troubles due to poor coal, and it is particularly desirable for this reason alone.

(b) The ability to take care of peak loads almost instantaneously. In other words, a pulverized-coal burning system is much more flexible than a stoker in stallation. Its flexibility approaches that of oil or natural gas.

(c) The amount of coal that can be burned per sq. ft. of grate surface on stokers is limited so that for increased capacity the boiler setting must be spread out to cover more area. When using pulverized coal, this condition does not exist, for proper furnace conditions can be obtained by increasing the height of the boiler setting or the depth of the combustion chamber.

(d) By throwing a switch the entire firing operation ceases; an advantage in case of accident or emergency.

(e) Ash is in much better condition to handle. The ash is in the form of a dust or slag depending upon its melting point. This helps to maintain constant furnace temperature as there are no interruptions to firing conditions on account of cleaning fires.

(f) Since there are no grates used when the fuel is burned in pulverized form, we experience no clinkering of grates, as in the case of stokers, particularly after operating at maximum rating.

(g) Pulverized coal is fired dry, containing less than 1 per cent. of free moisture, whereas coal burned on stokers may vary anywhere from 1 to 10 per cent., of free moisture as fired.

(h) Considerable less excess air is necessary for complete combustion. This item is of the utmost importance when making comparisons. Less excess air means less power for furnishing air supply particularly where forced draft is used. With less excess air the stack losses are less. Lower grades of coal fired on stokers require more excess air as it is quite difficult for the oxygen to get in close contact with combustible. An air supply sufficient to furnish all the air for combustion should be available, although at times only 50 per cent. of the air is necessary to be injected into the furnace with the coal, the balance being supplied by the induction action of the burner or drawn in by the stack draft through the various adjustable openings in front and sides of combustion chamber. The air going into the furnace should be under control to permit close regulation under all conditions of firing. Less draft is required for pulverized-coal-fired furnaces.

(i) All the combustible in the coal is consumed when it is burned in pulverized form, providing the furnace capacity is not exceeded. None of the combustible goes out into the ash pile and therefore fires are eliminated in the ash pile.

(j) There is less erosion from sulphur on the boilers due to less moisture in the coal as fired, therefore high-sulphur coals can be burned more readily and without serious results.

(k) With furnace properly proportioned and with properly designed burning equipment smokeless operation may be maintained indefinitely. This is due to

PULVERIZED COAL AS A FUEL

TABLE 4. LOG OF TEST OF A PULVERIZED-FUEL-BURNING STATIONARY BOILER. DATE AUGUST 12-13, 1918.

Make of boiler			Edge Moor
Rated h.p.			468
Heating surface, square ft.			4685
Time fired or test started			11.15 a.m. 8/12/18
Time fire out or test finished			11.15 a.m. 8/13/18
Duration of test			24 hrs.
	Maximum	Minimum	Average
Temperature of boiler room (deg. fahr.)	99	85	93.3
Temperature of feedwater	168	135	157.2
Temperature of steam (deg. fahr.)	477	427	448.7
Barometer in. of mercury	29.35	29.20	29.25
Temperature of flue gases (deg. fahr.)	515	455	495.3
Average boiler pressure, lb.			167.0
Atmospheric pressure, lb.			14.4
Temperature of steam, deg. fahr.			373.8
Superheat, deg. fahr.			74.9
Safety valve set for, lb.			175
Fuel fired per hr., lb.			1,990.6
Total fuel, lb.			47,775
Total water, lb.			393,168
Water apparently evaporated per hr., lb.			16,393.0
Water apparently evaporated per lb. of coal, lb.			8.23
Factor of evaporation			1.1502
Water evaporated from and at 212 deg. fahr. per lb. of coal, lb.			1.47
	Maximum	Minimum	Average
Carbon dioxide (CO^2) per cent.	15.4	12.2	13.85
Oxygen (O) per cent.	5.6	3.2	4.38
Carbon monoxide (CO)			None
Fuel used			Bituminous screenings
Fuel analysis	No. 1	No. 2	No. 3 Average
Amount of coal represented by each sample, lb.	19,775	20,000	8,000 .....
Per cent. of total	41.3	41.1	16.9 .....
Moisture (per cent.)	10.3	11.0	9.7 10.49
Volatile (per cent.)	33.81	36.96	38.77 35.96
Fixed carbon (per cent.)	50.43	49.13	48.29 49.53
Ash (per cent.)	14.36	13.91	12.94 13.93
Sulphur (per cent.)	1.90	2.06	2.12 2.04
B.t.u. as received	10,600	10,763	11,263 10,779
B.t.u. dry	11,817	12,093	12,473 12,045
Vacuum in burner, in			0.000
Vacuum under primary arch, in			0.000
Vacuum in combustion chamber, in			0.000
Vacuum in first pass, in			0.000
Vacuum in second pass, in			0.0057
Vacuum in breeching, in			0.09
Feeder speed, r.p.m.			(No. 1), 53.6; (No. 2); 50.7
Coal per rev. of screw, lb.			0.318
Accumulation of slag on tubes			None
Flues blown during test			5 times
Operation of furnace			Very satisfactory
Pulsation			None
Condition of smoke			Light
Heat effect on brick			None
Back lash of flame in burner			None
Pounds of steam per hr. from and at 212 deg. fahr.			18,842.6
Horsepower			546.2
Per cent. of rating			116.7
Boiler efficiency, per cent.			85.22
*Memoranda—Fuel-preparation deduction:			
Coal used in drier, lb.			1,140
Motor operation			449.3 kw-hr
Coal equivalent at 3 lb. per kw-hr., lb.			1,348
Total deduction, lb.			2,488
Resulting net efficiency, per cent			81.1

*No deduction made for stand-by losses in drier.

complete combustion of all the particles of coal before coming in contact with the cold surface of the tubes of the boiler.

The following few points must be kept in mind for the successful burning of pulverized coal under boilers:

(a) A boiler furnace using pulverized coal should have as few burners as is possible consistent with good regulation. The burners must be proportioned for the maximum rating of the boilers, and they must be adjustable. Simplicity of design is desirable. It has been found much more desirable to introduce coal into the furnace as far away from the side walls as possible so that the rapid continuous expansion of the gases will not develop high velocities in close contact with the furnace refractories. Furnaces under boilers should be proportioned so that the velocity of the gases should not be excessive, particularly at the smallest cross-sectional area of the furnace. Vertical baffles should replace all horizontal baffles.

(b) A boiler of any size can be fired successfully with pulverized coal. Various designs and makes of boilers can be readily arranged for pulverized-coal firing, but those containing the smaller percentage of space for the lodgment of ash are preferable.

(c) Feeders for regulating the flow of pulverized coal to the furnace must be designed so that at all times the variation in quantity will be directly proportional to the speed of the screw and no flooding allowed. The speed of the feeder should be so regulated that operating at its maximum r.p.m. the supply of pulverized coal to the furnace will not exceed the capacity of the furnace. Soot blowers should be installed in settings where pulverized coal is used.

(d) The equipment for using pulverized coal is standard for any grade of coal so far as handling, preparing and delivering to the furnace is concerned. Only a slight change is necessary in the furnace to take care of coals of very low volatile content, such as anthracite, culm and coke breeze, and increased drying capacity is desirable when lignite coal is used. With stokers this is not the case as the varying quality of coals require different type stokers to obtain highest efficiency.

(e) The labor required to operate a pulverized-coal installation may be of higher class, but the number of men required will be less in the larger installations than that required for a stoker installation, thereby effecting a saving in the labor charge in favor of pulverized coal.

The following is a report of a test on a 468-h.p. boiler using pulverized coal as fuel. This installation is noteworthy not only by reason of the high efficiency obtained, but also because of the fact that it has made clear some of the conditions necessary for the successful operation of boilers utilizing powdered fuel.

When the boiler was first put into operation, a number of undesirable conditions resulted. An insufficient air supply caused high-furnace temperatures resulting in fusion of the ash particles and a consequent accumulation of slag between the tubes, on the furnace walls and in the ashpit. The removal of the molten slag presented considerable difficulty. It was also found that the combustion chamber was of insufficient size. High gas velocities resulting from insufficient air in the chamber tended toward destruction of the refractory surfaces of the furnace.

A new furnace was therefore designed. The combustion chamber was enlarged and a regulated air supply was provided for by means of a number of auxiliary air openings equipped with dampers. The accumulation of slag in the pit was prevented by raising the point of admission of the fuel into the furnace. As a result the flame path has been raised above the base of the pit, hence particles of ash dropping from the flame are not fused. The ash, therefore, can be drawn from the pit in the form of a powder and small slugs of slag. Analysis has shown that the ash contains practically no carbon.

Having established satisfactory furnace-operating conditions, a series of efficiency and capacity tests were conducted preliminary to proving the contact guarantees. The brickwork was then given a thorough trial by carrying the boiler at a continuous rating of 180 per cent. over a period of several days. On August 12 and 13 a final efficiency test, the results of which are given below, was run. The boiler is a three-pass water-tube boiler, equipped with a superheater.

At this same plant are other boilers fired by one of the most efficient types of underfeed stokers. A comparison is made between results of above test and tests made on the stoker-fired boilers.

Pulverized Coal vs. Mechanical Stokers

Under this heading fuel-preparation costs will first be considered. In the case of powdered coal this can be classed under three general divisions:

(a) The cost of crushing the coal. This expense is the same for pulverized-coal equipment as for stokers.

(b) The cost of drying and pulverizing the coal. Although no cost records are available at present, it is estimated that 32 cents per ton will cover this preparation cost on a 200-ton-per-24-hr. plant using bituminous coal containing about 12 per cent. moisture.

(c) The maintenance costs of the drying and pulverizing plant. This unit has not been determined from actual experience; however, it is estimated that 3 cents per ton will cover the maintenance. In stoker practice the maintenance cost per ton of fuel fired is close to 5 cents per ton.

Summarizing the above facts it is evident that, with fuel at $5 per ton, the gross efficiency shown by the pulverized-fuel boilers will have to exceed that shown by the mechanical-stoker-fired boilers by 6 per cent. in order to offset coal-preparation costs. A 6 per cent. deduction from a gross efficiency of 85 22 per cent. results in a net efficiency of 79.22 per cent. for the powdered-coal burner. In stoker practice the maximum attainable gross efficiency at any of our plants has been 80.54 per cent. Deducting the 2.5 per cent. for auxiliary uses, the resulting net efficiency is 78.04 per cent., which is lower by 1.18 per cent. than the figure obtained in pulverized-fuel practice.

Other advantages resulting from the use of pulverized fuel are summarized herewith:

(a) Continuous boiler operation at a uniform rating as well as a constant efficiency is made possible. At no time is there a loss in capacity due to the clinkering of coal on the grates or the cleaning of fires, as is the case in stoker practice.

(b) Heavy overloads can be taken on or dropped off in a very brief time through adjustment of the coal feeders and the furnace drafts.

(c) From 97 to 98 per cent. of the combustible in the coal is utilized, regardless of the quality of the fuel.

(d) The ash-handling costs are reduced to a minimum due to the reduced volume.

(e) The banking conditions when operating with pulverized coal are somewhat different from those obtained in stoker practice. By stopping the fuel supply and closing up all dampers and auxiliary air inlets a boiler can be held up to pressure for about 10 hours. The furnace brick work having been treated to incandescence during operation gives off a radiant heat which is absorbed by the boiler rather than being sent out through the stack. The ease of controlling the fuel, feed and drafts, the ability to take on heavy overloads in a brief time, the thorough combustion of the coal and the uniform high efficiency obtainable under normal operating make pulverized coal a most satisfactory form of fuel for central station uses.

The full story of maintenance expense is only partly known as yet, however. Indications are that no unusual difficulties will be met. The cost of fuel preparation and labor for operating a boiler room fully equipped with pulverized-coal-burning boilers will be a question for the engineer to decide for himself according to his particular conditions. If properly installed with respect to capacity of storage, size of drier and pulverizers, and on a sufficient number of boilers to properly and fully employ the minimum number of men, the pulverized-fuel installation will undoubtedly be more advantageous. The main item that must be borne in mind by engineers is that the ease with which a high efficiency is obtained and the constant nature of that efficiency, as compared to the lack of constancy of efficiency in a stoker-fired boiler, unless very closely supervised, is the one factor about the burning of pulverized fuel which justifies its use. There is no doubt that with a well-equipped plant burning pulverized fuel, having all the necessary recording and indicating instruments to guide the operators in maintaining the proper conditions, a lower cost of generating steam will be possible than has heretofore been the case in any type of equipment.

The Cross Drum Type Heine Water Tube Boiler

Description of the Boiler as Fitted in the Ships of the United States Emergency Fleet and Other Vessels—The Cross Drum Type Has Proved Very Satisfactory in Service

MARINE boilers of two types ave been built by the Heine Safety Boiler Company in their plants at St. Louis, Mo., and Phoenixville, Pa. —the "longitudinal drum" type and the "cross drum" type.

The former is built on the lines of their well-known Heine water tube boiler and the earlier ships were fitted with these, but the later and by far the greater number of ships have received boilers of the "cross drum" type, which has shown itself so superior for the peculiar and exacting marine service that it is now the Standard Heine Marine Water Tube Boiler.

The boiler proper consists essentially of three pressure elements joined together by a multiplicity of tubes. These elements are two flat rectangular box headers and a cylindrical steam drum, as shown in Fig. 1.

The main bank of tubes extends between and connects the two box headers, which are set with the flat surfaces a certain distance apart. The connecting tubes are all of the same length, straight and parallel with each other, and when this part of the boiler is set in operating position, are inclined at an angle of sixteen degrees to the horizontal.

Above the front box header and slightly to the rear of it is placed the steam drum, which is connected to the front header by a row of nearly vertical short tubes or nipples and to the rear header by a row of longer tubes, which are horizontal when the boiler is set.

The boiler proper, made of drum, box headers and tubes, is supported by a strong, rigid, steel structure resting on and secured to proper foundations in the vessel—partly shown in Fig. 3.

The steam drum is cylindrical and varies in the several sizes of boilers from 36 in. to 48 in. in diameter. It consists of a single plate steel shell of a thickness corresponding to the pressure requirements, rolled to a true circle, fitted with a double-riveted, double butt-strapped longitudinal riveted seam and at the ends with flanged and dished steel heads which require no braces. In one of these heads is arranged a flanged-in manhole for access to the interior of the steam drum.

Where the tubes enter and are secured to the shell of the drum, reinforcing plates are fitted. On top of the drum are fitted heavy pressed steel saddles for attaching the main stop valve, auxiliary stop valve and safety valve.

To the front side of the drum shell are riveted pressed steel flanges for attaching main and auxiliary feed check valves, surface blow valve, two water gauge glasses and three test cocks.

Inside the drum, properly secured to shell and firmly braced in position, is fitted a steel deflection plate. This plate is of sufficient length to cover the ends of the horizontal tubes and extends below the water level, its purpose being to act as a separator for the mixture of steam and water entering the drum through the horizontal tubes. The water thrown violently against this plate runs downward into the body of water below and the steam passes along and around the ends of the plate and to the dry pipe above.

An internal feed pipe is fitted between the feed check valves. This is perforated in order to distribute the entering feed water uniformly through the water already in drum to avoid producing undue strains. The same pipe is connected in both checks.

A scum pan of the usual "dish" type with its cover plate slightly raised to produce an efficient "skimmer" effect, is located at the centre of the drum, exactly on the water line, and piped to the surface blow outlet on the front of the drum shell.

Surge plates are fitted to check the rush of water along the drum as the vessel rolls in a seaway. These plates, together with the deflection plate, make a substantial structure for supporting and securing the various fittings within the drum.

The main steam outlet is provided with a dry pipe of ample area. This pipe is fitted as near the top of the drum as practicable and has slots cut through its upper side, the area through these slots exceeding the area through the outlet opening. Calorimeter tests show that the Heine marine boiler thus fitted delivers steam containing less than three-quarters of one per cent. of moisture.

Zinc slabs are also fitted in the drum of the Heine marine boiler. The Navy standard of three-quarters of a square foot of exposed zinc plate is provided for each one hundred square feet of heating surface of the boiler. These zinc plates are secured so as to give close metallic connection with the metal of the boiler and yet allow easy renewal. A pressed steel "basket" is also fitted to catch the disintegrated zinc.

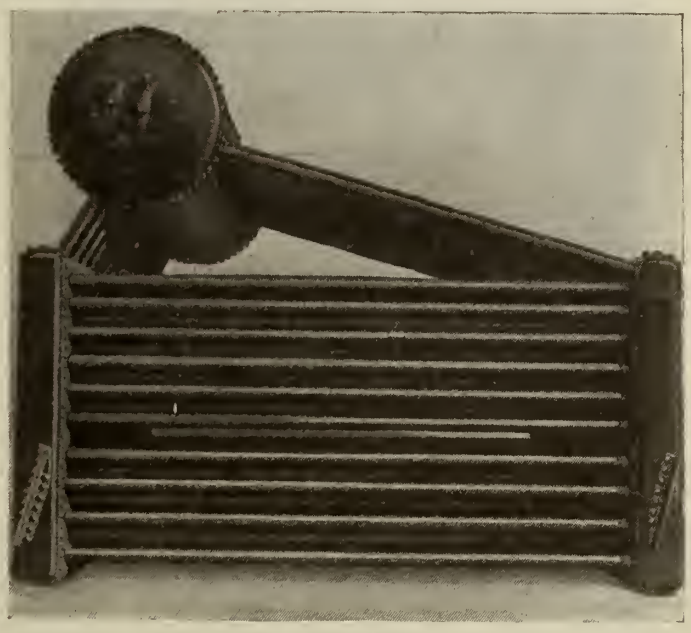


FIGURE 1

Zinc plates are fitted to a marine boiler to act as a negative element of an electric couple which is formed when it and iron or steel are placed in a saline liquid. It is impossible to keep boiler water in the ocean service absolutely fresh, and if correctly fitted, zinc thus avoid pitting and deterioration of boiler plates from electrolytic action.

The box headers are constructed entirely of steel plate. Each consists of two flanged rectangular heads or end plates to which are riveted a wrapper plate in two pieces. These headers are so designed that all seams are readily accessible for inspection and recaulking without tearing away the boiler casing.

The end plates are flanged by hydraulic pressure at a single heat and are of the exact shape desired. The two wrapper plates, known as the tube sheet and the handhole sheet, have their edges turned over at the top and bottom

of the headers, lapped and riveted together with a single row of rivets; with caulking edges facing outward.

The flat surfaces of the tube and handhole sheets are truly parallel with a hand hole exactly opposite each tube hole, thus permitting access to the tube for cleaning and withdrawal of tube through the handhole when necessary.

The two flat surfaces of the box headers are stayed to resist internal pressure with large hollow steel stay bolts

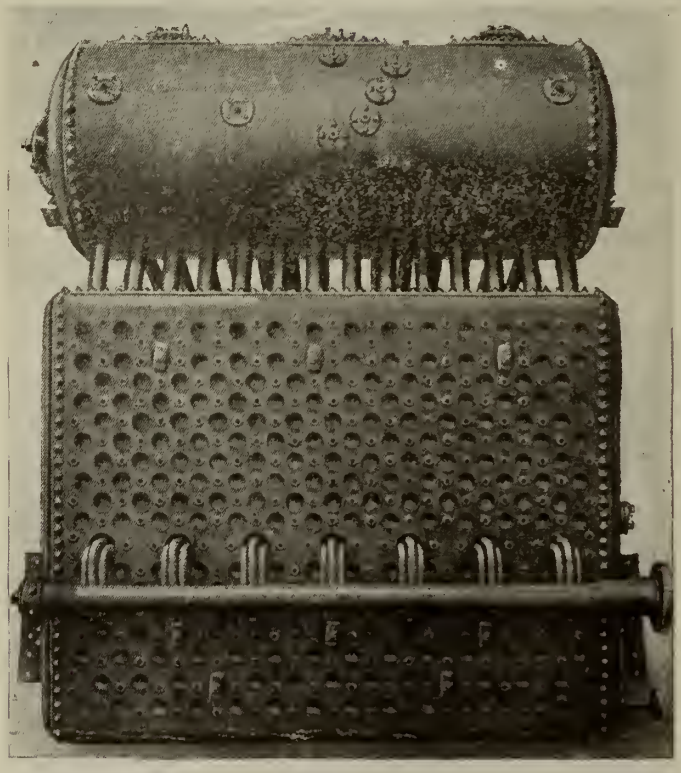


FIGURE 2

screwed through tapped holes in the plates, and with the projecting ends of stay bolts riveted over on the outside.

The stay bolts are threaded only at the ends, leaving a smooth cylindrical shank within the water space, thus offering no sharp edges or grooves to the corrosive effect of rust. Each stay bolt has a hole throughout its entire length of ample size to pass freely a ⅜ in. pipe lance for soot blowing.

Forged steel tee bar lugs (see Fig. 1), of heavy section. about 24 in. in length, are riveted to the outside of each flanged end plate of the headers for attachment to the supporting columns of the casing structure.

The flat bases of these tee bar lugs are caulked all around and the edges are ever accessible for inspection or recaulking without tearing out any part of the boiler support or setting.

Near the bottom of the front (lower) box header and on one side only (except in extremely wide boilers) is riveted a forged steel flange to which is bolted, with copper gasket in male and female joint, a heavily ribbed and flanged composition blow nozzle or extension pipe to the outer end of which is attached the bottom blow valve. An internal pipe leads to the extreme bottom of the box header and insures removal of sediment deposited therein.

The standard design of Heine marine water tube boiler has 3½ diameter tubes throughout.

For oil fuel only, they recommend the use of 2 in. tubes instead of 3½ in. tubes in the inclined bank between the headers, and build a special oil burning marine boiler so fitted.

They do not recommend the use of 2 in. tubes for coal fuel because of the great tendency of boilers fitted with small tubes, closely pitched, to "soot up," or become choked. Its superior steaming qualities are recognized. However, it is a fact that by the use of 2 in. tubes equal heating surface can be obtained in a boiler of much less height than is possible when larger tubes are employed.

They fit the Heine marine boiler with standard lap welded steel, charcoal iron, or seamless steel tubes, as the owner may prefer.

For low or medium superheat, Heine marine boilers are fitted with superheaters of the "waste heat" type placed in the base of the up-take, as near as possible to the exit of the gases from the boiler. For higher superheat the elements must be placed where they will be in contact with gases of higher temperature and are often fitted just below the middle baffle, the superheater elements passing through the 5 in. stay tubes between headers located outside the boiler (see Fig. 2). The right angle bend of the superheater tubes entering the top of the front pipe header is arranged at one end of the boiler only and permits of the tubes being more easily removed and replaced than if they were straight throughout.

Heine marine water tube boilers are built in accordance with the rules and regulations of the United States Board of Supervising Inspectors and are approved by Lloyd's Register of Shipping and the American Bureau of Shipping. When desired by the purchaser, either insurance company or purchaser is permitted free access to their works and given every opportunity for inspection and approval of plans and material entering into the construction of boilers

The setting of the Heine marine boiler consists primarily of a framework of rolled steel shapes so constructed that the four main columns, one each side of each box header, are tied together and braced, and thus secured rigidly against relative motion of any sort. These columns are secured at their bases to seatings prepared by the shipbuilder, the structure described forming a cradle within which, secured by the four tee bar lugs, the boiler proper is supported.

A steel plate casing is built upon this framework, entirely surrounding and covering the boiler and furnace with the exception of the drum. That portion beside the bank of inclined tubes is fitted in panels that may be readily removed for access to the brick lining, and a sectional bottom plate, that may be easily renewed, is fitted below.

The interior of the whole is lined with fire brick, non-conducting material or a combination of these. All parts are carefully fitted to prevent the ingress of undesirable air.

Where grates are furnished for coal fuel, a watertight pan is also fitted in the ashpit, but for oil burning installations the furnace space is made as large as possible. The casing about the furnace proper is lined with refractory walls 12 inches thick and above the lower baffle the lining is 7½ inches thick.

The furnace fronts for coal burning are fitted with balanced in-swinging doors above and below the grade. For oil burning the front is usually a steel plate with openings of suitable size cut to take burner castings.

When installed and ready for operation the Heine marine boiler is filled to the middle of the steam drum with water. The circulation is downward in the front box header and upward in the rear box header, upward and back in the lower majority of the bank of inclined tubes and downward and to the front in a few upper rows of inclined tubes; the steam parting from the water in the upper portion of the rear header and passing into the steam drum through the horizontal tubes as before described.

With this steam there is some quantity of free water which is separated and thrown down in the drum, the steam passing about the ends of the deflection plate to the dry pipe, the water passing down through the short tubes circulating water, it again passes through the lower inclined tubes.

Feed water entering the boiler issues

FIGURE 3

from the perforations in the internal feed pipe in jets, and is thus thoroughly mixed with the water in the drum before passing downward.

Should oil or impurities enter with the feed the scum formed may be removed by operating the surface blow with water level at middle of the glass. Sediment will be thrown down in front header, where the bottom blow is arranged to remove it.

Scale is removed from the tubes by using a hydraulic turbine cleaner, which, together with the necessary hoses, is provided with every boiler.

All boilers that are not too large are assembled complete at the manufacturer's shops before shipment. Usually, however, the clearance limitations of the railroads do not permit of complete assemblage and the drum and its connecting tubes must be fitted in place at the point of installation.

All parts are subjected to a hydraulic test of twice the safe working pressure before shipment. The work of fitting the drum at the ship's side or on board consists merely of inserting and expanding a few tubes.

The casings are assembled complete before shipment and knocked down after match-marking the various pieces so one cannot go wrong in re-erecting them at the shipyard.

When provisions at shipyard for handling the heavier pieces are inadequate and customer desires, the boilers will be shipped entirely knocked down. To assemble them aboard the ship will then be merely a job of rolling all tube ends, as the headers and drum will be complete in all respects.

ARMATURE CHOCKS

Several years ago at a power station a 600-kw. spare armature was laid in specially built wood chocks. These chocks were made of oak for strength. After the armature was laid in, the shafts were smeared in vaseline. Quite recently, when the armature was lifted out, the shafts were found to be seriously pitted (about one sixty-fourth in. deep) all along the shafts where they had touched the chocks.

This was caused by the acid action of the oak.

REMINDERS WHEN MAKING CONCRETE FOUNDATIONS

The following hints will prove useful to readers who may have to lay down concrete foundations for machinery or plant:

Get well down to firm soil before starting a concrete foundation, and do not stint it either in length or width. A one-piece foundation, though it might cost extra to make, invariably gives more satisfaction than a disjointed or sectionalized one. Two or more beds not fully integral can be stiffened and more firmly braced by building in short lenghts of old rails, tee, angle, or channel bars as reinforcement. Leave plenty of clearance in bolt holes. Use square-necked bolts and washer plates of ample area. The form boards for moulding above ground parts of a foundation must be sufficiently thick and well braced to prevent bulging and warping under the weight of concrete. The more irregular the faces of the excavation the better will be the grip of the bed. Well ram each "gauge" down with a bar of rammer, so as to force the material to the outside of the bed. Do not be afraid to have the concrete wet enough to run; a little excess water will not matter in the least. If possible, run the entire foundation without a break; but if this cannot be arranged well, wet the top of the old layer before starting with the new, and leave the face rough—the rougher the better. Do not remove the form boards under three to four days from the time of moulding; then wet the faces of the concrete every day for a week in order to prevent premature surface hardening and cracking.

For rough work, slow moving machinery, and where chances of vibration are not likely to occur—a mixture of one part cement, 3 parts sand and 6 parts broken down, or coarse gravel, makes a good concrete. For higher class work—high speed machinery, engines, generators, turbines, motors, etc., a better mixture would be 1, 1½, 3, respectively. One still better is 1, 2, 4. See that the cement is fresh and has not been exposed to the air. If any doubt of it exists, test a little for hardening time. Use well-washed, hard, sharp sand, and clean good stone with no dirt intermixed. Remove all loose, soft, rubble or old mortar. A good plan before preparing the concrete is to wash all gravel and stone with a hose. Do not hurry the setting of a foundation by employing artificial heat, or it may crack. Protect a newly-made bed from frost by covering it with dry sacks. The quantity of material required for a foundation of a given cubic content is generally reckoned as the approximate quantity of stone, since the sand and cement adds little to the bulk, but is taken up in the many interstices formed by the stones. In mixing each "gauge," adhere closely to the determined proportion. Use a square frame, having a known cubical content for measuring the material before mixing.

Face all above-ground parts of the bed when dry with a "wash" of 1 part cement to 2 parts fine sifted sand, and apply with a brush. If a machine requires to be grouted in subsequent to being set in position on the foundation, the top surface of the latter is best left quite rough, in order that the grouting material shall firmly adhere. Roughening or grooving the face of the concrete with a pick or pointed hammer is an advantage. Rounded corners of a bed are preferable to square, both for the sake of appearance and as a protection against wear and chipping.

PREVENTING THE GROWTH OF CAST IRON

Amongst the fascinating problems which make engineering science at once a most exacting and a most fruitful study, the characteristic behaviour of metals under varying conditions provides many curious cases. For example, grey cast iron grows appreciably in volume when exposed to high temperature. This characteristic, which causes much trouble in cast dies, valve seatings and other parts, is believed to be due to internal oxidation caused by the penetration of hot gases into the metal. A remedy recently suggested in England is to eliminate free graphite from the surface of the metal, this being the cause of its prosperity. Successful results have been obtained by annealing the parts for several days in iron rust at a temperature of from 1,650 to 1,830 degrees Fahrenheit.

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Oil to the Rescue

GREAT stress is being laid these days on the possibilities of oil as fuel to replace coal. The coal situation is becoming acute in every country in the world, and in Great Britain, where coal has for so long been king, it is felt more than in most places. The recent disastrous strikes, coupled with the constant fall of production due to shorter working hours, has caused widespread alarm among all sections of the population, except perhaps among the striking miners. These are evidently of the same frame of mind as the Irishman who, when being lowered down a well, demanded to be pulled up. He backed up his demand with the statement that if it was not complied with he would cut the rope.

The value of oil has been appreciated for a long time now, but one of the reasons it has not been used more generally for fuel aboard ship has been the lack of suitable fuel oil stations in different parts of the world. This is being rapidly overcome, and if the present boring operations in Great Britain result in the discovery of an adequate supply, the situation will be materially relieved. Oil, whether used as fuel for a steam boiler, or directly in the cylinders of an internal combustion engine, is a much more satisfactory fuel than coal. It is more easily and quickly handled than coal, and its heat value is about one-third greater. Combustion is carried out more efficiently than with coal, and there is an entire absence of smoke. The cruising radius of a steamer fitted with oil burners is considerably more than when coal burning, the crew required is less, and the oil can be carried in ballast tanks instead of occupying space that could otherwise be devoted to profitable cargo.

On shore there are a great number of uses for it. Besides being available for steam-raising purposes, it is the best and most economical medium for supplying heat to metal-working furnaces, for tempering, annealing, enamelling, etc. Mixed with the finer refuse of the coal pit, it makes a colloidal fuel of great value. We may look forward to the next few years for great developments in the use of this fuel, which provides a means of obtaining our power at a much higher rate of efficiency than we have been accustomed to getting with the use of coal. It should not be long before it can be applied safely and economically to the heating of houses, to the great relief of the average citizen of this country of long winters.

Boiler Corrosion

AS an instance of the obscure nature of boiler explosion the following instance may be cited. Corrosion commenced after a few months' operation in the drums of the water tube boilers of a 40,000 H.P. turbine installation in Germany. The make-up as well as the first charge of water was distilled and the water was, therefore, exceptionally pure. Corrosion was found to be particularly severe at the horizontal centre line of the drums. The tubes were ordinarily covered with rust, small pieces becoming detached by the use of wire brushes. The corrosive action was intensified when the turbines were worked intermittently with boiler pressure and vacuum maintained, the formation of blisters increasing and pitting becoming severe.

Another group of boilers fed with slightly oily water was found to be entirely free from corrosion, and the fact that boilers fed with condensate from reciprocating engines usually keep in good condition while the condensate from turbines sets up active corrosion, coupled with the action of the second group of boilers, led to the decision to produce a slight greasy deposit in the boilers by injecting oil through a sight feed arrangement. In addition all air was removed from the feed water. These precautions proved entirely satisfactory and corrosion ceased.

Is He Right?

By JAMES E. NOBLE

If you would a searching go to get an engineer,
There are some things to notice though seeming rather queer.
In going through the plant wherein there is a chap
Anxious for a change, to go another lap,
Have a look around the place, at him, too, have a look,
And notice if he dozes off in some sequestered nook.

And notice very carefully, this is the proper "cheese,"
If his pants have patches on the rear or patches on the knees.
Perhaps his clothes may look quite neat, the pressing neatly done;
His hands and face may be quite clean, he may be chewing gum,
But notice if the joints around the plant are good and tight;
And also notice if the charts and other things are right;
Note if the polished surfaces are shining bright and clear,
That everything looks spick and span with no dirt there or here.
The rear part of his trousers examine if you please,
And don't forget to note with care the trousers at the knees.

The man who stands upon his feet attending to his work,
Or wears his pants out at the knees is surely not a shirk;
But when the bearing surface of his breeches at the back
Begin to show a glassy shine around the baggy slack,
The time for careful thought has come, just give him the go-by;
Tell him the time has not arrived for him to change his sty;
Tell him that things are not just right, just tell him if you please,
His pants are too bright on the base and too rough upon the knees.

Meeting the Boss

(A Part of Reconstruction)

By C. H. STEPHEN

Did you ever try to approach the boss
In the way a real man should?
When you guess his gains, do you figure his loss?
As you might, if you only would?
Have you thought, as you envied him his "snap,"
Of the lots of hard spots in Dame Fortune's lap?

Can you always say at the end of the day,
You have taken a real man's stand,
And worked just as hard when the boss was away
As you do when he's close at hand?
Have you ever found, when you get in a pinch,
That being the boss ain't so much of a cinch?

Have you ever figured that most of the men
Who are now in authority
Need not look far back to the working day,
When they labored like you and me?
Have you ever thought that 'most every man's use
Can be based on the product that he can produce?

Have you ever found, when you carry a chip
On your shoulders the whole day long,
You tire much quicker with snarls on your lip
Than when your heart carries a song?
Have you yet discovered that friction of toil
Disappears when you use human kindness for oil?

Did you ever try to face squarely the fact,
With justice and truth in view,
That if you are square in thought, deed and act,
The world will be square with you?
Dame nature taught mankind, long years ago,
That the harvest increases the foul seed we sow.

Have you ever thought that most of the wrongs
That you to the boss ascribe
Would vanish if only your heart held more songs
And your mind fewer diatribes?
If you banish envy, and think what is good,
You can then meet the boss as a real man should.

—"Power Plant Engineering."

Speakin' of Profiteers

THE thing that's takin' lots of time and makin' lots of smoke, is the effort that's being made just now to corner certain folk who have been makin' dollars quick and grabbin' of the cash, while others strive to keep alive on sawdust, hay and hash.

They crooked a finger at some prune who ran a butcher shop; he had been gouging folks at home, he made them pay the shot.

He looked the judge right in the eye and waved his fist about, and opened up his sturdy jaw as though to hoot and shout. But then a tear stole to his eye, his voice was soft as lard, his heart was tender as a stew, his countenance not hard.

"Nay, nay," he said, "I am not he who profiteered, by heck, nor soaked the common horde for fair, nor camped upon their neck." Another tear chased down his face and crawled across his jaw, to think that folks suspected him of comin' 'gainst the law.

And then they brought a farmer, an honest son of toil, who gouged great holes into the folks, likewise into the soil. Oh, he had bought a joy cart new an' built a new bank barn, and likewise he had carved into the mortgage on his farm. But, bless my soul, he had not made no profits worth the name; his pickin's, so he said, were poor and most uncommon tame.

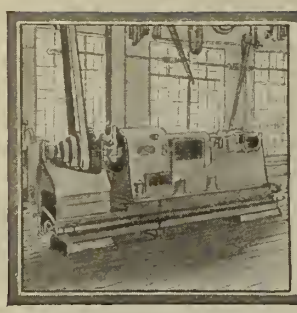
And so they had a whole procesh to try and find the chap who'd led the profiteerin' biz and staked it on the map. But, good land sakes, he was not there at mornin' nor at night, the chap who'd took the family purse and bled the hang thing white.

I long to see some hardy soul arise and make a bow, and in a voice that's noisy like, far more so than a cow—announce that he's a profiteer, a guzzler and a crab, who'd taken all the things in sight he had a chance to grab!

I would not hiss this chap, oh, no; nor would I heave a brick, nor take my heavy working shoe and aim at him a kick. Nor would I clamor for a chance to smite him on the jaw, nor ask that he be turned unto the 'steenth kind of law.

Far rather would I take my axe, my chisel and my hoe, and then unto some lofty place I'd grab my plans and go, and to this honest, kindly soul who owned up to the graft, I'd raise of granite and of gold a tall and glistening shaft. And on the thing I'd carve a verse, perhaps, in way uncouth, to tell the folks what's yet to come of him who spoke the truth.—ARK.

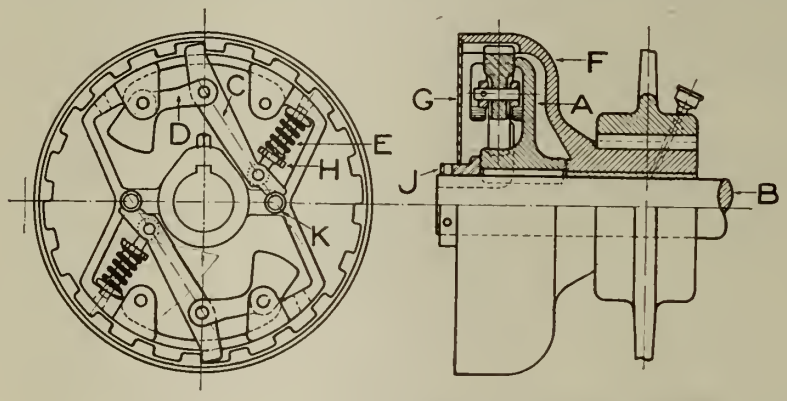
In dealing with the improvements which have been effected during the war in the construction of internal-combustion engines, Sir Dugald Clerk, in a paper before the North-east Coast Institution of Engineers and Shipbuilders, points out that towards the end of the war nearly 3,000 aircraft engines were produced in Great Britain per month, and in consequence, all internal-combustion engines were greatly improved in detail, so that the dry weight of these motors was reduced from about 4 lb. to 2 lb. per b.h.p. developed. Air-cooled engines became possible when mean effective pressures were employed equal to those of the best water-cooled engines. The h.p. value, that is the mean pressure equivalent of the brake horse-power developed in water-cooled engines, had risen to 125 per square inch of piston area by the middle of 1916, and the same h.p. value was obtained in air-cooled engines at the end of 1917. The struggle between the rotary and the six-cylinder radial engines was very keen, and recently it appeared probable that the latter would prove so advantageous in both military and mechanical properties as to displace all other types.



NEW POWER PLANT EQUIPMENT

MECHANICAL OVERLOAD RELEASE

The Link Belt Co., Chicago, Ill., have recently developed a safety device that will instantly disengage a drive if the load exceeds a certain pre-determined amount. This apparatus is better than a circuit-breaker, because it is placed



MECHANICAL OVERLOAD RELEASE.

closer to the work, and where it does let go there are no inertia forces from high-speed moving parts to cause damage. It is also better than a break pin device, because it is adjustable to the work and can be set and reset without spoiling the adjustment. Careless operators often use a big bolt to replace a broken break pin and thus destroy its usefulness.

The parts are symmetrical and will thus run in any direction.

In the illustration, spider A, keyed to shaft B, has triggers C pivotally mounted on links D, with the ends engaging inside notches in rim of drum F, and roller K in hub of spider A. Springs E, regulated to any desired pressure by adjusting nuts H, hold ends of triggers on rollers K under normal conditions, but when the drive is overstrained, the compression of the springs will permit the ends of triggers to drop into position shown in cut below, releasing connections with rim F, and allowing the machine to stop immediately.

To set release triggers in driving position again, collar J is provided, having fingers which engage pins in lower ends of triggers C. By turning this collar by means of a spanner wrench, the triggers will be moved to the original position and the outer ends will at the same time enter notches in drum F, thus renewing the transmission connection.

Cover G, fitting end of drum F, encloses and protects the entire mechanism. Hub of drum F may be extended to receive wheel or gear, and have a bushing for running loose on shaft; or may be keyed directly to a separate shaft, thus forming a coupling device, in which either element may be the driver, according to the circumstances.

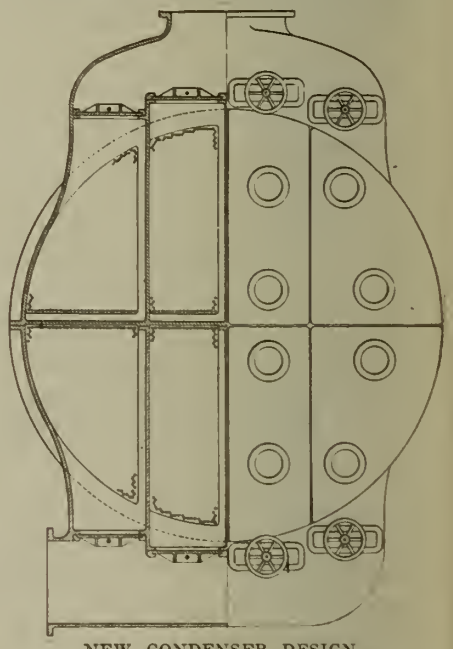
SOMETHING NEW AND GOOD IN CONDENSERS

A new and valuable development in steam surface condensers is announced by the Wheeler Condenser & Engrg. Co., Carteret, N.J. It is a patented "compartment condenser" that can be cleaned while in service without shutting down the turbine. Any tube or tubes may be temporarily plugged and other repairs made without taking the condenser out of service.

This is a timely development in view of the persistent claims made by well-known fuel authorities that the price of fuel is not likely to go down for some time, if at all. This condenser will enable the chief engineer to constantly maintain clean condensers, hence a constantly high vacuum. All engineers of experience know that in addition to increasing output a high vacuum means low fuel consumption and a considerable saving in money year in year out.

Also upon installation of this condenser there need be no interference with the operation of the turbine. At the present time, in many important power stations, even where water conditions are regarded as good, it is necessary to occasionally shut down the turbine for a period sufficiently long to give the condenser a thorough cleaning. In such cases, and in fact in all cases where continuous and highly efficient operation are desirable, this new type will fill a long-felt want.

To clean the average condenser is not a difficult task, but it is time-consuming, and for that reason the chief engineer is naturally tempted to put cleaning off until "to-morrow," or "next week," or "next month." During his wait for the opportune time the vacuum gradually drops, and with the drop coal wastage increases. Sometimes the loss of vacuum amounts to several inches of mercury.



NEW CONDENSER DESIGN

The illustration shows clearly how the compartments are arranged. The condenser shown is divided into four compartments, each compartment being equipped with a set of valves to control the circulating water. To clean the condenser while the turbine is delivering full power, the operator simply shuts off the water from one compartment, removes the cover, cleans the tubes, replaces the cover, turns on the water again, and then passes on to the next compartment, repeating the operation until the four compartments or the entire condenser is clean. Thus, while one compartment is being cleaned, the other compartments are in full operation, temporarily taking over the entire turbine load.

Peace-Time Exhibits in Machinery Hall C.N.E.

Manufacturers and Agents Have Representative Display of Power Plant and Industrial Equipment at Canadian National Exhibition

PEACE time activities are reflected in the various exhibits in Machinery Hall this year. The entire absence of shell machinery and munition-making apparatus is quite noticeable, albeit expected to those accustomed to the exhibits of former years. Space is again at a premium, and as usual comment unfavorable and forcible, is apparent at the inadequate provision made for the machinery industry. Much is in evidence of interest to the power plant operator, as the following partial list of exhibitors will show:

Exhibits

Geo. W. Cole, Ltd. are exhibiting the Cole steam trap in its various designs. Cross-section models of the working parts of these traps are shown, and a typical double trap boiler feeding installation, together with other features, render this exhibit interesting to the power plant engineer. Representative, Wm. H. Rose, Sam Craig and Geo. E. Cole.

The Dodge Co. are featuring steel pulleys, wood split pulleys, transmission chains, split clutches, hangers and bearings, conveyor material, gears, couplings, etc. Representatives, W. Burrows, S. M. Bowen, J. R. Gray.

Jones and Moore have a representative display of their various motors and generators and of the American shoe machine for which they are the agents. This firm handles a large stock of Century motors for all conditions of service.

The Canadian Ice Machine Co. have an excellent exhibit of refrigerating supplies and materials; fittings, ammonia, calcium, chloride, and other supplies being featured. This firm are the manufacturers of the York refrigerating systems and compressors, installations being made from ¼ ton up in the direct expansion, absorption or CO_2 systems, the latter being popular and of considerable adaptability for hospital and marine work.

The Cling Surface Co. are exhibiting for the eleventh consecutive year. The preservation and waterproofing of belts and the lowering of the friction load consequent upon the permissible slackness of the belts are shown to advantage by means of a one h.p. motor driving a three-plunger oil pump through a number of belts treated with cling-surface. Representative, G. W. Faatz.

The Chapman Double Ball Bearing Co. have, as usual, a most attractive exhibit of the various lines manufactured by them in the centre row at Machinery Hall.

In addition to the ball-bearing shaft hangers used in the line shafting, the exhibit includes bearings for all sizes of shafting up to six inches; also annular and thrust bearings for machinery, automobiles and trucks. Representative, Mr. Hocken.

D. K. McLaren Ltd., represented by Mr. W. S. Hamilton, sales manager, are exhibiting their line of single and double leather beltings, together with their waterproof varieties. In connection with these latter an interesting demonstration is given. Two belts are arranged to pass through pans of water while turning over pulleys. Other lines shown are the D. K. wood split pulleys, the Philips pressed steel split pulley and mill supplies for the carding, weaving and spinning trades.

The Goodyear Tire and Rubber Co. are showing a complete line of mechanical rubber goods such as their fire hose, extra service pneumatic hose, and Goodyear cord hose, extra power belting, packings, perforated mats, etc. Representatives, W. H. O. Crosby, F. Woods, F. Fox, and E. Dodge.

The Dominion Belting Co., Ltd., are exhibiting Maple Leaf brand stitched cotton duck waterproof belting for transmission of power and conveying. This is shown in various sizes, and excellent literature is distributed, showing its capabilities and endurance. Maple Leaf belt dressing is also on exhibit. Representative, John Scott.

The Hoyt Metal Co. are featuring their lead-lined and resisting products such as valves, centrifugal pumps. Together with this line they are displaying their various other lines of metal goods such as solder, babbitt type metal, etc. Representatives, G. F. Allen, manager; S. Wheatley and W. G. Downes.

The Lyman Tube and Supply Co. are featuring Shelby seamless steel tubing, together with the Chisholm and Moor anti-friction hoists. These latter are capable of 80 per cent. efficiency and are made in sizes up to 40 tons. Hyatt, Timkin and New Departure ball bearings are shown, together with electric railway supplies, made by the Electric Service Supplies Co. Chain belt and Rex products are also shown. Representatives, H. A. Jones, J. E. Openshaw, R. B. Bennett and Wm. Gardiner.

The John Hall & Sons, Ltd., Brantford, represented by Mr. Thompson, are showing several examples of their pipe threading machines. The large machine which can handle pipe from 2½ inches to 8 inches diameter is a fine looking piece of work, while the smaller sizes are also worthy of examination.

The Boiler Repair and Grate Bar Co., of Detroit and Toronto, have an exhibit of their shaking and dumping grate bars. These bars have been fitted in several local schools and public buildings. Mr. A. H. Hett and Mr. O. C. Hett are in charge of the exhibit.

The Canadian General Electric Company have an electric welding exhibit on view, which they are demonstrating to anyone interested. The machines are the direct current type operating at 60 volts.

The Dunlop Rubber Company, represented by J. R. Thompson, have a very effective display, consisting of a belt conveyor, elevator, and drive belt all in operation. The background of the booth represents a quarry in operation, showing the different uses to which rubber belting can be put in conveyor operations. They have also different types of rubber hose, and a full line of rubber goods.

The Allen General Supply Company, represented by Mr. Wilkes, are showing a number of power plant accessories designed to effect economy in fuel consumption. The well-known Venturi Feed Water Meter is the principal of these appliances, backed up by the Copes Boiler Feed Water Regulator, the Dwight CO_2 Indicator, and the Howell electric motor. In these days of high fuel costs, this exhibit should receive considerable attention.

The W. R. Sexton Boiler Setting Co. are displaying a full line of fire bricks, nonpareil grate bars and boiler settings. They have also a line of engine and pump packings, representing the William C. Wilson Co. in these lines. Mr. Sexton has charge of this exhibit.

The Canadian Hauck Burner Co., Ltd., are showing a number of their coal oil burners, which are in general use in foundry and shipyard work. Mr. Housel is in charge of the booth.

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(Continued on page 44)

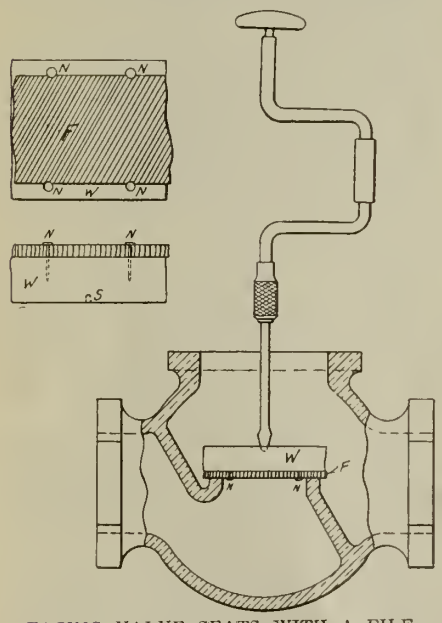
The Operators' Point of View

FACING VALVE SEATS WITH A BROKEN FILE

By David R. McNally

I have never seen this kink used and have been advised by several to submit it to POWER HOUSE. A quick and simple made rig for facing up a rough valve seat of the flat type can be easily made from a flat file.

"W" is a block of wood cut so as just to go in the opening in the bonnet connection of the valve. F is a piece of the best end of an old or new flat file



FACING VALVE SEATS WITH A FILE

broken to about the length of the block W. N are nails to hold the file into the block and driven far enough from the ends for the heads to just fit loosely inside the valve seat. This keeps it travelling in a true circle while it is turned with a brace and screwdriver bit.

A few turns will make a steam-tight job under ordinary circumstances, but in a bad case it will be necessary to clean the file grooves out when they fill and apply again.

ANCHOR BOLT DISCUSSION

Terrell Croft Replies

Mr. Hal B. Beecher, in his contribution, "Fastening Anchor Bolts," on page 349 of your August 5 issue, makes the statement:

"I wish to repeat: do not adopt Mr. Croft's plan, for it looks to me that a headless bolt set in cement might possibly be loosened into its bed if the bolts were subject to sharp and constant vibrations, which would have the same effect all through the bolt."

I fear that Mr. Beecher did not read carefully my contribution, "Anchoring Foundation Bolts in Concrete," to which he refers.

In my article appears this statement:

"However, as a matter of precaution, it is always well to use for a foundation bolt a rod threaded and having a nut on the lower end. On this nut a cast iron building washer or a square piece of wrought-iron plate can rest. . . ."

It was not the writer's intention to recommend the omission of anchor plates, where conditions are such that they can be installed. They should always be added as a precaution, inasmuch as the cost increase due thereto is very small.

Personally, I have never in my own experience known of an anchor bolt pulling out of a concrete foundation. Such happenings may have occurred, but I have never known of such and I have been more or less intimately connected with machinery foundation construction for the last fifteen years.

It sometimes occurs that it is impossible to, at reasonable cost, install an anchor plate and nut on the lower end of an anchor bolt. For example, in a number of cases it has been unavoidable that anchor bolts be set in an existing foundation at new locations. Where this is required, it is merely necessary to drill a hole in the foundation with an air drill, if such is available, or with a hand drill if it is not. The hole should preferably be one and one-half times or twice the diameter of the anchor bolt, which is to be inserted in it. The hole should be at least thirty diameters deep. Then, after the anchor bolt has been set centrally in the hole, a grout of one-half fine sand and one-half cement mixed to the consistency of thick cream is poured into it around the bolt, filling the hole. After setting a reasonable length of time, such a bolt becomes almost an integral part of the foundation mass.

A great number of anchor bolts installed as described above have been set for almost numberless sorts of services. Some of them have been subject to extra vibration. None, insofar as the writer is aware, has ever failed. Obviously, common sense dictates that an anchor bolt set as just described should be reasonably free from oil and should not be thickly coated with rust. If there is excessive oil on it, it should be wiped off.

If there is a rust scale on the bolt body, it should be scraped off. A corroded surface without scale, such as is acquired by any mild steel rod which has been exposed to the weather, will do no harm.

I would hesitate to assume the cost of Mr. Beecher's board and lodging during the period which would be required for him to loosen a bolt set as above "by tapping or striking said bolt for some time close to the cement, using a hammer or other tool." He might break the bolt off, but if it is properly set it could not be loosened so it could be pulled out.

About ten years ago the writer was connected with a company in New England that made some field tests on the resistance to withdrawal of plain unthreaded rod anchor bolts set in cement. An endeavor was made to withdraw, with a suitable appliance improvised for the experiment, from a concrete foundation, some bolts set by this method. In every case the bolts pulled asunder outside or near the top surface of the foundation. But in no case was it possible to pull one of the bolts out.

If any reader of POWER HOUSE knows of an instance, or instances, where anchor bolt set as above described have failed, I would like very much to have a record of the incident, inasmuch as I am interested in and make a specialty of machinery-foundation design.

To summarize, there should, if possible, always be an anchor plate, or, as Mr. Beecher suggests, a right-angle bend or hook at the lower end of every anchor bolt. But if conditions are such that it is impossible to provide the anchor plate or deformation, an anchor bolt may readily be so installed that it will not fail by withdrawal.

BOILING OUT A STEAM BOILER

When a boiler becomes heavily coated with scale through neglect or through long continuous use of very bad feed water, it is sometimes more convenient and safe to clean it by what is known as the "boiling out" process than any other method. Heavy scale diminishes the efficiency of any boiler, and if it is hard and compact it is less impermeable to the water than when of a porous nature, and neglecting to remove the scale at frequent intervals may damage the boiler by causing the metal to become overheated and burned.

Taking this into consideration it is advisable when a boiler is found to be

heavily scaled to immediately apply the "boiling out" process, although the time required may occasion considerable inconvenience in plants in which there is only one boiler. The "boiling out" process consists simply of filling the boiler with water to a point a little above the tubes or the upper limit of the scale deposit, and adding to the water a liberal amount of soda ash. Soda ash alone is usually sufficient, but in order to increase the efficiency of the treatment a small proportion of caustic soda may be added and both should be thoroughly disolved before being put into the boiler. With a slow fire and the man-hole left open the water should be kept boiling gently until the scale becomes loosened, when the water may be run out and most of the scale removed by means of convenient hard tools and by flushing out with a stream of water from a hose nozzle.

Particular care should be taken to remove all the scale possible from between the tubes and places difficult to reach, for the reason that when the boiler is restored to service, pieces of scale already loosened will fall down on the fire sheets and other heating surfaces which may result in overheating in spots.—"The Refrigerating World."

PUMP PROBLEMS

By J. E. McCormack

THERE is nothing new or original in the devices I am about to mention, but I have at one time and another made the acquaintance of pumps in various plants and in different counties, and the fact that none of them had been equipped as fully as I like to see a pump equipped leads one to bring up these subjects even if they are old. Only one pump had a foot valve, although this would be an aid in holding the priming when the pump was stopped. (Perhaps I should mention that at this writing I am not taking boiler feed pump into consideration at all). On those pumps which had piping for the suction line throughout, few of them had any more convenient means of priming the pump for a start than to take a cover off of the water end and pour water in. Two, or possibly three, had a tee at the highest point in the discharge line and through which water could be poured down on to the discharge valves, but, although an aid, water there is not nearly so effective on appreciable lifts as is water in the water cylinders themselves to prevent air passing the pistons, and especially to reduce possible air cushioning in the clearance and valve spaces, which said cushioning would expand again and follow the piston back on its return stroke instead of an unbalanced air pressure (suction) being produced to cause water to rise in the suction pipe. The amount of this possible cushioning depends on the degree to which the air must be compressed before it can escape through the discharge valves or other passage provided for it.

I like to have a foot valve on and a pipe connection from the discharge line or chamber to the suction chamber and a valve in this with which to make or break communication between at pleasure. With the valve shut, the pump works about the same as if this device was not on it, but in the event of the priming becoming lost and there being water in the discharge line the opening of this valve permits water to flow from the discharge line into the suction line and work up into the cylinders, the foot valve preventing its escape through the lower end of the said suction line. By this arrangement the pump can be quickly, easily, and effectively primed.

A suction chamber is a well-known device which can be constructed by means of a tee inserted in the suction line but close to the pump and into which a piece of pipe at least as large as the suction pipe (or hose connection) and two or three feet long is screwed and having a pipe cap on its upper end. The pipe constituting the suction chamber stands in an upright position. Although generally not necessary, yet, with a long suction line or a high lift, this device is an aid to prevent pounding when the pump reverses and also to enable the cylinders to fill with water at a high speed.

I think not more than four pumps had any means provided for letting the air (drawn from the suction line when starting the pump) escape, except through the pumps' discharge line. If but little pressure rests on the discharge valves this feature is of but little importance, but where an appreciable water pressure per square inch normally rests on the said discharge valves some way should be provided for allowing air to escape when starting and without requiring it to be forced through the discharge line. A bib cock or pet cock inserted in the bottom part of the air chamber, or even in the cover of the discharge chamber, is an aid, and sometimes a valuable one, though it still remains necessary to force the air through the discharge valves against whatever pressure is holding them down. With a foot valve on and the pipe connection I spoke of installed to, by means of a valve, allow water to flow from the discharge chamber or line into the suction line then the water pressure above and below the discharge valves becomes equalized with the valve open and the pump at rest and the air is therefore more easily sent through the discharge valves when the pump is started. The valve is closed before starting the pump or it may be left just a little open while the pump makes a few very slow strokes at first to exhaust the air, then entirely close the valve before allowing the pump to run up to normal speed. In a pump thus equipped, a bib cock in the foot of the air chamber will, when open, provide a short route escape for the air being displaced from the suction and the pump by the water admitted thereto from the discharge line.

Joints in the suction line should be as carefully fitted and as tight as similar joints would be made in a steam line, but if a joint there becomes leaky although at the same time well set up, a Yarway pipe clamp (formerly the Simplex) is as useful here as on a steam line, although I would not recommend one as a permanent remedy to be merely set up more from time to time as became necessary and without giving proper attention to the actual condition of the joint itself.

Strainer holes should aggregate five times the area of the suction pipe.

Put a globe valve in the discharge pipe to shut back the water in it when the water end of the pump needs repairing.

The longer the suction pipe, the larger it should be, and there should be a foot valve attached if the lift exceeds twelve or fifteen feet.

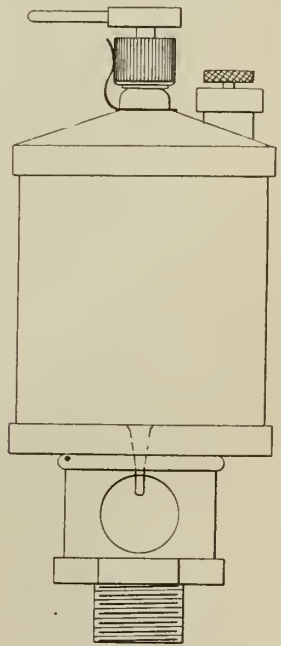
Lack of a suction chamber, or too small a suction line, will cause a pump to hammer in the water end. Squirting action may be lessened by increasing the suction valve area; by giving more suction chamber and more air chamber.

Pumps should be installed in such a position that there is room enough at both sides for working when making repairs and room enough at each end to admit of removing the piston rods if their removal should happen to become necessary later.

IMPROVING A LUBRICATOR

In a well-known type of air compressor lubricator in which the sight feed glass is of the disc or bullseye type, the feed nozzle terminates above the line of sight, so that before the drop can be seen it has broken away from the nozzle.

To make the drop visible while forming a strip of metal was soldered to the



FIXING THE LUBRICATOR

nozzle, bringing the point of the nozzle well into view.

The sketch will indicate what was done, the dotted lines indicating the nozzle as it was originally.

R. McLAREN.

BOOK REVIEWS

Analysis of Babbitt, by James Brakes, The Allen Book and Printing Co., Troy, N.Y.

It has been the desire of the author, as stated in his preface, to place before the mining, civil, electrical and mechanical engineer and others who have taken chemical analytical training, a small practical book on the analysis and manufacture of babbitt. The methods have been selected from the many methods in use for their simplicity, neatness and accuracy. At the same time reactions and data have been inserted which will prove interesting to the student in analytical chemistry. One of the most valuable features of the work is an extensive bibliography on books dealing with metallurgical engineering. The various metals met with in the manufacture of babbitt metal and similar alloys are each given a chapter to themselves and their properties, their qualitative, quantitative, volumetric, gravimetric and electrolytic analyses are taken up in detail. Each chapter closes with a biblography on the metal concerned. Antimony, tin, lead and copper are dealt with. Chapter five takes up the determination of magnesium and bismuth in babbitt, the qualitative analysis of babbitt and gives a bibliography on white metal analysis. Chapter six is devoted to notes on the manufacture of babbitt, examples of calculation, the sampling of babbitt metals and a bibliography of metallurgy. To the works chemist this book of 170 pages will prove an admirable aid where anti-friction metals, etc., are concerned.

"The Financier," London, Eng., has recently published An Empire Peace and Reconstruction number replete with commercial and other information relative to the British Dominions and Colonies. As might be expected, Canadian information is unusually complete, and the other dominions are also fully dealt with. Aside from the financial and other information contained in this number, much other data is found.

"Boiler Safety," a new booklet just off the presses of the Travelers' Indemnity Company, is a sister booklet to "Boiler Economy" recently issued by that company. Its purpose is to describe approved ways of preventing accidents in the boiler room. It is a convenient pocket size and will be a handy reference book for the engineer and fireman, as well as the plant owner.

In 175 pages the subject matter is divided up into forty sections, each of which relates to some particular phase of boiler room work, or to the care and operation of certain equipment or apparatus in the boiler room. Boiler explosions occur frequently, and many of them are enormously destructive to life and property. They are often caused by weakness due to improper design, inferior construction, or the use of unsuitable materials, but many of them on the other hand are plainly the direct results of careless or unintelligent operation of the boilers. In this booklet design, construction, and materials are not discussed. Emphasis is laid on the operation of the boilers.

The first section is headed "Putting Boilers in Service," and covers all the principal operations necessary to making sure that everything is in a safe and satisfactory condition for starting up. Among other important subjects treated are: cutting-in boilers, superheating, economizers, safety valves, blow-off valves, repairing boilers under pressure, laying up boilers, working inside of boilers, scale, water-hammer, mechanical draft, low water, and handling coal and ashes.

In short, "Boiler Safety" is a practical book for practical men. Its language is clear and concise, and although it covers its ground thoroughly and well, there are no formulas or theoretical discussions to discourage the man with a limited education. There are also thirty-two illustrations which show the results of boiler explosions, defective parts of boilers, approved power-plant equipment, and other subjects of interest to engineers.

As mentioned, the booklet is a companion volume to "Boiler Economy," which is now in its second edition, and for which there has been a constant demand since its first appearance in 1913. It is largely written by Allan D. Risteen (Ph. D. Yale), director of technical research of The Travelers.

CATALOGUES

The H. Mueller Mfg. Co., Sarnia, have issued a new catalogue (A) which shows evidence of considerable pains and expense in its preparation. This publication shows their complete line of brass plumbing products.

What Worried Jellico Most is the title of an interesting pamphlet issued by the Wheeler Condenser and Engineering Co., Carteret, N.J. This publication emphasizes the importance of good condenser tubes in naval, marine and land work, and tells the story of how the Wheeler Co. started the manufacture of their own tubes so as to be assured of their quality.

Guy S. Hamilton, advertising manager of the American Steam Conveyor Corportation, Chicago, has been appointed editor of the "Booster," the Corporation's newly-established sales organ.

S. F. Bowser and Co. have issued a folder illustrating and describing a Bowser battery oil storage system for lubricating oil. The folder can be arranged to show one outfit, two outfits, three outfits, or a battery of four tanks, so that a prospect may understand that as many units as desired can be purchased. The folder shows how units of various capacities line up in a uniform manner.

The Johns-Pratt Co., Hartford, Conn. cordially invites all members of the N.A.S.E., as well as all superintendents, master mechanics and operating engineers, to visit booths Nos. 221 and 222 during coming convention at Huntington.

THE RICHARDSON-PHENIX COMPANY ANNOUNCES NEW GENERAL MANAGER

Mr. L. E. Strothman, who, for several years, has been manager of the steam turbine and pumping engine departments of the Allis-Chalmers Manufacturing Company, left that firm on August 15th to become vice-president and general manager of the Richardson-Phenix Company, in which firm he has acquired a financial interest, Mr. J. Wm. Peterson becoming president and treasurer of this firm. Mr. Strothman is well-known in manufacturing circles, having been connected with the Allis-Chalmers Company since 1902, and prior to that with the Filer & Stowell Company and the Nordburg Manufacturing Company. As manager of the steam turbine and pumping engine departments of Allis-Chalmers, Mr. Strothman has gained an enviable reputation in national engineering circles. He is a member of the American Society of Mechanical Engineers, having held the chairmanship of the Milwaukee section during 1915 and 1916. In 1916 he was appointed associate member of the Naval Consulting Board by Josephus Daniels, Secretary of the Navy. Mr. Strothman is also a member of the American Society of Civil Engineers and the American Water Works Association.

MR. L. E. STROTHMAN.

NEW HOUSE ORGAN

Purdy, Mansell, Ltd., Toronto, have issued the first number of a new house organ, "The Sprinkler." While the title might indicate the subject of fire prevention by means of sprinkler systems, the subjects covered by their periodical will embrace the fields of power plant and heating and ventilation engineering as well. Sprinkler engineering is featured in this first number, typical illustrations being given of several installations recently completed by Purdy, Mansell, Ltd.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in	67 16	84 18
4 in.	79 57	99 74

Standard Lapweld

2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	236 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 26% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

¼ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon....	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....	$42 50	$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus	10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper .....$	22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided .....$	0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila....	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. .....$	12 00	$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

PEACE-TIME EXHIBITS

(Continued from page 403)

to anyone interested. The machines are the direct current type operating at 60 volts.

The Clemens Electrical Corporation of Canada, with headquarters in Hamilton, are showing their electrical soldering irons, and as these irons work at a voltage of 8 volts, the necessary transformers are also included in the exhibit. An interesting feature of the booth is the J. C. refillable fuse, a very neat and economical type of this largely used article. The booth is in charge of Mr. R. C. Guest.

Estimates Soon Ready.—Sir Adam Beck has assured the citizens of Galt through the mayor, that an estimate of the cost of the proposed Hydro Radial System in this district will be made by the new year. The municipalities will then be able to submit the by-law to the electors.

Paper Mill For Morristown.—The property owned by the Gillies Brothers at Morristown, directly opposite Brockville, who used the plant as their American depot, has been sold to representatives of Hearst, the American publisher. It is said that he will erect a mammoth paper mill on the site. Gillies Bros., who are large lumber mill men at Braeside, near Arnprior, formerly conducted a lumber business at Morristown, but closed down when lumber prices rose so high during the war.

BOILERS FOR SALE

ALL IN EXCEPTIONALLY GOOD CONDITION —17 Atlas Horizontal Tubular Boilers (Babcock & Wilcox), 60 inch by 16 feet, with Jones Underfeed Stokers: Boilers lying at Kitchener. 1 350-H.P. Erie City Boiler. 4 250-H.P. Scotch Marine Boilers with wet heads, now lying at Wallaceburg plant.

Dominion Sugar Co., Limited - Chatham, Ontario

The J. C. Wilson Mfg. Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

Makers of the "Little Giant" Turbine.

Put your water wheel proposition up to us

Diamond Specialty Company literature has always been distinguished by its direct appeal to the engineering knowledge and sound business judgment of its readers. This is particularly true of Bulletin 132, "Profits That Get Away Through Your Boiler Room," just issued by the company. This bulletin, which is

an attractive, well-written book of twenty-four pages, deals first with the importance of exercising business-like supervision over the boiler room; the effect of soot on boiler efficiency; and in its concluding pages describes Diamond scot blowers for horizontal return tubular boilers. The book is well illustrated with charts, graphs and ledger sheets, showing actual improvements effected, and it should be in the hands of every operator of horizontal return tubular boilers. Copies may be had on application to the Windsor, Ont., office of the company.

To Buy Power.—The clerk of the York Township Council has been instructed to write to the Ontario Hydro-Electric Commission, requesting that negotiations be opened to purchase the lines of the Toronto Electric Light within the township. The council is preparing to extend the Hydro through the thickly settled districts, and with only one power company the expense could be lessened considerably.

New Power Company.—A Dominion charter has been obtained for the Wendigo Power Company, which has been capitalized at $1,000,000. The plant of the company will be twenty miles south of Larder Lake, and the head office at Guelph. Water powers on Wendigo Lake and the Blanche River will be developed.

Largest Airplane Engine.—The Sunbeam Works at Wolverhampton, England, have been recently testing what is said to be the largest airplane engine in the world. The engine is a twelve cylinder one, the cylinders being arranged diagonally. The horsepower expected to be developed is 900 at normal speed, and the weight per horsepower is less than two pounds.

The Matthews Engineering Co., Sandusky, Ohio, have issued an exceedingly attractive booklet on their fuel automatic lighting systems for private installation and use in suburban and farm homes. The effect of proper lighting and illumination upon civilization is treated of in the first portion of the publication and the actual generating sets in the remainder.

Colliery Loses Three Days.—Owing to a dispute over the employment of two men on the bankhead, a colliery of the Sydney Reserve mine has been idle for three days. The disagreement rose over the fact that two men had been employed to push the boxes on and off the scales, and the company thought that one should be sufficient. The men finally resumed work on the understanding that when production was increased sufficiently two men would again be employed.

Making Money From Moss.—The swamp lands in the vicinity of Brockville are to be used as money producers, the medium being the moss that is found in abundance thereon. Three carloads of this moss are being shipped to Rochester, N. Y., for use by nurserymen and florists, who wrap it around the roots of trees that are being shipped, and also in preserving cut flowers. The moss is sold by the cord and brings a good price.

New Industry for N.B.—The Hardwood Last Block factory, which was spoken of some time ago as about to be located at Mullin's Brook, York County, N.B., is now being built. The site is about four miles from McGiveny Junction on the Canadian National Railway. The interest behind the enterprise is H. Mobbs, of Kettering, England, said to be the largest maker of last blocks in the world. Between one and two hundred persons will be employed to begin with, and the manufacturers have entered into an agreement with the Nashwaak Pulp & Paper Company for 3,000,000 feet of hardwood lumber.

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The Canadian Mining Manual for 1918, edited by Reginald E. Hore. The Times Publishing Co., Toronto and Quebec.

This well-known annual has been enlarged considerably over former years and contains much new material of a statistical and mining nature about Canada's mineral wealth. In this new edition is to be found information concerning all minerals and metals produced in Canada, and all metallurgical and mining companies operating in Canada. Two chief objects have been achieved: to present in concise form matter of interest to persons connected with the industry, and to attract attention to the opportunities for the development of Canada's mineral resources.

The volume is exceptionally well illustrated with colored plates, half-tones and line cuts. A large number of mineral specimens are shown in natural size and color, these plates including some of the best reproductions of ore that have ever been printed. In the section of the book devoted to mine products useful information concerning the character, use and occurrence of each mineral treated. The minerals are dealt with in alphabetical order and the amount of space given to them varies. Owing to the great demand recently for information concerning certain minerals and metals special attention is given to war minerals such as magnesite, fluorite, pyrite, molybdenite, etc. A second large section of the book is devoted to mining and metallurgical companies operating in Canada. In each case is given the office address, the location of the property, and the name of the manager. In most cases capitalization, names of directors, officers, nature of operations, recent financial statement and record of production during the last year are given. These companies are treated of in alphabetical order.

Contents

Mineral production in Canada in 1917; Canada's water powers and their relation to the fuel situation; metals and metallurgical research; annual meeting of the Canadian Mining Institute; Alberta coal mines; the gold industry; the magnesite industry; fluorspar mining in Ontario; oil prospecting in Ontario; tungsten ore deposits in Manitoba; the Matachewan gold area; Molybdenite mining in Quebec; copper mining and refining in British Columbia; mining in Northern Manitoba; mining companies operating in Canada; mining companies listed according to product.

FIRED WITH POWDERED COAL

Powdered coal is to be used throughout for firing boilers and furnaces in the new sheet mill of the Falcon Steel Company now being erected at Niles, Ohio

The power plant boilers will be powdered coal fired, using the Quigley compressed air system for transporting and burning the coal. The pulverized coal will be transported from the milling plant through standard 4-inch diameter wrought pipes to furnaces and boilers for various distances aggregating approximately eight hundred feet, and will be switched from the main distribution line to a storage bin in the power house for use as required for the boilers. The contract for the complete equipment for preparing, distributing and burning the fuel has been awarded the Quigley Furnace Specialties Company, of New York.

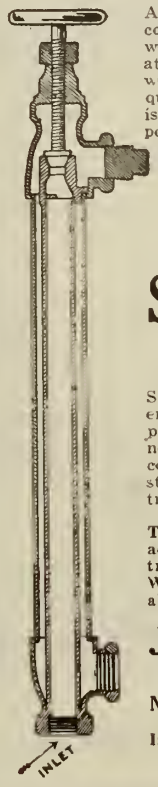
Large Power Drives is the title of a publication recently issued by the Morse Chain Co., Ithaca. This pamphlet deals, as the title indicates, with the chain drive in its application to large power transmissions of various types.

Electric Furnaces in the Iron and Steel Industry; Rodenhauser, Schoenawa and Vom Baur. John Wiley & Sons, Inc., New York.

This is the second English edition of this well-known work. In it a number of changes and additional matter have been incorporated consequent upon the rapid growth of the electric furnace industry. While a considerable number of books has been written on the subject of the electric furnace, the majority of them are of such general scope that the iron and steel industry does not receive the attention it warrants. An historical resume of the development of this branch is given and is followed by a chapter devoted to the explaining of the laws and principles of electricity which enter into electric furnace work. This chapter is somewhat elementary in its scope and has been inserted for the benefit of the general student interested in this branch of metallurgy. The effects of the electric current in the production of heat by resistance, arc or induction heating is dealt with next, together with other actions of the electric current in the furnace, such as the motor and pinch effects. Chapters IV, V and VI deal with power factor and alternating current theory in general, general conditions for the operation of electric furnaces and arc furnaces in general. The various types of arc furnace dealt with are the Stassano, now practically obsolete, the Heroult, the Girod and the Rennerfelt. Induction furnaces, now little used, are also treated of. Space is given to the electric shaft furnace for the reduction of iron ore. Part II takes up materials for furnace construction and the costs of operation, and Part III, the electro-metallurgy of iron and steel. These latter two parts of this book are of value from the economic standpoint as an exhaustive treatment is given of everything affecting the operation and economics of the electric furnace.

Fireman Scalded.—Through the blowing off of a cap on the boiler of the Smith Manufacturing Company, East Front Street, Toronto, a fireman was badly scalded about the face and arms. The man's name was John Smith, and he is 55 years old. He was removed to the St. Michael's Hospital.

Power House Economy



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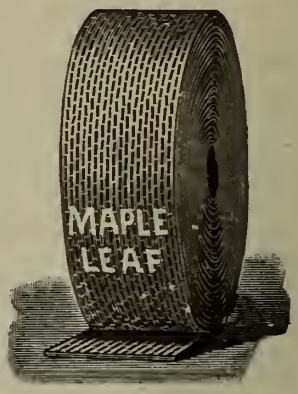

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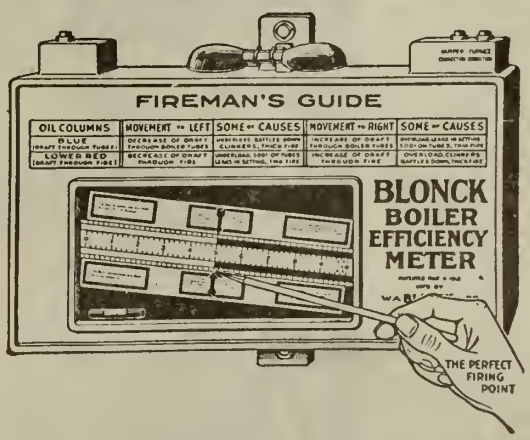

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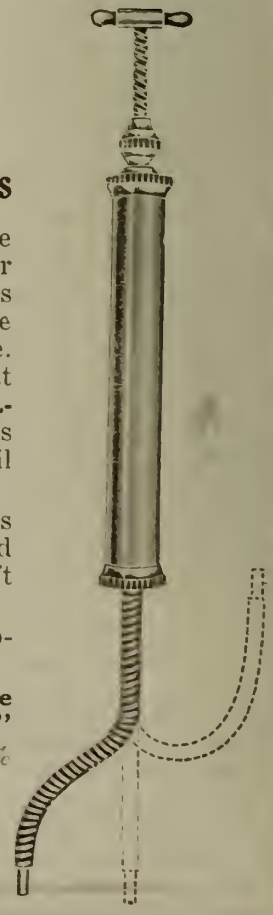

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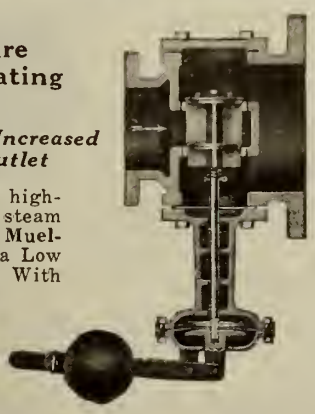

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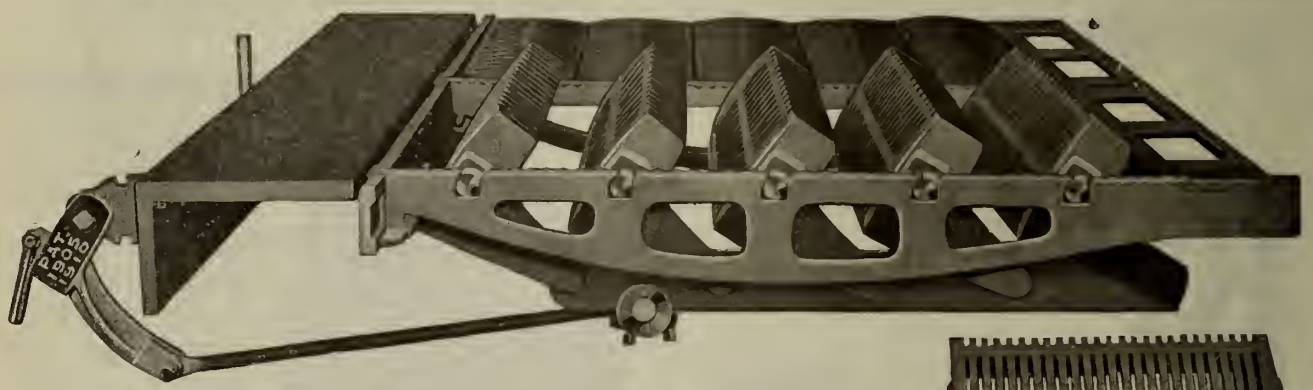

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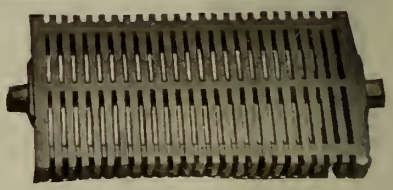

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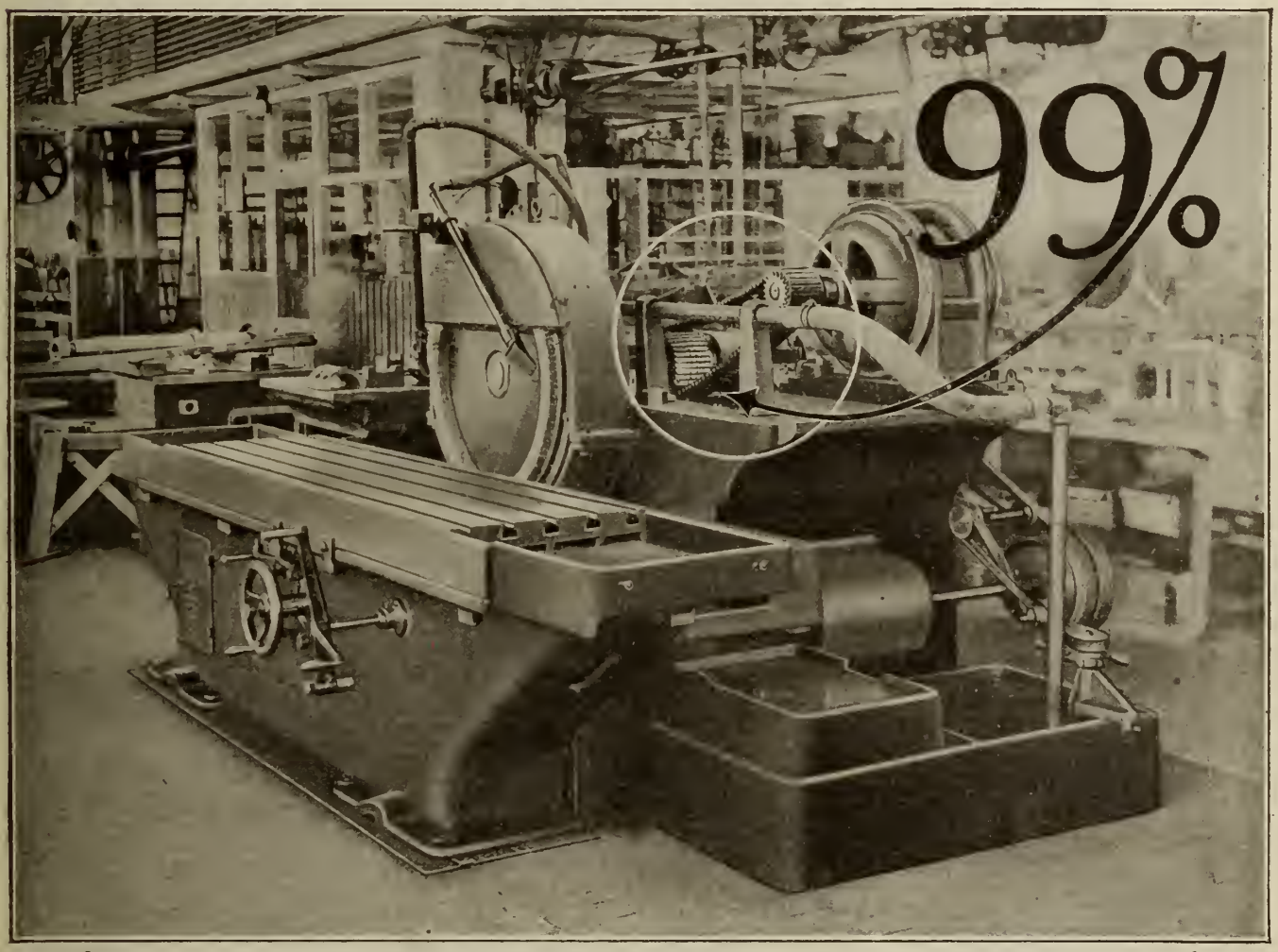

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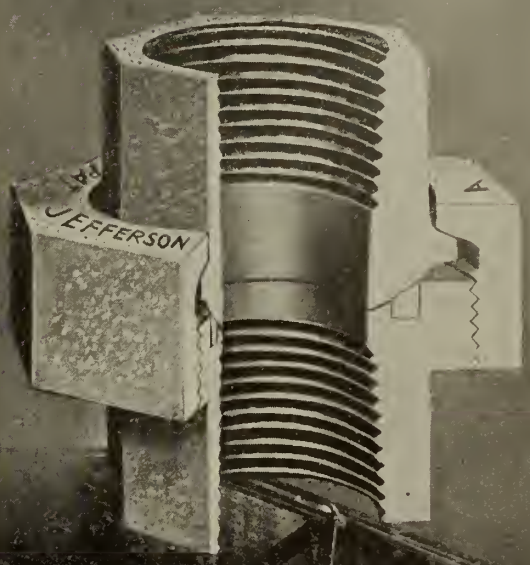

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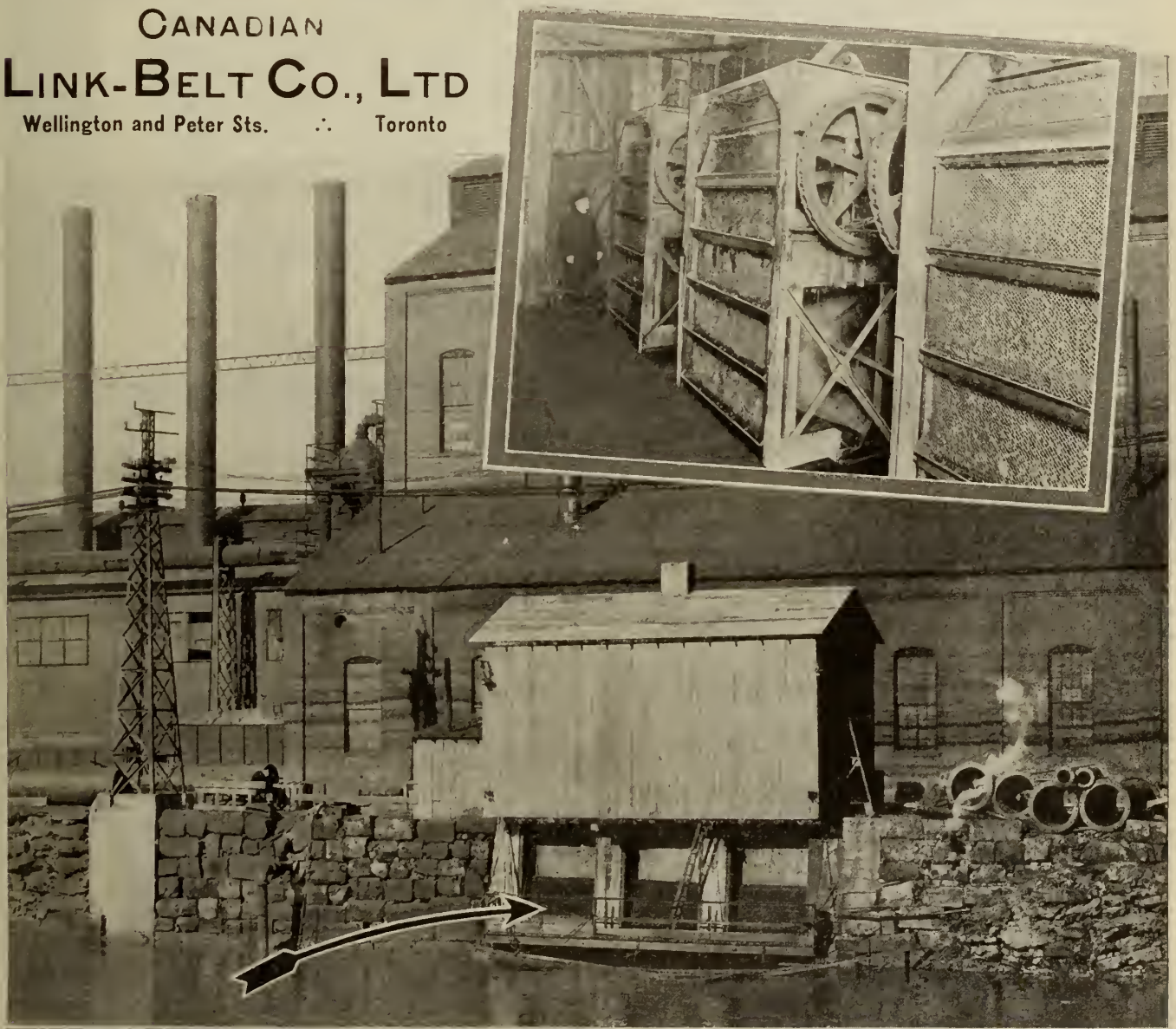

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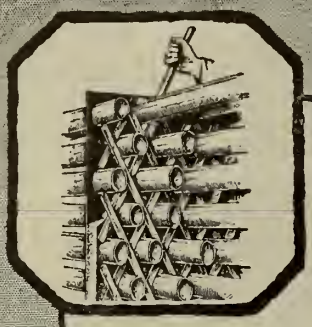

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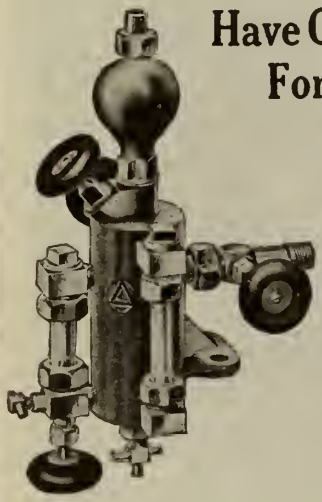

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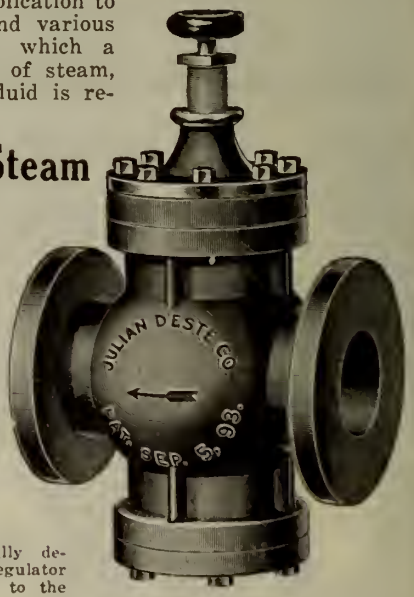

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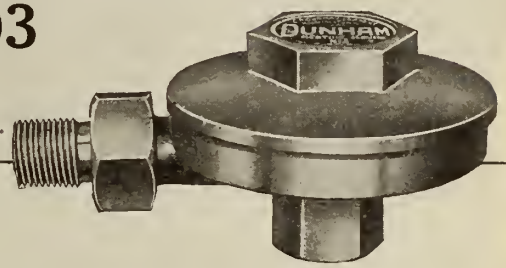

INVESTIGATE the trap question and you find two truths: that in the last fifteen years the carbon post type and the float type trap have been supplanted by the thermostatic disc type trap—and that the Dunham Radiator Trap, the *first* thermostatic disc trap, is essentially the same in principle to-day as when it was first marketed.

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In the Norwalk the intercoolers are placed **above** the gas cylinders. This permits of taking the gas out at the lowest point. Thus the intercooler is automatically drained and kept clear of any lubricant discharged from any cylinder or water coming from a chance leak.

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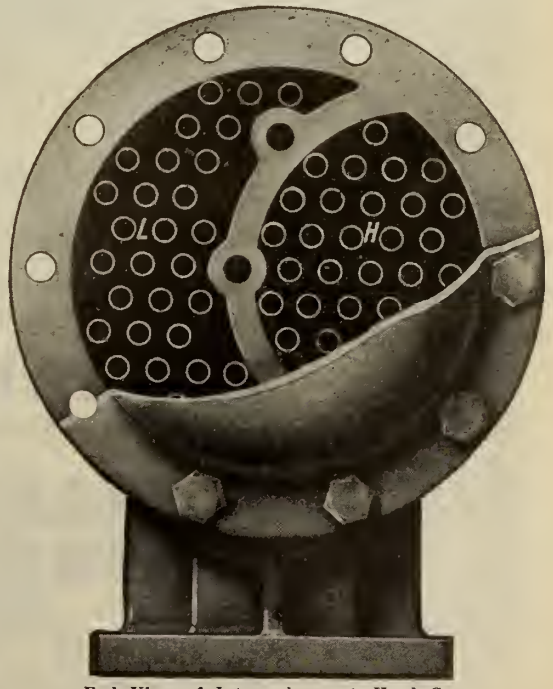
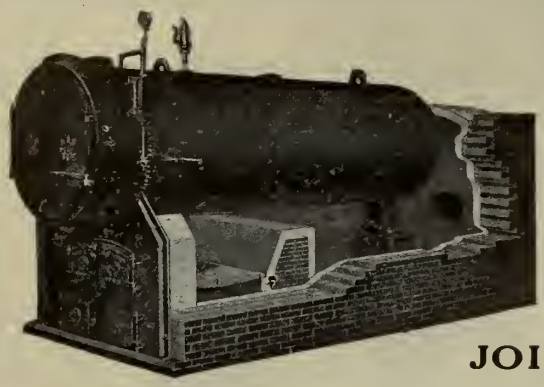


End View of Intercooler with Head Cut Away to Show Water Tubes and Partition Between High and Low Pressure.



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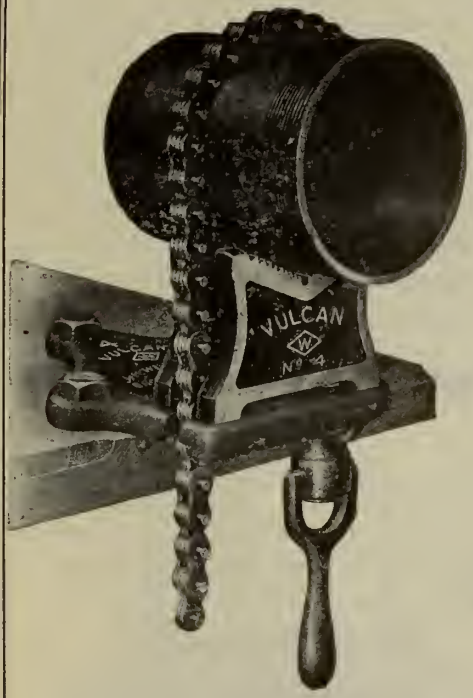

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Vises in 3 sizes for ⅛ to 8-inch pipe.

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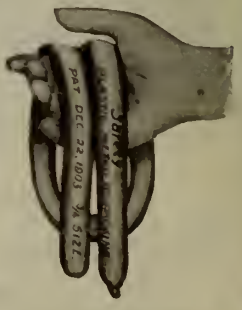

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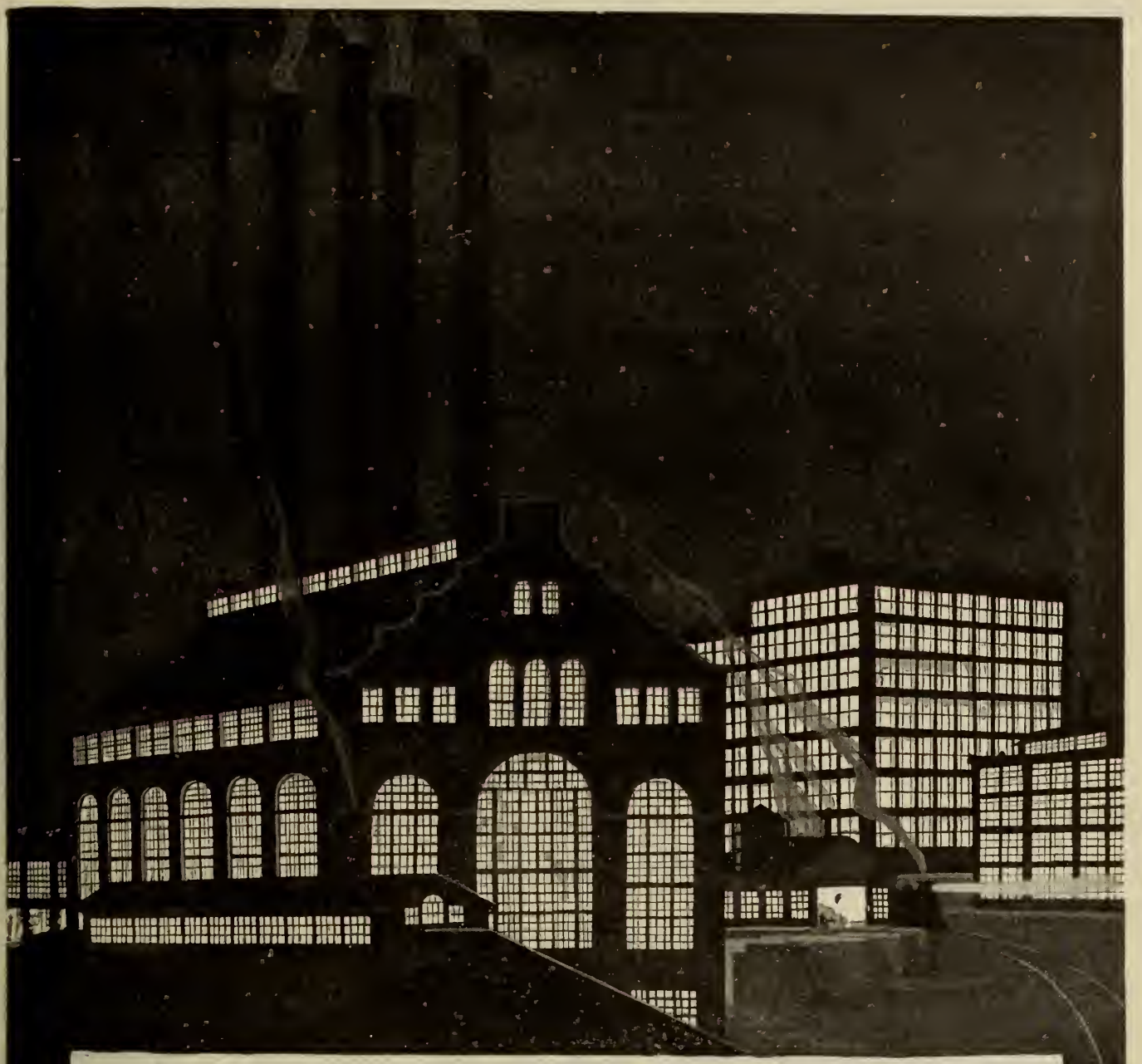

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Read this story of "Klondyke" Boyle, by Arthur Beverley Baxter, in September MACLEAN'S—it starts on page 13.

"Growing Under Gouin"

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His Majesty's Well-Beloved—By Baroness Orczy.

Canada's Great National Asset—By D. B. Hanna, president Canadian National Railways.

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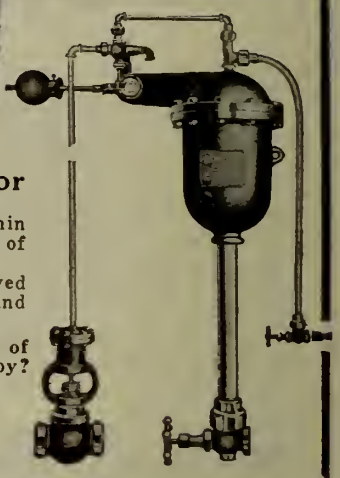

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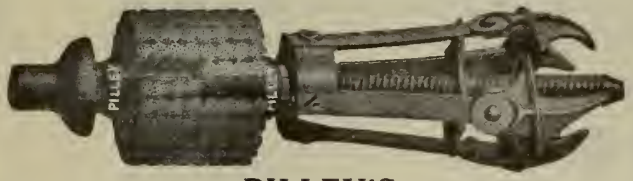

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Guaranteed not to break or the wires to pull out or lay over.
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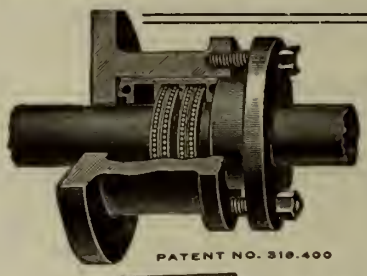

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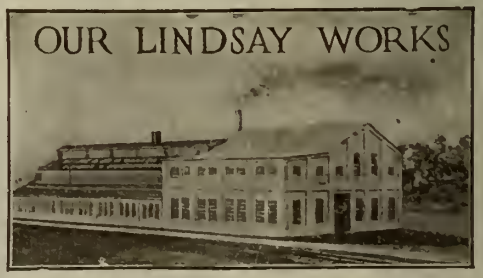

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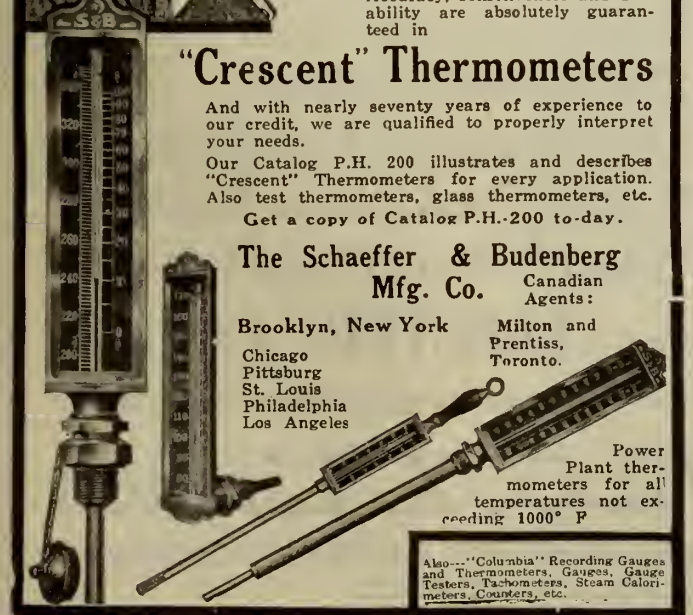

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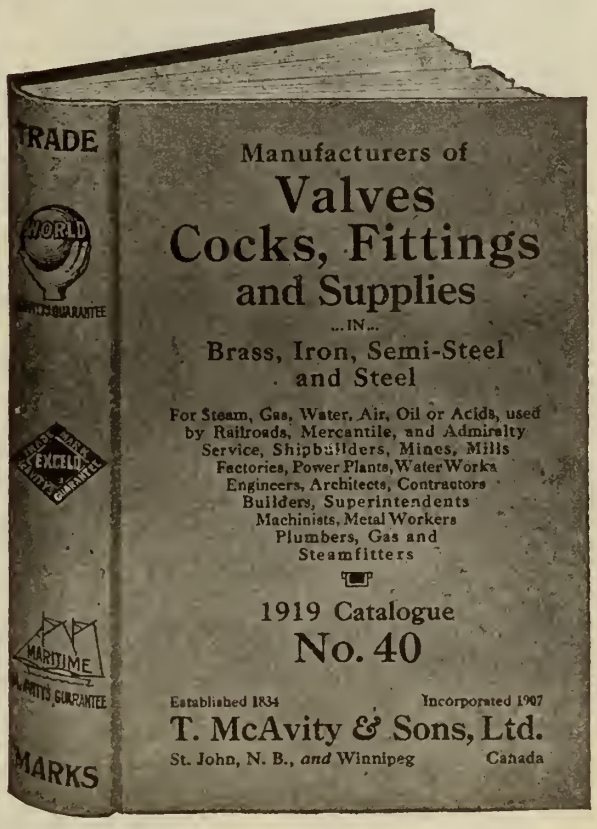
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1919 Catalogue
No. 40
Established 1834
Incorporated 1907
T. McAvity & Sons, Ltd.
St. John, N. B., and Winnipeg Canada

Cut shows reduced facsimile of our new No. 40 catalogue (7½ x 5½, 1,200 pages) shortly ready for distribution. If interested in valves and fittings, please advise us, that we may put you on our mailing list for a free copy.

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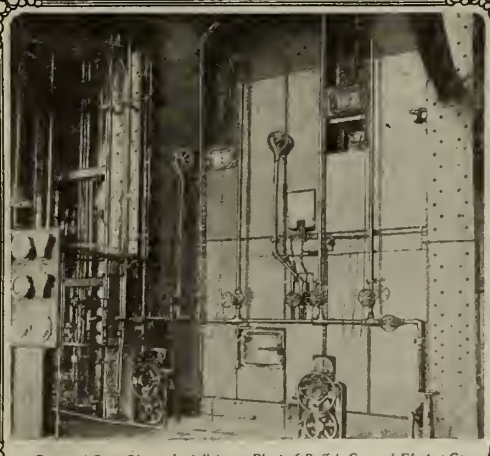

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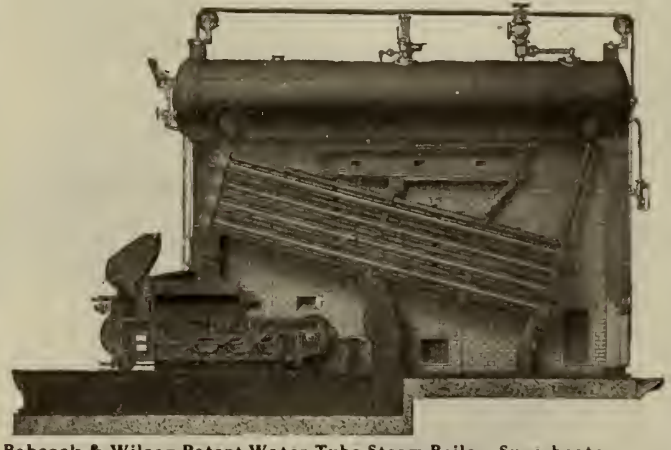

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BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates Refractories, Limited, Montreal.
Jointless Fire Brick Co., Chicago, Ill.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
MacGovern & Co., Inc., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd. Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.

BRASS GOODS
Penberthy Injector Co., Windsor, Ont.
Empire Mfg. Co., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

BRASS FOUNDERS
McAvity, T., & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS SHEETS AND TUBES
Empire Mfg. Co., Ltd., London, Ont.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BUCKETS, ELEVATOR
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHINGS, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALOFIFIERS
Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

CAR LOADERS AND UNLOADERS
Portable Machinery Co., Inc., Passaic, N.J.

CAST IRON FITTINGS
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
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Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford, Ont.
Wilson Mfg. Co., J. C., Belleville.

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Mueller Mfg. Co., H., Sarnia, Ont.

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Beveridge Paper Co., Montreal, Que.

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Shell Bar Boico Supply, Ltd., Toronto.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.

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Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

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Canadian Allis-Chalmers, Ltd., Toronto.
Waterous Engine Works Co., Brantford, Ont.

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CHAINS, AUTOMOBILE ENGINE
Morse Chain Co., Ithica, N.Y.

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Darling Brothers, Ltd., Montreal, Que.
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Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Green'a Economiser, Ltd., Toronto.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

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Mueller Mfg. Co., H., Sarnia, Ont.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford, Ont.

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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

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Green'a Economiser, Ltd., Toronto, Ont.
Jeffrey Manufactnring Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Portable Machinery Co., Inc., Passaic, N.J.
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Jas. Morrison Brass Mfg. Co., Toronto.
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Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Royles, Ltd., Irlam, Manchester, England.
Smart-Turner Machine Co., Ltd., Hamilton.
Taylor Instrument Co., Rochester, N.Y.

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American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chambers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford

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York Manufacturing Co., York, Pa.

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Cole, Ltd., Geo. W., Toronto.

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Dart Union Co., Ltd., Toronto, Ont.

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MacKinnon, Holmes & Co., Sherbrooke, Que.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

CONVEYORS, PORTABLE
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CONVEYORS, BELT
Portable Machinery Co., Inc., Passaic, N.J.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

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Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.

CRANES, HAND POWER
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Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Link-Belt Co., Toronto, Ont.

CRANES, OVERHEAD TRAVELLING
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Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

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DISCS, LEATHER
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York Manufacturing Co., York, Pa.

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Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.

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Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithica, N.Y.

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Smart-Turner Machine Co., Ltd., Hamilton.

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Can. H. W. Johns-Manville Co., Toronto, Ont.
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Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
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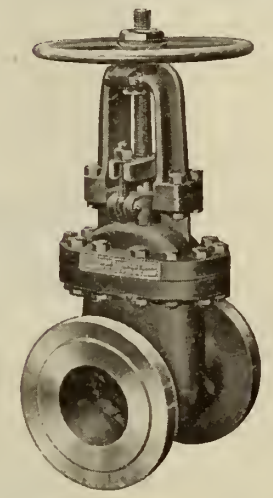

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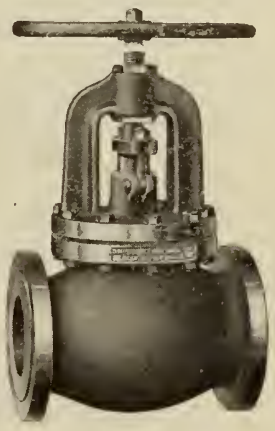

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McAvity, T., & Sons, Ltd., St. John, N.B.

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Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

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Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, BOILER
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE GRATE BARS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal, Que.
Shell Bar Boico Supply Co., Toronto, Ont.
Sarco Co., Inc., New York, N.Y.

GAS ANALZERS CO-2
The Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GASOLINE METERS
S. F. Bowser Company, Limited, Toronto, Ont.

GASOLINE PUMPS, SELF MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont

GASOLINE TANKS
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Wilson Mfg. Co., J. C., Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar. Boico Supply, Ltd., Toronto, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
The Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

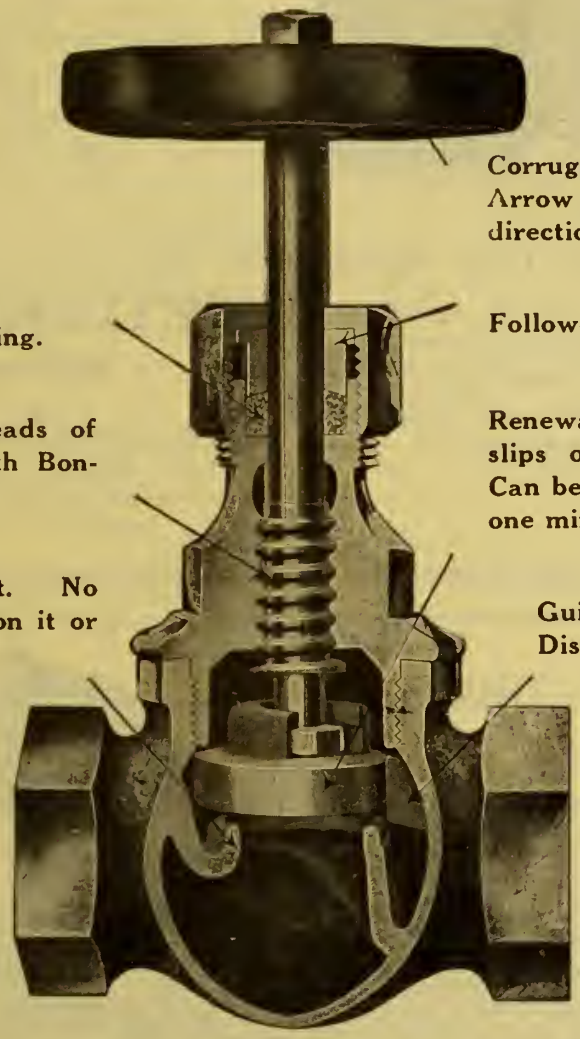
HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Follower in Stuffing Box.

Palmetto Twist Packing.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

At least Four Threads of Spindle engaged with Bonnet at all times.

Guide cast on Body holds Disc centrally over seat.

Raised Round Seat. No sediment can lodge on it or injure disc.

Globe or Angle

Screwed or Flanged

The disc of the Fairbanks Renewable Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

Everything in Mechanical Goods.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Scale in Your Boilers

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

METLSKIN CO., Inc.

Rochester, N. Y.

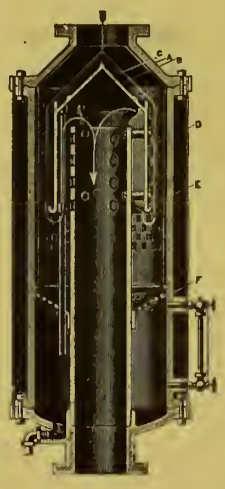
Canadian Representatives:

Canadian Fairbanks-Morse Co., Limited

St. John Montreal Quebec Ottawa Hamilton
Toronto Windsor Winnipeg Calgary
Vancouver Victoria Saskatoon

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

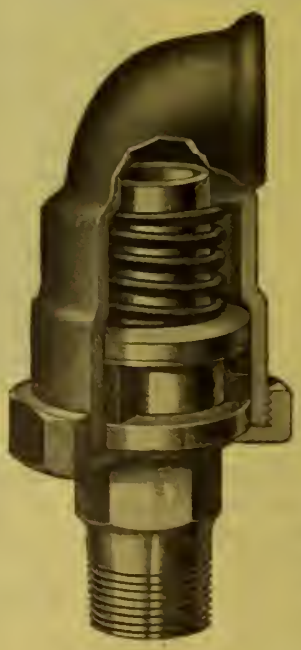
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Graton & Knight
Standardized Series
Leather Belting
Tanned by us for belting use

Triple Insurance

A Belt is a beast of burden that can spill a large part of its load without your eye perceiving it.

Here is a belt travelling at a speed of more than a mile a minute. It operates completely around the pulleys 70 times every 60 seconds. At more than a revolution per second, think how even little leaks would foot up a big total if this were not the proper belt for the work to be done.

All Graton & Knight Standardized Series Leather Belts give triple insurance against power leaks because, first, they are made of leather, the one belting material that has the right degree of elasticity to give and take up its tension, and the best of pulley-gripping qualities. Second, this leather is tanned in our own tannery, specifically for belting purposes. Third, our belts are graded into a Standardized Series which includes belts built specifically for every power transmission need Each is standardized in its manufacture and standardized for its work.

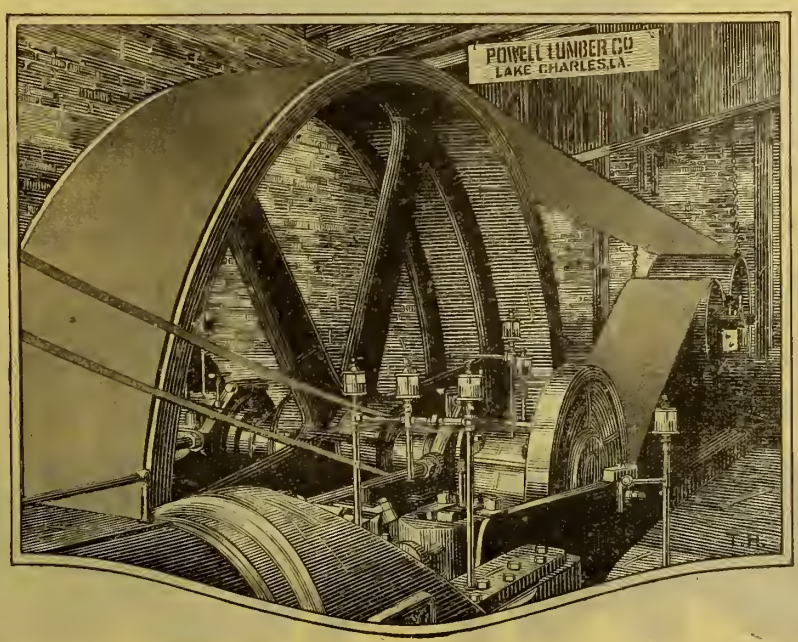
Selecting the proper belt and judging of its efficiency is not a job for guesswork or for the naked eye. It is a true engineering problem. Many of the best belted plants ask us to specify the belting for every pulley drive. Try the plan yourself. Then, when buying, call for "Graton & Knight——Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for Book, "Standardized Leather Belting"

CANADIAN GRATON & KNIGHT, LTD.
Montreal, Canada

Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria

By means of standardized methods of grading and manufacture, together with extensive investigations in our Engineering Laboratory, our Engineers are able to specify the correct belt for a given drive. Tests show that a 14 to 16 ounce belt should be rated at not more than 90% of the capacity of a 16 to 18 ounce belt. Consult our Engineering Department.



Here is a 34" Gra-Knight 3-ply Belt 82½ feet long. It was installed in December, 1915, in the plant of The Powell Lumber Co., Lake Charles, La. 14 ft. Drive Pulley, 136 R.P.M. 52" Driven Pulley. Belt Speed 5900 F. P. M. 443 horse power. The cost per horse power per week to date is 1 1/3 cents with several more years service to come.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

50% More Heat

ALBERGER HEATER

You will avoid all expense and trouble common to ordinary heaters by giving your plant an Alberger Heater.

NO CORROSION, NO SPLIT TUBES, NO LEAKY HEADS, NO EXPANSION STRAINS

Alberger Heaters work fast, heating the water as fast as it is drawn. In fact it transmits 50% more heat than any straight tube heater.

Made in both horizontal and vertical types.

May we send descriptive bulletin?

THE small, corrugated, pure copper tubes in this Alberger Heater are expanded into **floating head** independent of the cast iron shell, which means that there cannot be trouble from expansion and contraction strain.

ALBERGER HEATER COMPANY
BUFFALO N.Y. U.S.A.

General Sales Agents: Canadian Fairbanks-Morse Company, Limited St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria.

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

DURABLA HIGH PRESSURE GAUGE GLASS

Three years of experimental work have been necessary to develop and perfect an American glass possessing the elastic properties necessary to withstand sudden and radical changes of temperature and highest steam pressures, which will remain clear in any service.

Announcement is now made that DURABLA High Pressure Gauge Glasses, made in America, have passed every known test in actual service to determine the above qualities and are now ready for distribution.

DURABLA gauge glasses are carried in all regular sizes and are sold under the DURABLA guarantee.

MADE IN U. S. A. *Write to-day for circular and prices*

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada:
The Canadian Fairbanks-Morse Company, Limited

DURABLA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

For Rods

"Palmetto" Packing is braided round and square with a layer upon layer construction that gives it the great tensile strength necessary to long service under high pressure superheated steam and compressed air.

"PALMETTO"

Packing possesses the quality and perfect lubricant that insures the economy of long service. Let us send you free working samples to prove our claim.

For Valves

"Palmetto" Twist stands in a class by itself

Is ready for instant use, and any size valve may be packed from the spool by unstranding, each strand being a perfect packing in itself.

"Palmetto" Twist has great tensile strength, is heat-resisting and carries lubricant in each single strand.

PACK THE SMALL VALVES WITH "PALMETTO" TWIST
AND THEY STAY PACKED

GREENE, TWEED & CO.,

Sole Manufacturers

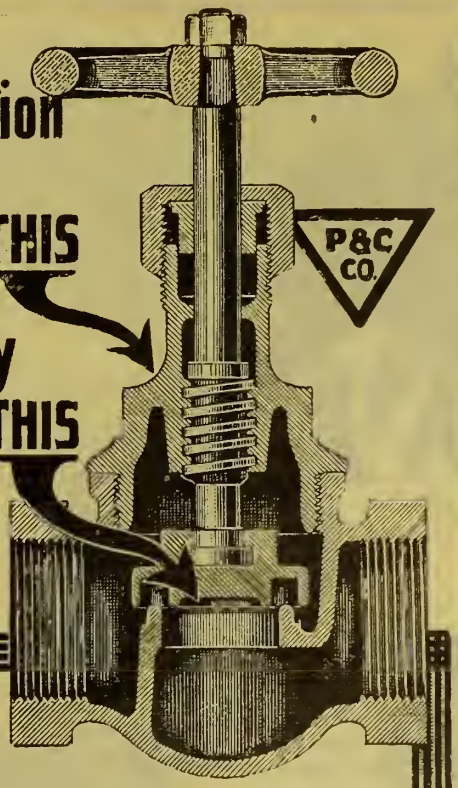
109 DUANE ST. NEW YORK

Canadian Agents :

The Canadian Fairbanks-Morse Co., Ltd., St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Conservation says SAVE THIS When only THIS is worn



If you believe in conservation you will believe in the Pratt & Cady Renewable Disc Globe Valve.

It is the valve of practical economy. The valve of common sense.

Instead of tossing the whole valve aside when the disc is worn down, you insert a new disc.

In this way you save the rest of the valve, which lasts indefinitely. The rugged construction of a Pratt & Cady Renewable Disc Globe Valve enables it to outlast many discs.

In the operation of renewal, which is quickly accomplished, the valve remains in the line. A saving of time and labor. Conservation at all points.

Thousands of these valves are in daily use by many industries, and they are all making good.

The economy of the Pratt & Cady Renewable Disc Globe Valve appeals to practical business men. Therefore we suggest that you

Write for the Booklet that gives full details.

PRATT & CADY CO., INC.
HARTFORD, CONN.

Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Power Pumps and Asbestos Packed Cocks.

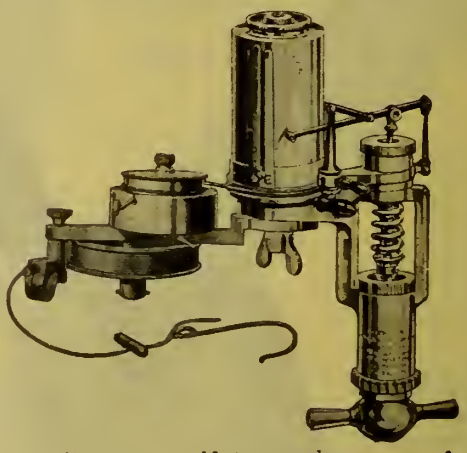
Canadian Representatives:
THE CANADIAN FAIRBANKS-MORSE CO., Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

PRATT & CADY
RENEWABLE DISC GLOBE VALVES

Mr. Engineer!

DO YOU OWN AN AMERICAN THOMPSON IMPROVED INDICATOR?



You owe it to yourself to purchase one of these NOW and secure all the benefits it makes possible. The price is right and easy terms can be arranged.

Write us

Our Canadian Agents:

Canadian Fairbanks-Morse Co., Ltd.

St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Windsor, Vancouver, Winnipeg, Victoria

American Steam Gauge & Valve Mfg. Co.

New York Chicago BOSTON Atlanta Pittsburgh

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

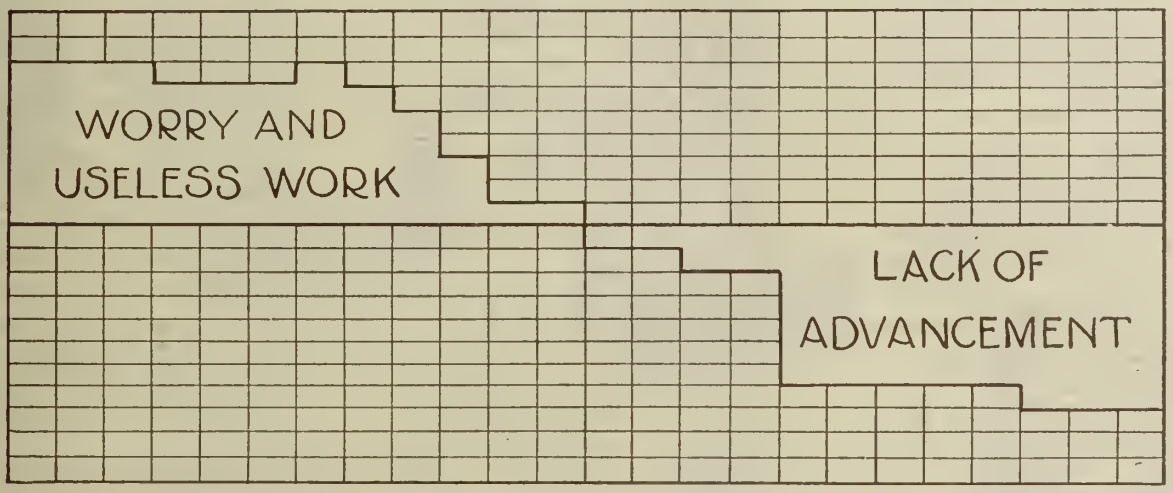
for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

MacGovern & Co., Inc., Montreal, Que.

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Yarnall-Waring Co., Philadelphia, Pa.

HYDRAULIC PRESSES
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Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.

ICE MAKING MACHINERY
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Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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Uehling Instrument Co., New York, N.Y.

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Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.

INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, England.

KEROSENE PUMPS (SELF MEASURING)
S. F. Bowser Company, Limited, Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Company, Limited, Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

LUBRICATORS, CYLINDER

CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. J. Philip & Sons, Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Company, Limited, Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
S. F. Bowser Company, Limited, Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

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Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
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Can. Link-Belt Co., Toronto, Ont.

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POWER PUMPS
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

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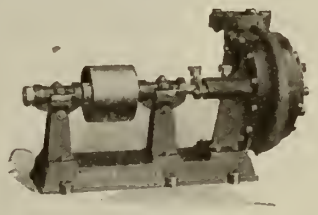
AMERICAN-MARSH PUMPS

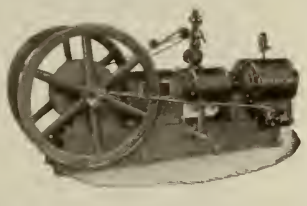
SIMPLE **RELIABLE** **EFFICIENT**

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.



American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.



The line also includes—

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Deep Well Engines
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Jet Condensers
Dry Vacuum Pumps
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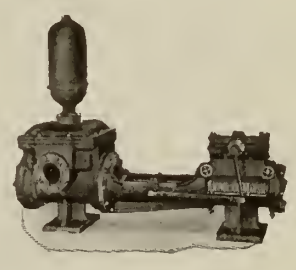

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AMERICAN STEAM PUMP COMPANY

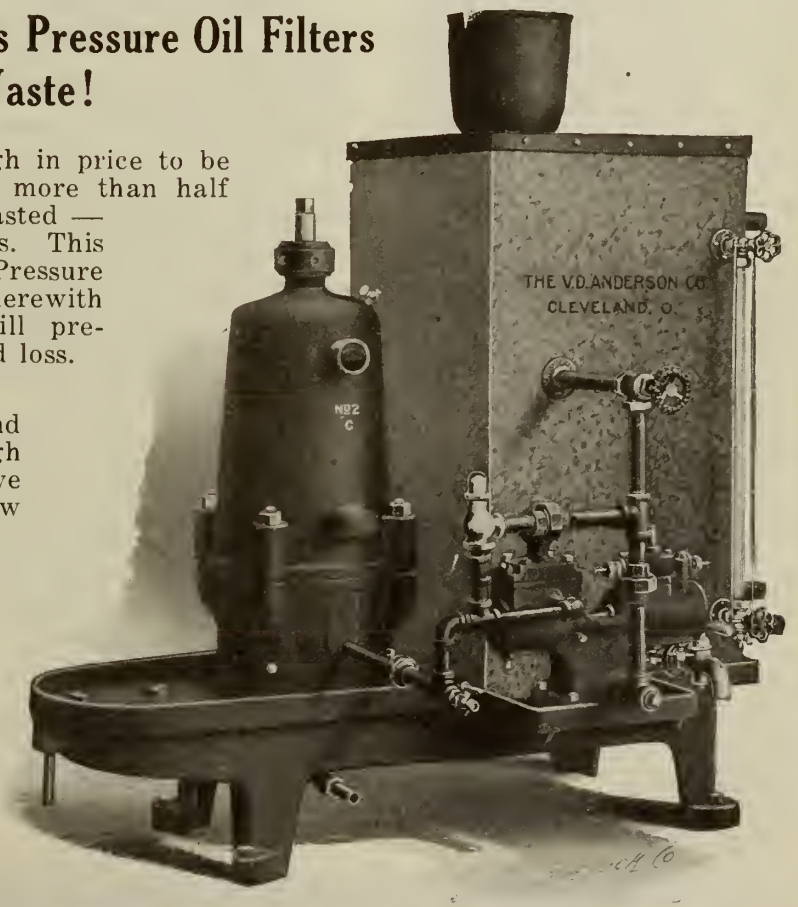
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanics' Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

Why Waste Oil?

Anderson's Pressure Oil Filters Prevent Waste!

Oil is too high in price to be wasted. Yet more than half your oil is wasted — lost on wipers. This Anderson Pressure Oil Filter herewith illustrated will prevent this dead loss.



Place drip pans beneath engines and machinery. Then pass this oil through the **Anderson Filter** and you will have oil just as clean and as pure as the new oil you purchase.

You can use oil over and over again with the Anderson Filter. No other filter will do the work so thoroughly.

There are a few more points about the Anderson that we would like to take up with you. Pleased to have you drop us a line.

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West 96th St., Cleveland, Ohio

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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
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Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
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Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

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Coppus Eng. & Equipment Co., Worcester, Mass.

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Laurie & Lamb, Montreal.
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Darling Brothers, Ltd., Montreal, Que.
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Escher, Wyss Co., Montreal, Que.
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Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

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Mason Regulator Co., Boston, Mass.
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Darling Bros., Ltd., Montreal.
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Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

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Smart-Turner Machine Co., Hamilton, Ont.

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Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

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Darling Bros., Montreal.
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Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

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Smart-Turner Machine Co., Hamilton, Ont.

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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

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REBOILERS
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Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

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Taylor Instrument Co., Rochester, N.Y.

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H. Mueller Mfg. Co., Ltd., Sarnia.

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Beveridge Paper Co., Montreal, Que.

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Babcock & Wilcox, Ltd., Montreal.
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Green's Economiser, Ltd., Toronto, Ont.

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Shell Bar Boico Supply, Ltd., Toronto.

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Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

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Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

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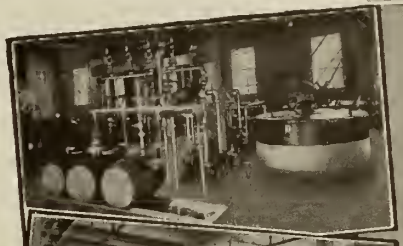

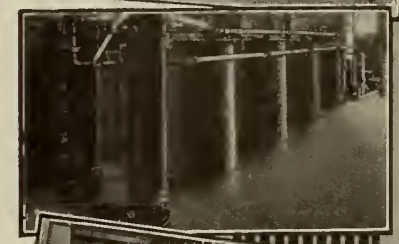

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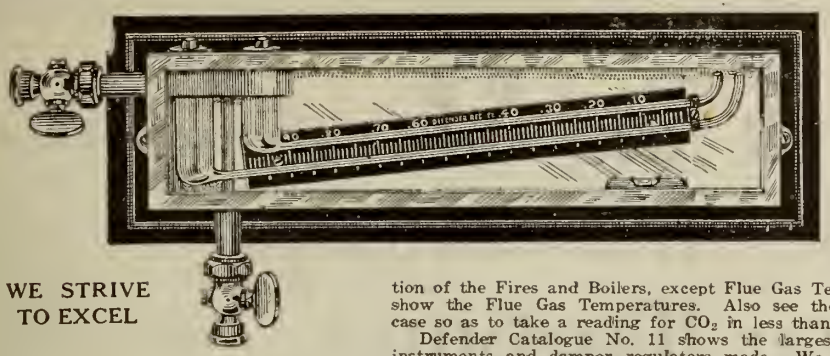

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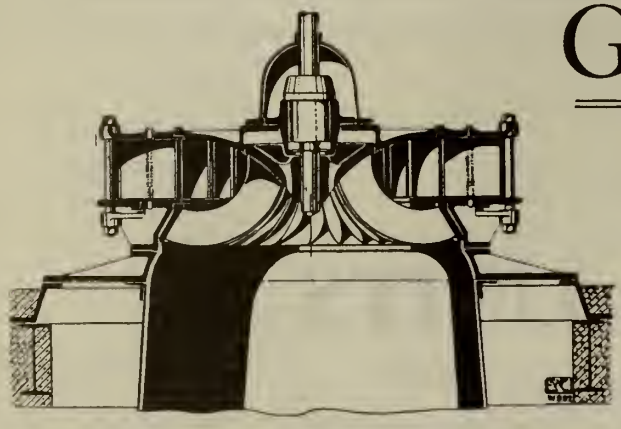

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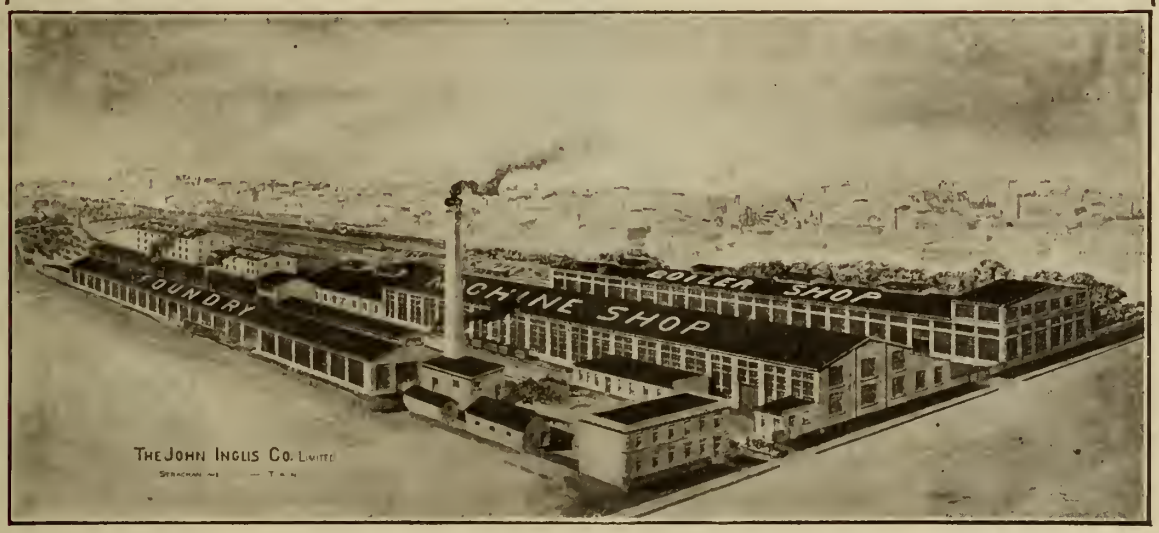

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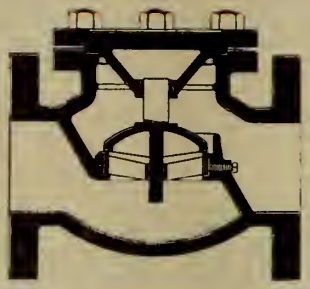
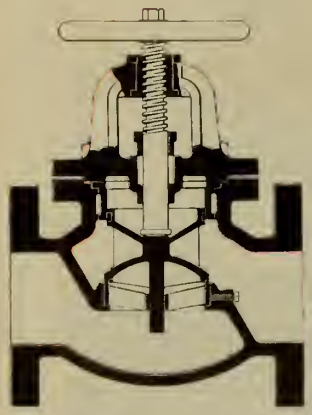
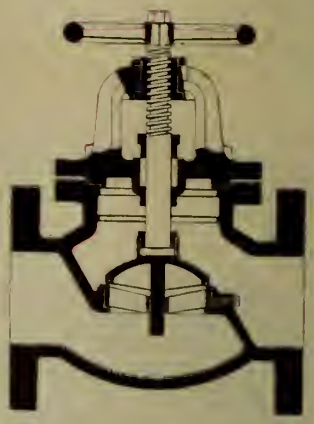




Imitations Speak Loudly for Beaver Valves



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Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

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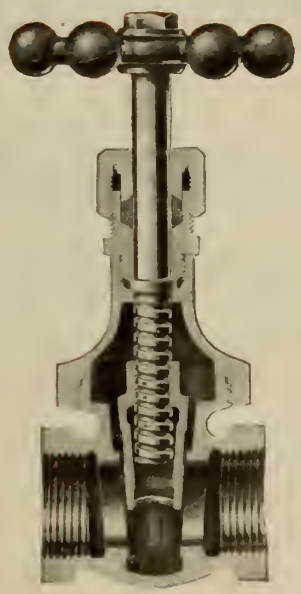
Vol XII.—No. 15. Publication Office, Toronto — September 20, 1919 Published Semi-Monthly $1.00 per Year

PENBERTHY

BRASS VALVES



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175 lbs. steam pressure.

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SOLID WEDGE GATE NON-RISING SPINDLE
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Doesn't this valve appeal to your own good judgment?

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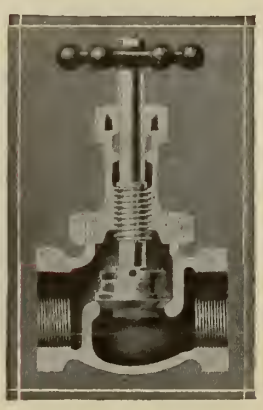

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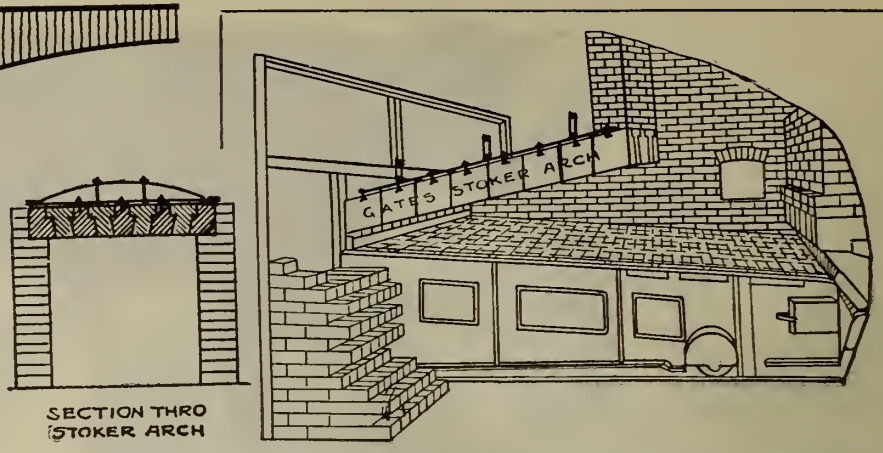

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DART

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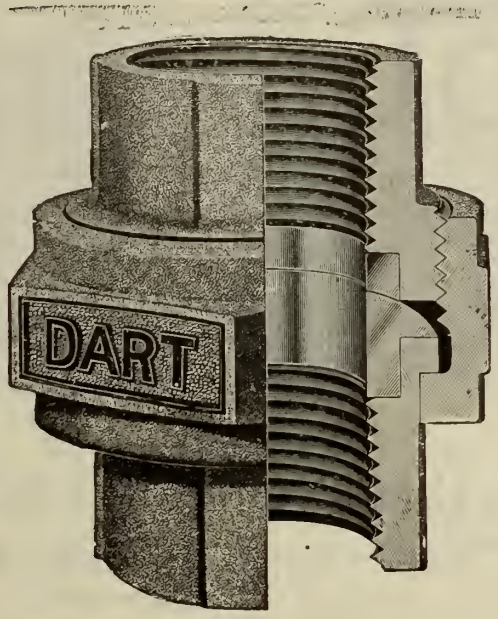

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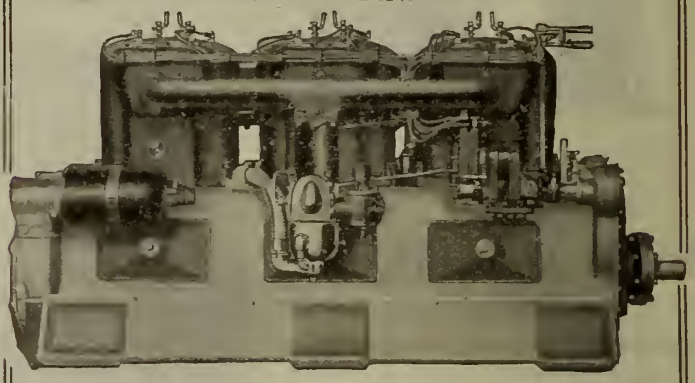

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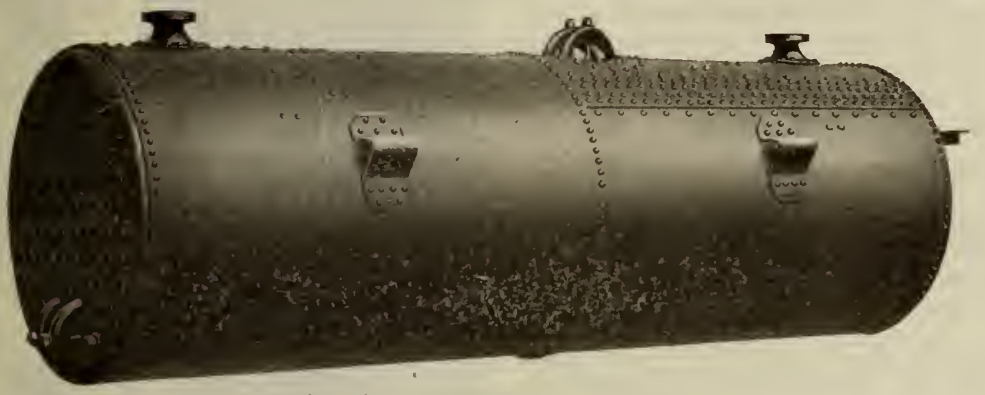

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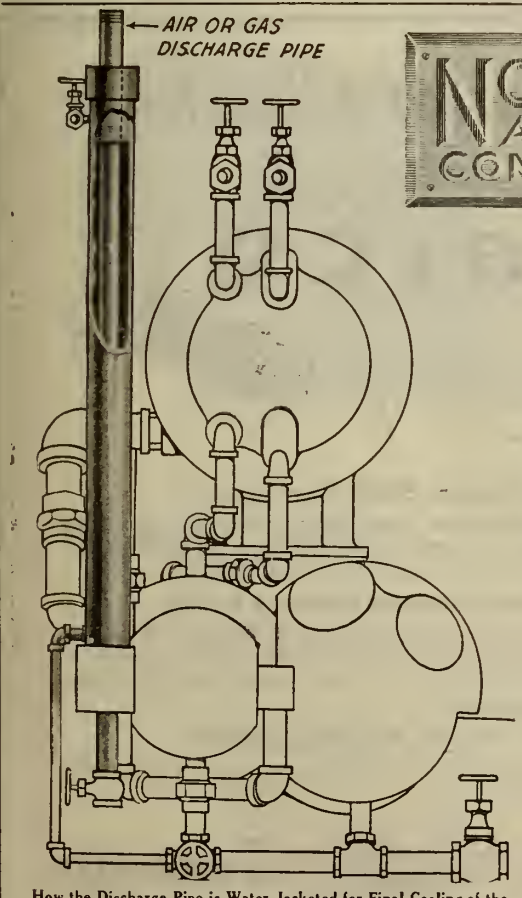

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Design and Construction — Article No. 1

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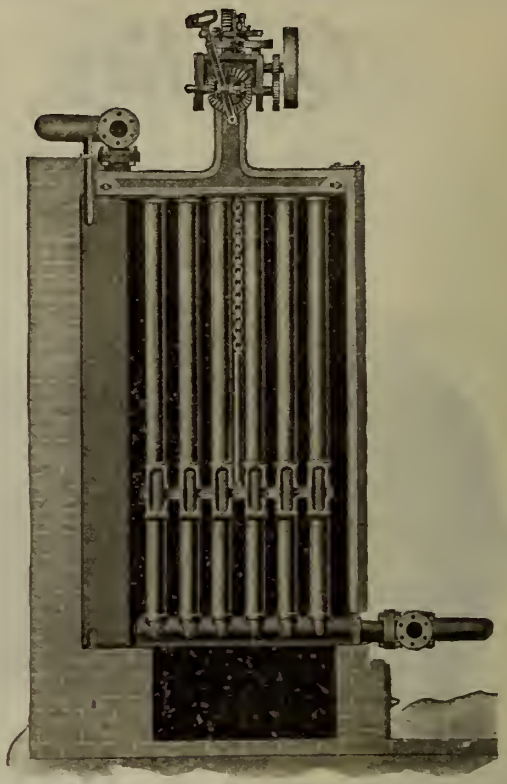
consist of a series of sections, each composed of from 4 to 12 cast iron tubes varying in length from 9 to 12 feet. The tubes are fitted into top and bottom headers which are in turn connected by top and bottom branch pipes. The exterior of the tubes is easily kept clean from soot by self-aligning scrapers running slowly up and down the tubes. The economiser is usually enclosed by a brick wall on one side and sectional covers on the other.

Feed water enters through bottom branch pipe and leaves by the top branch pipe. The waste gases of combustion pass through the economiser at right angles to the sections, thereby heating the slowly circulating water in the economiser and reclaiming large quantities of heat which would otherwise be wasted.

The remainder of this series will be devoted to describing separately the design of the major parts of the economiser.



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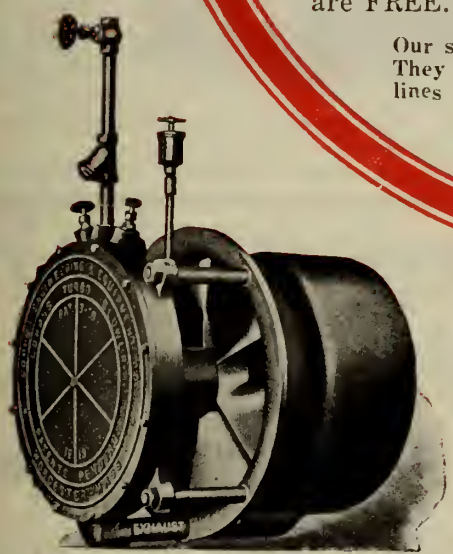

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Users should profit by their installation, regrinding the seating surfaces or replacing a part when necessary, in preference to discarding the entire device. To repair means to conserve. To conserve means to economize. To economize is to practice THRIFT.

13-18A-43

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"QUALITY"
Largest Manufacturers of High Grade Engineering Specialties in the World.
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Leather Belting
Tanned by us for belting use

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Here is a belt travelling at a speed of over a mile a minute. At more than a revolution per second, think how even little leaks would foot up a big total if this were not the proper belt for the work to be done.
All G. & K. Standardized Series Leather Belts give triple insurance against leaks because each is standardized in its manufacture and standardized for its work.

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There are no leaks where Homestead Quarter-Turn Valves are in use.

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Best for all services—air, steam, oil, water, acids, etc., and stand up under 3,000 lbs. pressure.

If you believe in economical plant operation adopt Homestead Valves.

HOMESTEAD VALVE MFG. CO.
HOMESTEAD, PA.

Starrett Hack Saw Chart

MATERIAL TO BE CUT	No. of Blade for Power Machine				No. of Blade for Hand Frame	
	Light Machine	Medium Machine	Heavy Machine	Extra Heavy Machine	All Hard	Flexible or Soft Back
Light Angles, Channels, Tee Iron, Ornamental	115					252
Heavy Angles, Channels, Tee Iron	115-B					250
Light Structural	115-B					250-B
Heavy Structural	114					250-B
Steel and Iron Pipe, Conduit and Brass Pipe	115					252
Solid Stock, Cold Rolled, Machine Steel	114					250, 250-B
Tool Steel, Cast Iron	114					
Brass	115					
Sheet Metal and Tubing, Less than 18 gage, Over 18 gage						258, 252

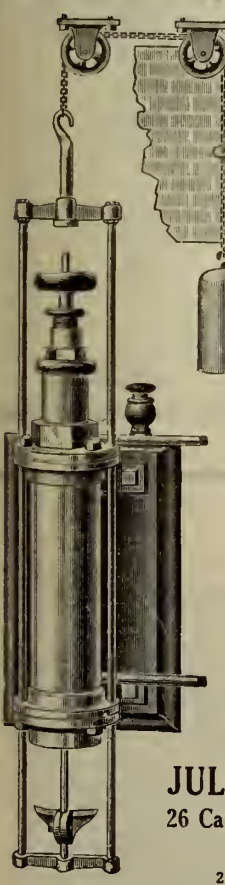
Numbers above are those given in the S... Get the Starrett...

The Right Way

Follow the chart. There's never any question then about what blade will do that job of cutting easiest, quickest — and cheapest. And remember this — uniformity is one of the strongest points of Starrett blades. Send for Catalog No. 21 "CD" and Chart "CD".

42-960

THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1918 catalog showing the Curtis line of Engineering Supplies.

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Agencies:
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"See How That Thimble Locks Tight In The Side Bar"

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Lugs in the steel side bars are locked tight to notches in both ends of the bushings confining all wear to the bushings which are readily renewable.

The two hardened steel bushings are assembled one within the other. The outer one is fixed to the inside bars and serves as a bearing for the chain roller. The inner bushing is fixed to the outside bar, and acts as a chain pin and receives the carrier cross rods.

Write for Catalog No.210-4 describing in detail all the strong points of the Jeffrey Improved Carrier. Send for copy.

THE
Jeffrey Mfg. Co.

Canadian Branch and Warerooms

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CANADA

Handle it Mechanically

MECHANICAL REFRIGERATION

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If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

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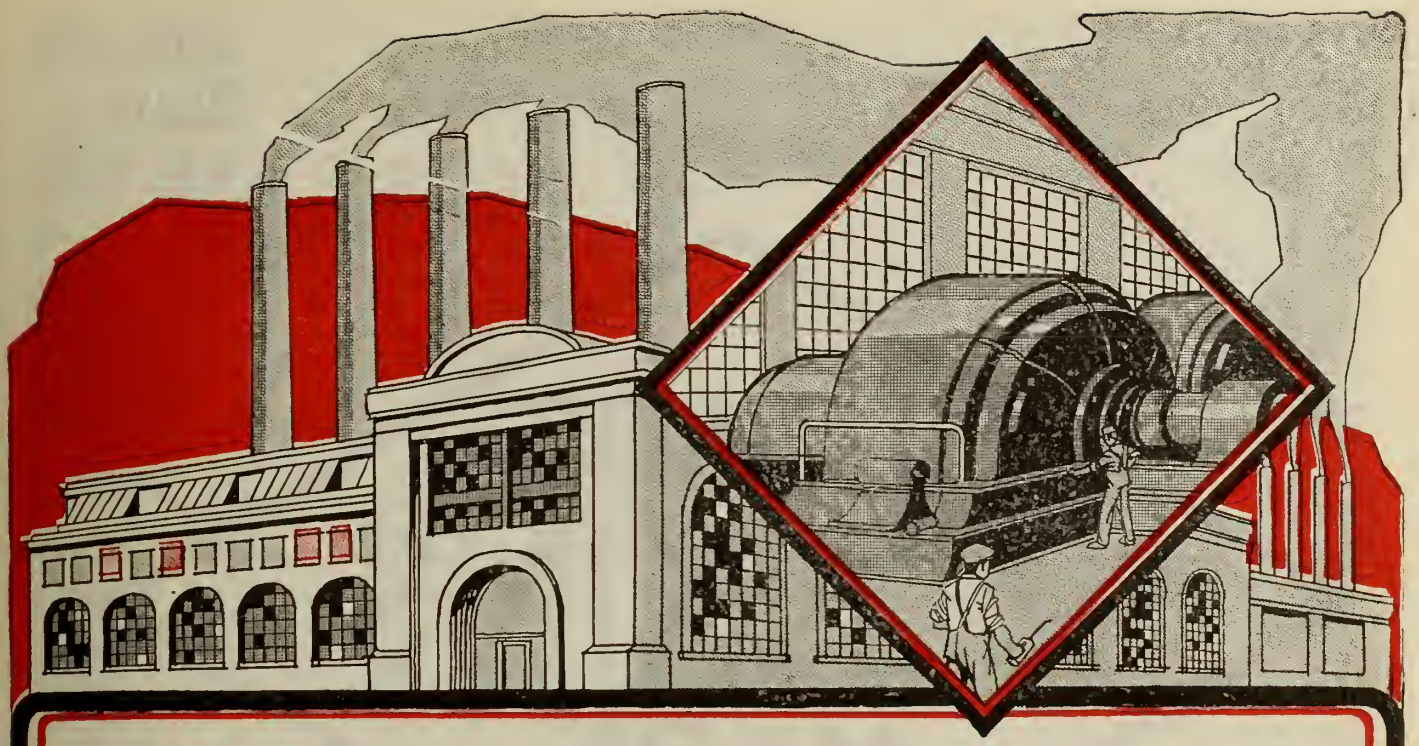

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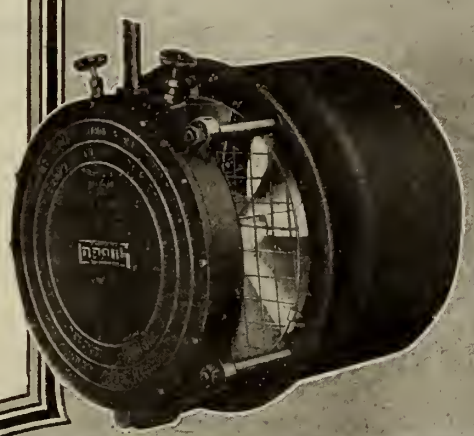

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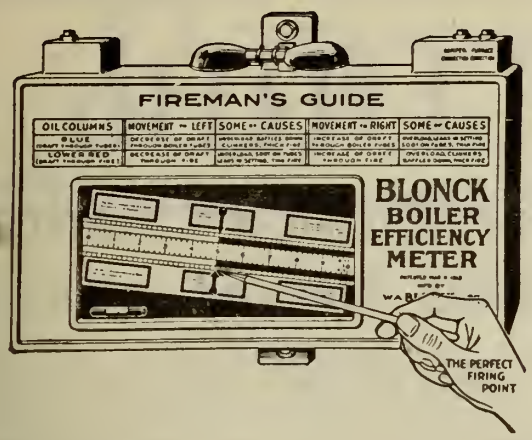

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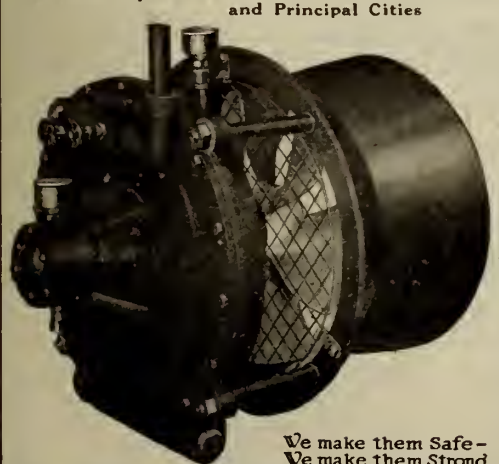

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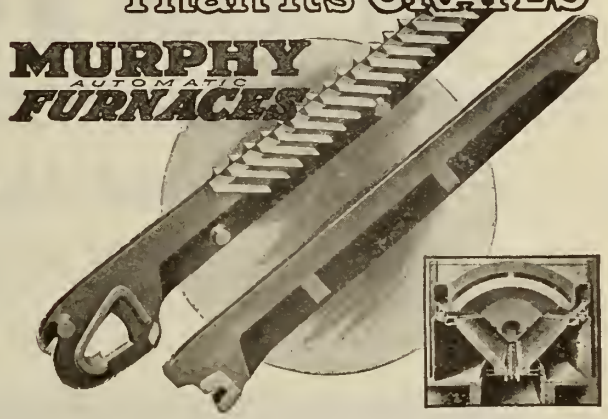

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POWER HOUSE

Established 1907 — Published Semi-monthly

Construction of The Ljungstrom Steam Turbine

This Turbine is Unique in Its Design, Permitting as It Does of a Radial Flow of Steam Through the Blades From the Shaft Outwards

THE accompanying illustrations and drawings show the Ljungstroms Angturbine of Finspong, Sweden. This Swedish steam turbine of the reaction type suffers from certain drawbacks, some of which are shared by impulse machines and others are peculiar to itself.

It is stated that to get high efficiency at practical blade speed involves a very large number of blade rows, and consequently a long and expensive rotor. With a high or rapidly varying superheat, there is always a risk of distortion of the casing, which may result in the stripping of the blades, while the necessary normal temperature gradient down the casing combined with the effect of heavy joint flange and equalizing pipes also brings expansion troubles and the necessity of providing for ample clearances. This limits the possibility of economically utilizing high pressure and high superheated steam. This has led to the adoption in certain cases of a combination of reciprocating engines and turbines which would otherwise be unnecessary.

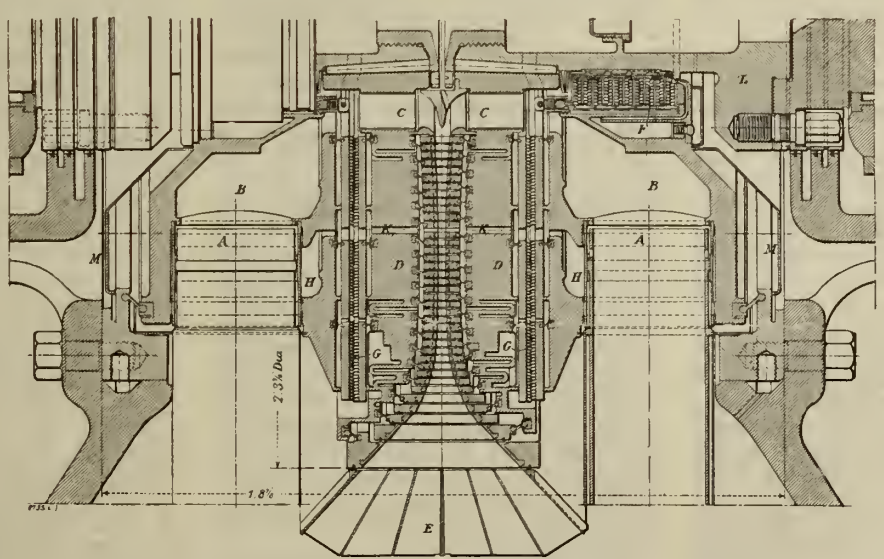
Mr. Birger Ljungstrom, a Swedish engineer at Stockholm, designed this reaction turbine in which certain drawbacks to the usual type are avoided. He was assisted by his brother, Mr. Frederick Ljungstrom, producing a machine of an undoubtedly remarkable character. The Ljungstrom turbine is a radial flow reaction turbine, the steam being admitted between two discs, and in its passage from their centre to their circumference passing between concentric blading rings, carried alternately by the two discs. In the usual design both of the discs revolve, driving their shafts at equal speeds, but in opposite directions, and to each shaft is coupled an electric generator.

The relative speeds of each set of blades is thus twice as great as in a standard reaction turbine of equal revolutions and diameter, and thus for equal efficiency the total number of blade rows is only one-quarter as great. Moreover, as there is no split cast-iron carrying blades or dummy packings the whole of these parts being mounted on the solid circular discs, the fear of distortion troubles is completely eliminated. The inventor has made provision for the highest superheat it is practicable to use, and disc design provides a very small turbine for the power developed, and although two generators are required, the overall size of the complete unit is materially less than that of an ordinary reaction turbo-generator of corresponding power.

At Liljeholmen, Sweden, the first turbine was built, which was so promising that a machine of practically identical design, but of 1,000 k.w. capacity, and complete with electric generators, thoroughly tested and constructed, and gave excellent results. The 800 kw. steam turbine is in the centre, with an alternator on each side of it, and at the end of one of the alternator shafts is mounted a small exciter for the fields of both machines. The lower half of the turbine casing is formed into an exhaust branch, which is bolted direct to the condenser heat, without the intervention of any expansion joint or similar device.

The exhaust branch is the only rigid support the turbo generator possesses, so that the latter is as free as possible from any strain due to its attachments. There are springs contained in cast iron boxes beneath each generator which support the weight of these and prevent strains due to their overhang. It is intended to carry everything on the condenser alone, so that no foundations whatever are required except those for the condenser and auxiliary machinery. This, of course, is great practical convenience, apart altogether from the elimination of strains in the turbo generator.

There are two hand wheels on the upper part of the turbine casing, which admit extra steam from overloads, and allow for hand adjustment of operation under the feet of each generator are the spring boxes, while outside these again are the rectangular air ducts for the generators, descending through the floor. The air enters by these ducts, and, after traversing the generators, escapes through the orifices on top of the turbine casings. Each generator has its independent air service and its own tachometer. The rectangular box underneath the exciter contains the oil pump and cooler, and the governor is between the exciter and tachometer dial. There is the shield of the end alternator, and attached to the bearing a steel cable, traversing the outside of the exhaust branch



CROSS-SECTION THROUGH LJUNGSTROM STEAM TURBINE.

in a sloping direction, and this cable is under tension, holding shut an oil relief valve in the relay actuating the stop-valve. The cable can be released either automatically by the melting of a very fusible metal plug in any of the bearings, or at will by a small lever at the stop valve.

In case it should break, get loose, or be released by the overheating of any bearing, the turbine is automatically shut down and there is an excess speed safety device on each alternator shaft, which also acts by releasing the cable and thus relieving the oil pressure. The 1,000 kw. steam turbine operates at 3,000 revolutions per minute and has an overall length of not more than 17 ft., 4 11-16 in., the greatest diameter being side discs fit in turned seatings in the of the governor only about 5 ft., 6 in.

The turbine is surrounded by exhaust space and there is no need for lagging of any kind upon the surface of the casing, which never exceeds the condenser temperature, and this not only minimizes radiation losses and permits of ready access to the bolts, but conduces to a pleasant temperature in the neighborhood of the machine.

The steam, after leaving the stop valve, enters the casing by a pipe passing through the side of the exhaust branch, where it branches off and ascends to the turbine by means of two vertical pipes, which are of steel. Radiation from them is minimized by jackets of thin steel, enclosing an air space, and the branched pipe is made by welding, the jackets being also welded on.

It will be noted that they are turned down on the outside, leaving a shallow collar about ½ in. wide near the end, this collar being a tight fit into a thin steel brush firmly fixed into the cast steel side discs of the turbine. These side discs fit in turned seatings in the casing, and serve to locate the turbine. When the turbine is removed it is lifted off the ends of the branch pipes.

Except around the collar there is no contact between the pipe and the bush, but steam freely circulates between them. The steam from each pipe enters an annular chamber in the side discs, whence it passes by means of a number of large holes to the space between the turbine discs. The opposing faces between the turbine discs carry rings of blading, supported from the discs by means of conical rings of bull-headed section.

When the steam leaves the last blade-ring it enters a diffuser comprising a number of diverging channels in which the residual steam velocity is re-converted into pressure, and the vacuum at the blade edges thus lightly increased above that maintained in the condenser. It is of interest to note that this diffuser is built up of sheet steel by welding, and is mounted on suitable supports in the turbine casing, and it comes away with the turbine when the latter is removed. In such a turbine steam packings have to be provided both to prevent the steam escaping along the shafts where the latter pass through the side discs and also to prevent it escaping freely up the back of the running discs, and thus uselessly into the condenser.

This packing has to fulfil another function constituting a balancing device to neutralize the pressure of the working steam, tending to force the discs apart. When the turbine is required to take an overload steam is admitted to the annular chambers, by means of either or both of the overload valves on the casing, which allows it to pass through the turbine discs.

Each turbine shaft is hollow and carries the running part of the packing and the turbine discs. The packing is mounted on solid feathers, and held in position against a collar by the turbine disc between which and the packing are two concave spring washers. The disc is keyed to the shaft by a number of taper pins, and is held from coming off by a flanged spigot screwed into the end of the shaft. The turbine shafts themselves have no bearings, but are registered and fastened with set screws each to its own generator shaft, the bearings belonging to the latter. There is, however, very little overhang as each turbine shaft is only about 10½ feet long.

The weight of the two running discs, complete with blading, being only 265 lbs. and 303 lbs. respectively, no difficulty is experienced in securing true running. It is of interest to note the small dimensions of the turbine, namely 27¾ in. diameter by 20⅞ in. long. Extreme care has been taken at every point to minimize heat losses and to avoid possible trouble from the very high superheats for which the turbine is designed.

It may be mentioned that the only external parts of the turbine which are heated by live steam are the small surfaces of the side discs and these are lagged and cased with sheet metal. Every part is circular and without flanges or horizontal joints. The packings, dummies, turbine discs and blading system are all of nickel steel, and wherever there is either a gradual or an abrupt temperature gradient steps are taken to provide against distortion. This is particularly noticeable in the formation of the turbine discs, which are nearly cut through in places by deep annular grooves, to avoid the distortion which would inevitably otherwise occur in thick discs highly heated at the centre and comparatively cool at the circumference, against distortion, there is a system of conical rings forming a connection between parts which are liable to be momentarily or permanently of different temperature and the side discs, which are hot, are held to their supporting rings, which are cold, by this device. The two sets of the dummy discs are similarly supported, one to a facing on its side disc and the other to the back of its turbine disc.

Every individual blade-ring is fixed to one or other of the turbine discs by the same method of attachment. How these rings are made and fixed will be described in conjunction with the blading.

The blading of the Liungstrom turbine consists of a number of concentric blade rings carried alternately by the two turbine discs. It will be seen that in the 1,000 kw. turbine there are altogether thirty-eight rings, the blades being of the Parsons pattern. From the centre the first 33 rows are 5 mm. wide, the next 2 are 7 mm. wide, and the last 2 12 mm. and 20 mm. wide respectively. The blading is first made in lengths of about 3 ft., being milled from the solid round bar of nickel steel. This is done on an ordinary horizontal milling machine, having four formed cutters mounted on its spindle. The first cutter roughs out the convex side of the blade, the next finishes this side, and the third and fourth respectively rough out and finish the hollow side, while the blade strip is extremely well finished when it leaves the machine. Still it is polished to a mirror-like surface, both inside and out, before it is built into the rings. Polishing is effected by the use of a simple machine using a tape band about 2½ in. wide, treated with polishing paste.

The discs, which are of soft iron, are mounted on a mandrel and their edges turned, inside and out, to the proper contour, and they are then dismounted and punched to receive the ends of the blading, a second punching process nicking the inner faces of the discs in such a way as to form registers for holding the blades to the exact angle. When the punching is done, the discs are reassembled on the mandrel with the blades in proper position. The mandrel is then held vertically and the rim of the disc and projecting blade roots are welded up solid together by melting iron wire into the groove by the aid of an oxy-acetylene blow lamp. Both ends of the blades having been welded into the discs by this process, which is neither difficult nor particularly slow, the mandrel is again put in the lathe and the discs and welded part are turned down and the ring parted.

The ring then consists of band blades with homogeneous root rings at each end, the latter having a small and slightly dovetailed mate register formed on the outer faces of the proportions. The very small pitch of the blades, as compared with standard practice, is also noticeable, the pitch sometimes being less than ⅛ in. The discs on the mandrel are ready to have their edges again turned to form rings of smaller diameter. Strengthening rings are next to be fixed to each end of the blade ring. These strengthening rings are made of spring steel containing 6 per cent. of carbon.

The strengthening ring is first formed on the circumference of a disc, and before it is parted off its side faces are machined. While the disc is still in the lathe the dovetail on the blade ring is entered into the groove on the face of the strengthening ring, and the edges of the latter squeezed in, so as to grip the dovetail tightly. To effect this, a simple device, consisting essentially of a pair of hinged arms, having rollers at their ends, is carried by the tool rest of the lathe. The arms embrace the ring and the rollers are brought towards each other to bear against the inside and outside of the dovetail joint by means of a screw.

When the lathe is started and pressure maintained on the rollers, the edges of the groove are rapidly and firmly closed upon the dovetail and to all intents. The outboard strengthening ring is the first to be formed, and when the blade ring is secured to it the composite ring is then parted off. The other strengthening ring is then formed, and after having the composite ring inserted and fixed, this also is parted from its disc.

There is then completed a blade ring but for the fine radial fins on the exterior circumference which are provided for afterwards. The conical, double bulb-headed ring connecting the blade ring to the turbine disc is turned from the edge of a steel disc, but before it is parted off the blade ring is closed on to it by rollers in the manner already described, and the rectangular steel seating ring, which is caulked into a recess in the turbine disc, is also closed on to it in the same way.

The conical ring is then severed from its parent disc. The complete element, consisting of blades, strengthening ring, conical ring and seating ring is then lightly chucked in the lathe and a groove is turned round the outside of each of the strengthening rings.

Into each groove a U-shaped section of extremely thin nickel is inserted and secured by a piece of wire rolled into it. A finishing cut over the nickel fins and on the internal points opposite the corresponding fins of the next smaller blade ring completes the process. The seating ring is fixed into its recess in the turbine disc by means of a piece of iron wire caulked in on one side of it. The ends of this wire are left slightly turned up, so that they can be gripped by a pair of pliers in case it is necessary to extract the ring.

The rings are turned out of solid steel and are designed to expand freely in all directions without distortion. They are mounted on feathers, the fixed ones in the side disc. There are no less than 158 constructions for the steam, although the packing occupies less than 3¼ in. of the shaft. The circumferential labyrinth walls of the rings are turned with thin edges. These edges are then rolled inwards, thus forming minute internal conical flanges. When first made these flanges exactly fit the walls of the next rings, which they embrace, but a few minutes running suffices to wear a minute working clearance, which is maintained unaltered afterwards.

Actual tests showed the leakage steam from both packings of the 1,000 kw. machine amounted to only about 110 lb. per hr. What steam does pass does not find its way into the generator or the engine room, but is led into a chamber, in the side discs, around the packing, whence it is taken to a feed water heater or elsewhere by a special pipe. Not only the shaft-packing but also all other labyrinth packings in the turbine, adjust their own clearances in the same way. On account of the thinness of the fins no dangerous heating occurs in case of contact, even should the running parts shift out of centre. At the same time such an occurrence as this is very carefully guarded against by the self-contained arrangement of the whole plant, its great stiffness and its symmetric form affording temperature differences the least possible chance of altering the central position to which the bearings are originally adjusted. This, together with the very rigid construction of the rotor shaft, which will later be referred to, seems to constitute the necessary conditions for the maintenance of small clearance and leakage in prolonged use and continued safe running of the plant.

The clearances of the labyrinth edges at different radii of the 1,000 kw. turbine from the shaft packing outwards

TURBINE DISC AND BLADE RINGS FOR 1,000 KW TURBINE.

to the larger blade rings, are easily maintained at .004 in. to .010 in., even with the high superheat used. The high pressure being confined to the inner parts, which are of small radius, the leakage as calculated comes out very moderate, even when using steam of very high superheat, as already demonstrated, but also very high pressures.

To start the turbine the handle at the top is screwed back a few turns, and the steam then raises the disc valve from its seat, and equalizes the pressure above and below it. The double heat piston valve above is a sufficiently easy fit in its sleeve to permit of a small amount of leakage past it, and this is quite sufficient to warm up the small mass of the pump in the oil box as the end of the turbine is then worked by hand for a few strokes until the oil pressure is sufficient to raise the piston on the valve spindle against the downward pressure of its spring.

The turbine then starts, and within about ten minutes from the commencement of warming up is running at its full speed of 3,000 revolutions per minute. When starting there is, of course, no reason why the two sides of the turbine should drive their respective alternators at precisely the same speed and, as a matter of fact, they do not do so. But when the speed rises to about 1,400 revolutions the exciting current becomes strong enough to cause the two generators automatically to synchronize themselves and thenceforward to run electrically as one machine. The automatic synchronization can be easily seen by watching the behaviour of the switchboard instruments. The fields of the two machines are connected in series, so that a single field rheostat only is needed, and in ordinary practice no more switches or instruments would be required than are necessary for the control of an ordinary generator.

In case either of the generators become disabled, provision is made for bolting it rigidly to the casing, so that, if necessary, the other generator alone may be used. The result would be a reduction of output by one half, and higher steam consumption per unit, but the frequency and voltage being normal the supply could be maintained in emergency.

There is an arrangement of the emergency trip lever and the valve connected to it which releases the oil pressure and causes the main valve to be closed. The tension cable, already described as causing the stoppage of the turbine if it is slackened by any cause, such as too high speed or unduly heated bearings, passes through the small hole in the toe of the emergency lever. By turning down this lever into a horizontal position the oil pressure is released and the turbine stopped.

This method of stopping can be used whenever desired, as it obviously interferes in no way with the adjustment of the cable. Another point worthy of note is the attachment of the pipe leading from the stop valve to the turbine. This is formed by oxy-acetylene welding, and is designed to prevent expansion troubles from the high superheat, amounting to nearly 300 degrees F., which is normally used. The simple circular form of the valves and casing is maintained with the same object.

For regulation the governor is driven by means of a worm on the generator shaft and has no special features. It controls the stop valve by means of an oil relay. The bearings are short for their diameter and consist of cast iron steps, turned cylindrically on the outside and lined with sheet metal. The two halves are registered by two long pins fitting in holes drilled along the sides of the joint when the halves are clamped together. The set screws holding the half steps together prevent the pins from working out endways. The pair of steps is located centrally by four pads fastened on to the spherical heads of screws which project through the housing, and form a means of adjustment for the position of the shaft.

The bearing caps are secured by taper fitting bolts, with a nut at each end. This type of bolt is used throughout the

turbine, all the casing bolts being thus made. It is claimed that they are very cheaply made and fitted, and when in position they serve to locate the parts they hold together with absolute accuracy. They are easily withdrawn by tightening one of the nuts. The oil supply is led to the bearings by a pipe entering the bottom step. This pipe is placed inside the discharge pipe from the bearing.

The incoming oil passes through holes machined in the bottom step and emerges at the horizontal diameter at one end, whence it flows to the other end along clearances provided for the purpose in the top step. The spent oil returns to the pump from the bottom of the bearing by the outer of the two concentric pipes shown. There is no water cooling of the bearings, the oil alone being relied on to carry away the heat. The circulation of oil amounts to a pint per second for each bearing. The oil pump is of the gear type and is driven directly by the governor spindle.

The oil pump maintains a pressure of about 34 lbs. per sq. in., but this is lowered to about 15 lb. per square in. for the bearings by the use of a reducing valve. The higher pressure is maintained beneath the piston controlling the throttle valve, this pressure being regulated by a slide valve operated by the governor. Variations of oil pressure thus vary the position of the throttle valve, and this. in turn, by means of a floating lever and side shaft, reacts upon the oil system, so as to maintain a onstant relationship between the position of the stop valve and that of the governor.

The force available for keeping the throttle valve closed is about 360 lb., but the spring tension in its working position is double this amount, so that should the emergency device or other cause release the oil pressure a force of about 720 lbs. is applied to the closing of the throttle. A fan maintains an air pressure of 6 in. water gauge in the end of the alternator casing, and thus a tremendous blast is created axially through the machine. The air escapes through orifices in the casing. above the top of the inner generator bearings, and notwithstanding the blast, the machine runs in a way that compares exceedingly well, as to silence, with any ordinary turbo generator.

During the construction of both 500 kw. and the 1,000 kw. machines all work was carried out on a purely manufacturing basis, and exact labor, material and management costs have been kept concerning every important detail. The cost-keeping system was in fact, better than in many manufacturing works, and altogether unusual in connection with work of a preliminary and somewhat experimental nature. From estimates formed on this basis, engineer Ljungstrom says that his turbine is extremely cheap to build.

The inventor says, "that the economy already attained with the Ljungstrom turbo generator for stationary purposes has been sufficiently noteworthy. For marine propulsion, however, the prospects are, I consider, still more favorable with respect to size, cost and efficiency since the voltage need not necessarily be kept constant under various loads. Consequently the stator windings may be calculated for delivering about 70 or 80 per cent. more current than is usual with the same size of the generator, with but a comparatively very small increase in the total losses and with a corresponding increase in effectiveness."

If the electric motors be dimensioned carefully, and for a high peripheral speed, the overall efficiency of the electric transmission turns out to be very high, and exhaustive calculations show that under favorable conditions 90 to 92 per cent. is obtainable. The thermo dynamical efficiency of the turbine, based on results already attained with a 1,000 kw. set, and giving due consideration for later improvements and the larger power, should, for 4,500 kw. at 3,000 revolutions per minute, I consider, reach about 85 per cent.

For a turbo generator and condenser of 4,500 kw. capacity with generators of special design for ship propulsion, the main dimensions are length, 23 ft., 7 in. (7189 mm.) width, 6 ft., 7 in., (2010 mm.) height, including condenser, 14 ft., 6 in., (4420 mm.) The weight of the turbo generator alone is about 34 tons, and the total for the whole plant with pump and water in the condenser, is 65 tons, or 11.5 lb. and 22 lb. per brake horse power respectively. On the exterior the turbo generator is kept at the temperature of the condenser. which has special advantages, particularly in tropical climates.

The weight and size of the electric motors vary considerably with the periodicity, peripheral speed and the proportion of diameter to length. With 50 periods in certain cases, the weight cannot be reduced to less than 38 lbs. (17.25kg.) per brake horse power, whereas in a destroyer, with 100 periods and with the rotors running at 400 to 500 revolutions per minute in a light framing of steel casting or autogeneously welded plating. the weight is about 9 lb. to 10 lb. (4.08 kg. to 4.54 kg.) per brake horse power.

In this case the turbo generators. without condensing machinery, and running at 6,000 revolutions per minute will show about the same weight per brake horse power. With synchronous electric motors on the propeller shafts, manoeuvring does not involve any difficulties, two or three motors may be built together in one casing, and by coupling them in cascade the shaft is caused to run at one half or one third of its normal speed. Other speeds are obtained by slowing down the turbines. On reversing resistances should be switched into the rotor circuits. If these resistances are made adjustable and of ample dimensions, they also may be used exclusively for varying the speed of the motors, thus doing away with the necessity for cascade coupling, or variation in turbine speed.

NEW LABORATORIES OF THE BUREAU OF MINES

Mechanical engineers and others who are interested in the problem of obtaining greater efficiency in the burning of coal, especially since the increase in the price of coal has made the problem even more urgent than ever before, will attend the dedication of the new million-dollar laboratories of the Bureau of Mines, Department of the Interior, in Pittsburgh, Pa., September 29th, 30 and October 1.

The fuel investigations of the Bureau of Mines constitute a large and important part of the work of the Bureau and ample recognition of this fact will be seen in the arrangements of the new laboratories and their equipment for the highest grade of research and routine work. It is here that typical coal, gathered from all parts of the country are analyzed and tabulated in such a manner as to give to the public general information of the coal fields of the country. It is also here that the actual experiments in the combustion of coal take place under experts, and their findings are given publication.

So far has this work advanced that the National Fuel Administration, organized during the war to urge the greatest conservation of fuel as a means of helping to win the war, builded on the work of the bureau of Mines and distributed to the public a large number of the publications of the Bureau, and also called on the bureau in an advisory capacity in many cases.

The Bureau of Mines has been the pioneer in the combustion experiments in the United States, and has already issued a number of reports that are well known to engineers and firemen. It is expected that engineers and men familiar with combustion experiments will attend the dedication showing their interest in Government research in this fundamental field.

The dedication ceremonies promise to bring to Pittsburgh for the three days the most prominent mechanical engineers and mining and metallurgical men of the nation.

A hardening solution for concrete floors that prevents dusting, says "Concrete" is made from sulphate of alumina and acidulated water. To 10 gallons of cold water add 1 fluid ounce of sulphuric acid. Heat the liquid to boiling point and stir in 25 lb. of sulphate of alumina, then let the solution cool and strain. The concrete surface to be treated must first be swept and thoroughly washed. After drying, the hardener is put on in four applications of varying strength, ranging from 30 per cent. solution and 70 per cent. water, up to 100 per cent. solution. The above quantity suffices for the complete treatment of an area of from 50 square yards to 100 square yards. depending upon the porosity of the surface treated.

Power Plant Management—Lubrication

The Following Article Gives Some Interesting Data Relative to Lubrication Problems Encountered in the Power Plant

By ROBERT JUNE, Mechanical Engineer

OF vital importance to the economical operation of the power plant is an accurate knowledge on the part of power plant operators and engineers of lubricants and lubrication. This is true, because even in a plant where the lubricants for each particular service are the ones best adapted to that service, losses of power, caused by friction, may range from 5 to 30 per cent.

With improper lubricants, the losses, due to friction may run much higher, and to these losses may be added the losses due to depreciation of equipment, caused by wear on bearings, guides, cylinders, etc.

As a general proposition, losses due to friction will be found to vary from 8 per cent., in central stations where energy is simply produced, but not utilized, to 25 per cent.; in plants where manufacturing processes are carried on, such as textile, refrigeration, iron and steel, brick and clay, paper, etc. Reducing this power loss friction by 1-10 will generally pay for all lubricants in the course of a year. Hence we are concerned, not with the proposition of saving oil, but with the problem of saving power, for by saving power we may be enabled to save the cost of our lubricants several times over each year.

This is an aspect of the problem of lubrication that is, unfortunately, not generally sufficiently appreciated by the plant manager and superintendent, or by the operating engineer.

The latter know that they get better results with certain lubricants than others, but the value of these results in dollars and cents is almost never placed before them, so that they can vividly realize their importance.

Friction and Lubrication

The function of a lubricant is to reduce friction, which may be defined as the resistance or binding action produced when one body is drawn over another. Friction will vary with the character of the materials, the smoothness of the surfaces, and the pressure exerted to force them together.

Figure I illustrates the conditions existing when bodies of different degrees of smoothness are drawn over each other. It is evident that as the roughness of the surface increases there is a greater tendency for the projections to lock together, and that greater force will be required to draw the bodies with rougher surfaces over each other than to draw those with smoother surfaces.

This clearly illustrates the importance of giving bearings, guides, and cylinders the smoothest possible finish. Unfortunately, we can never obtain complete smoothness of surface with any metal, and must, therefore, content ourselves with obtaining the smoothest surface possible with the particular materials employed.

The purpose of lubrication is to interpose a film of oil between the surfaces, thus forcing them apart so that the actual contact of metal with metal is avoided, and we have only to deal with the fluid friction of the lubricant.

The expression, "fluid friction of the lubricant," may be taken as referring to the resistance of the oil to the force tending to pull its particles apart. This can best be understood by referring to Figure II, wherein an attempt has been made to show the condition of the lubricant in a bearing in action. It will be seen that the oil which is in closest contact with the shaft moves at a much faster rate than that which is in closest contact with the bearing. In other words, we have what may be termed a number

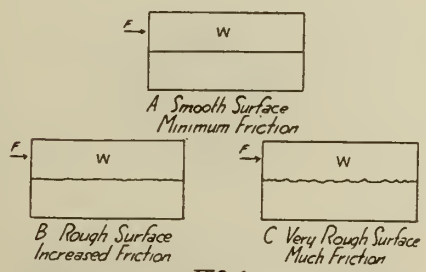


FIG. 1.

of layers of oil between the shaft and the bearing, each moving at a progressively faster rate, depending upon its proximity to the shaft.

It is this condition of fluid friction set up in the oil which makes our choice of a proper lubricant extremely important. The reason for this is that operating conditions vary widely, depending upon the pressure tending to force the bodies together, the temperatures existing at the point at which the lubricant must be used, the speed of one moving body with relation to the other, etc. Obviously, no one lubricant can be expected to meet all conditions of service, so we must find the lubricant best adapted for each particular service.

Characteristics of a Good Lubricant

A good lubricant is that which, for the particular service under consideration, possesses the following characteristics:

1. It should prevent the surfaces from coming into contact under conditions of maximum pressure, and ability to do this is a function of viscosity, or, as it is sometimes called, "body" of the oil.
2. It should absorb and carry away heat.
3. It should have a low co-efficient of friction.
4. It should be of the lowest viscosity consistent with the work required.
5. It should be free from any tendency to oxidize.
6. Temperature of vaporization (flash point) should be high, but its freezing point low.
7. It should be free from acids.

Characteristics of Various Lubricants

Having outlined the qualifications of a good lubricant for any particular service, let us now examine the characteristics of the general lubricants available to see the services for which they are adapted. Lubricants may be divided as follows:

1. Vegetable oils.
2. Animal fats.
3. Mineral oils.
4. Solid lubricants.
5. Greases.

Examining each of these in turn, we find that they possess the following characteristics:

Vegetable Oils.—Vegetable oils consist principally of linseed, castor, rape seed, rosin, cotton seed, etc. These do not, in themselves, possess lubricating properties of any great practical value since they oxidize at comparatively low temperatures and are apt to become thick and gummy after a short use. These oils are therefore of very poor cold test, congealing at a comparatively high temperature, thus making them inconvenient for use in cold weather.

The principal use of these oils for lubricating purposes, is, therefore, confined to compounding with mineral oils for certain purposes.

Animal Fats. — Animal oils in general use, are tallow, neat's-foot oil, lard, sperm oil, wool grease, fish oils, etc. Individually, these oils possess the same objectionable features as vegetable oils. They are, therefore, seldom used in a pure state, but are, on the contrary, frequently compounded with mineral oils. The reason for this compounding, when done, is that the animal oils in general have better lubricating qualities than pure mineral oils of equal viscosity or body.

In cylinder lubrication, especially in the presence of moisture caused by steam, the addition of 2 to 5 per cent. of tallow seems to increase the lubricating effects. When used in these proportions the bad effects from the decomposition of the tallow, which may set free acids which attack the metal, and the bad effects of gumming or oxida-

tion, are not so great as to overbalance the advantage of lubrication.

Mineral Oils.—Mineral oils have many advantages as lubricants over animal or vegetable oils:

1. In their cheapness.

2. Being of non-organic origin they are of more stable chemical composition and do not tend so readily to change their condition by becoming rancid, thick or gummy, by exposure to the air, and they have no corrosive action on metals.

3. By what is known as fractional distillation, mineral oils can be separated into a great many different grades, from the lightest spindle oils to the dense, heavy cylinder oils.

4. They are of lower coal test and not so liable to spontaneous combustion as the animal fats.

5. They present wider range of lubricating properties than those derived from animal or vegetable sources—the thinnest being more fluid than sperm; and the thickest more viscous than fats and tallows.

Mineral oils may be classified as:

1. Distilled oils, which are produced by distillation from crude petroleum, and are so treated by various processes in which alkalis and acids are employed as to appear in the finished product as transparent fluids of extremely stable composition.

2. Natural oils, which are prepared crude petroleum, from which grit is suspended and tarry impurities have been removed. They are usually dark, opaque, and rich in lubricating properties.

3. Reduced oils or, as they are sometimes termed, heavy, natural oils, from which the lighter hydro-carbons have been evaporated, and from which the tarry residue has been removed by filtration.

Solid Lubricants.—Mica, soap-stone and dry graphite, are the principal solid lubricants. When used, they are mixed with grease or oils. Their principal use is to be found at points where great weights have to be carried on small areas, and is usually confined to low speeds. The co-efficient of friction of solid lubricants is high, and they are, therefore, not particularly economical. Better results can usually be secured by the use of larger bearing surfaces, but when design does not permit of this, there is a real field open for their use. Under certain conditions of speed, solid lubricants will sustain pressures under which no liquid would work.

Graphite exists in two forms—flake and amorphous. Crystalline graphite or flake graphite is dense and compact and is not easily reduced by crushing between the fingers, so that the individual particles maintain their size. "Amorphous" graphite, under pressure, continues to be reduced in size until the particles are no longer evident to the touch. Flake graphite is the better lubricant, because it has good wearing qualities and adheres to metallic surfaces with which it comes into contact. Graphite is not affected by heat. The value of flake graphite as a lubricant lies in its property of filling any irregularities that exist in a bearing surface, thus reducing the roughness of the surface and producing a better surface for lubrication with oil or grease.

Graphite is of value as a lubricant for steam engine cylinders, provided it is used in great moderation and not fed in excess. The entire value of graphite as a lubricant is lost if an excessive amount is used.

When the valve seats and cylinder walls of an engine are badly cut or scored, the addition of a little graphite, (several teaspoonfuls), mixed with the cylinder oil, will greatly aid in smoothing up the bearing surfaces.

For steam engine cylinders using superheated steam, flake graphite is of great value. It aids in filling up the irregularities of the cylinder wall surfaces, so that the cylinder oil, which is greatly reduced in viscosity by the high temperatures found in these cylinders, will have the best possible surface conditions to work on.

In order to obtain a clear idea of the value of graphite as a lubricant, the engineer must appreciate the fact that in order to be efficient, graphite must

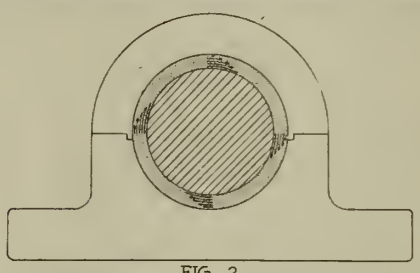


FIG 2

Illustrating the relative speeds of the various layers of oil surrounding shaft in bearing

identify itself with the metallic surfaces to be lubricated. Its function is to fill up the pores and depressions in the surfaces, giving them a smooth polished finish. Lubricating oil must then be introduced between the rubbing surfaces so as to produce a film, which will be more efficient in its results because of the reduced frictional resistance to be overcome, due to the graphited surfaces.

The specific gravity of graphite is 1.81, and, therefore, is greater than that of oil, and for this reason it will settle out of oil on standing. It is not possible to permanently suspend graphite in oil. A mixture of oil and graphite should never be put in an oil cup or sight-feed lubricator, as the graphite will soon clog the feed passages.

For engine bearings a heaping teaspoonful of graphite to a pint of oil is sufficient.

About 4 per cent. by weight of graphite is the average good practice when mixed with oils and greases, and gives good results when applied at reasonably long intervals.

Graphite should never be used on bearings supplied with forced or flooded continuous lubrication.

Lubricating Greases.—Petroleum cup greases consist of lime soaps, mineral greases, and rosin oils. Soap gives the grease melting-point and body. Nevertheless, greases are excellent lubricants when properly used, but they have, however, a very narrow range of service and they should not be called upon to perform the function of lubrication under conditions to which they are not suited.

The use of any solidified lubricant places a drag or friction load on the machine it is used upon. The chief advantage of grease as a lubricant lies in its cleanliness and in its property to "stay put." In bearings revolving at a slow speed, where it would be difficult to maintain a film of lubricant, grease may be used to advantage.

For crank-pin bearings of high-speed engines, grease will give satisfactory results. In the case of the low speed bearings mentioned above, grease is an efficient lubricant, because, due to its adhesiveness, it will maintain a layer of lubricant when the machine is at rest, and thus reduce the starting friction when the machine is placed in operation.

Testing Lubricants

While it is possible to lay out quite elaborate specifications for lubricants, covering every type of service, the fact, nevertheless, remains that these specifications are, after all, only a starting point.

After the particular lubricant has been chosen, by specification, it remains to test it out under actual working conditions, and then to try other lubricants whose general nature is such as to lead the engineer to believe that success might attend their use. Only by comparing the performance of a number of lubricants under actual working conditions can the best lubricant for the particular service under consideration be chosen. Our first step, however, is to choose our several lubricants which we expect to test out intelligently. In order to do this it may be well to review the tests and specifications used by large consumers in the purchase of lubricants.

The test of an oil consists of three parts—chemical, physical, and practical.

Chemical Tests of Lubricating Oils.—To pass the chemical tests of the Navy Department, "all oils should be neutral in reaction and should not show the presence of moisture, matter insoluble in petroleum ether (hard asphalt), matter insoluble in ether alcohol (soft asphalt), free sulphur, charring or wax-like constituents, naphthenic acids, sulphonated oils, soap resin, or tarry constituents, the presence of which indicates adulteration or lack of proper refining. Except in oil for engines without forced lubrication, no traces of fixed oils (animal or vegetable fats) should be found.

"In lubricating oil for main engines without forced lubrication, approved

fixe doils, such as rapeseed, olive, tallow, lard and neat's-foot oil, may be used, when the foregoing fixed oils are used, they must be well refined with alkalies, unadulterated, containing a minimum of free fatty acids, with no moisture or gumming constituents. Olive oil should not have a high specific gravity. If satisfactory emulsifying results can be obtained with straight mineral oils on engines without forced lubrication, they may be submitted for service test."

While the small plant owner is not usually in a position to have various tests for oil made in his plant, he can usually have them made by a commercial laboratory at a cost, which, in view of the possible savings to be effected, is well worth the time and expense involved. Large plants, of course, often possess laboratories and are in a position to make the tests themselves.

The procedure may be outlined as follows:

Moisture Test.—Wet the walls of a test tube with the oil under investigation, then put three or four cc of the oil in a tube and place in a bath of liquid paraffin which should be brought up to a degree of 300 degrees Fahr. If the oil contains water, emulsions will form on the walls, and foaming and sputtering will be noted.

Sulphur Test.—Take a small piece of metallic sodium, the size of the little finger nail, boil it in 50 cc of the oil in a test tube for 30 minutes. At the end of this time, add an equal amount of water and again place over the burner flame until the sodium is dissolved. After the sodium has disappeared pour off the water and pour in one per cent. solution of sodium nitroprusside. If the mixture turns violet color, the oil contains sulphur.

Tests for Acid Alkalies.—Pour 25 cc of oil and twice as much of distilled water into the test tube; boil for several minutes, dividing the mixture into two portions; add methylporange to determine acids, to one portion, and to the other add phenolphthalein for the determination of alkalies. The formation of emulsions in either test tube will indicate the presence of acid or alkali as the case may be. Acids cause corrosion and should be religiously avoided.

Tests for Matter Insoluble in Ether.—Place 14 cc of ether alcohol (which consists of 8 parts of ether and 6 parts of alcohol) and 11 cc of oil in the test tube—shake thoroughly for a minute or two—then allow the two to stand for twelve hours. At the end of this time if there is any precipitation at the bottom of the tube, it will be asphalt. Even a trace of asphalt makes the lubricant undesirable, since it causes scoring of journals and clogging of oil lines.

Tests for Matter Insoluble in High Grade Gasoline.—Filter several times 300 cc of 86 to 88 Baume gasoline. Place in an absolutely clean or dustpro f glass receptacle. Sprinkle 2 cc of oil into the gasoline and allow to stand for 12 hours. If there is any precipitate at the end of that time it will consist of soft asphalt or carbon particles, and even a slight trace would make the oil extremely undesirable.

Test for Tarry or Suspended Matter.—This test is carried out in the same manner as the previous one, using, however, 95 cc of gasoline and 5 cc of oil. The receptacle may be examined for precipitate at the end of half an hour.

Test to Determine Mineral or Vegetable Oils.—Take a small piece of metallic sodium and bring to a boil in 10 cc of oil. The presence of animal or vegetable oils will be indicated if the mixture becomes gelatinized or semi-solid.

Test for Presence of Undesirable Carbon or Hydro Carbon.—This test is made by simply heating a small quantity of oil in test tube to a boil, and then comparing the color of the heated oil with that of unheated. If there is any discoloration in the oil it indicates the presence of undesirable constituents.

Gumming Test.—This test indicates the extent to which the oil has been refined and will, therefore, serve as a guide to indicate the extent to which oil may be expected to oxidize or gum when in use. This test is undoubtedly of great value and it should always be made when opportunity is afforded. It consists simply of mixing a small quantity of oil in the test tube with an equal quantity of nitro sulphuric acid, and it the oil has been properly refined, no change will be noted, but if the oil has been poorly refined, the fact will become evident by the simple separation of material of dark color. This separation is the result of oxidation of tarry matter in the lubricant.

It has been found that the result obtained by the gumming tests compare almost exactly in results with what is known as the carbon residue test, which is made by distilling the oil to dryness in the test tube. This carbon residue test has been found of great assistance in choosing a satisfactory cylinder lubricant for gas engines, as the presence of carbon always and invariably means trouble in gas engine cylinders.

Tests which have just been outlined are easily within range of even the small plant operator and the writer believes that the investigation of the characteristics of the oils being used is well worth the attention of operators in both large and small plants.

This is particularly true because of the fact that the presence of undesirable matter in the oils may mean very heavy costs for repairs to equipment, and may even cause a shut-down of the plant at critical moments.

Next month we will take up physical tests of lubricating oils and will then discuss the characteristics of oils for various services.

KEEP BUSY, KID!

Beware the deadly sitting habit,
Or if you sit be like the rabbit,
Who's ever ready for the jump,
By springs concealed beneath his rump.

A little ginger 'neath the tail,
Will oft for lack of brain avail.
Eschew the warm but slothful seat,
And move about with nimble feet.

And so, my son, avoid the snare
That lurks within the easy chair.
To meet each duty quick and well
Both feet must hit the pike like ——!

The National Engineer.

THEY SPEAK OF CABBAGES AND KINGS

Topics of Discussion Are New And Change as Quickly as the Seasons

A Canadian who calls on the machinery trade in United States, submits the following:—

Some well-informed person should compile a book which would enable Canadians intending to visit the United States, to discuss with satisfactory assurance many of the ponderous questions which our being hurled at them somewhat persistently. Here are some of them.

What does Canada do with all her import duties?

What are you going to do about these exchange rates?

What do you think about Pershing?

When is Canada going wet again?

What's the labor situation, if any?

Who is the Prince going to marry?

What do you think of Woodrow, anyhow?

What about your returned soldiers?

If we didn't win it, who did?

* * *

No longer is first place given to such burning topics as: "Why do people marry Lillian Russell?" or "Who makes Queen Mary's millinery?" Canadians who get past the U. S. immigration officials find that the great American people are taking a keener interest in Canadian affairs—that is affairs that may be said to have an international bearing.

* * *

Space is Cramped.—American machinery manufacturers who visited the National Exposition at Toronto, express themselves as surprised that, considering the splendid showing by other industries, the machinery industry should be confined to such limited quarters as the present machinery hall. The display is regarded as by no means representative of Canadian enterprise. A Galt manufacturer suggests that a new building should be of sufficient size to permit of displays being grouped according to towns or cities. Galt alone, he declares, could just about fill the present structure if all firms were represented.

Air Lift Installation with Special Features

A Highly Efficient Air Lift Installation at Fort Bliss, Texas, Which Incorporates Some Novel Features of Design. Reprinted From "Compressed Air"

By CAPTAIN J. F. BROWN

CAREFUL analyses of conditions to be met and thorough study of air lifts in successful operation have made possible the design and installation of such a plant at Fort Bliss, Texas, tests of which show operating efficiencies never before attained—51.9 per cent. as the average of the better of two sets of air lift tests, and 28.66 per cent. as the corresponding over all or wire-to-water efficiency.

The footpiece, Fig. 2, consisting of a double conical bronze casting (inverted at lower end), set within and at the foot of the eduction pipe, is the special feature of design. Particular attention was also given to the proportions of the eduction pipe and to the head tanks at the top of each eduction column. Small water storage reservoirs, with sand settling compartments and measuring wires, are provided.

Water for all needs of the permanent military establishment, as well as for several bodies of troops encamped temporarily on the Fort Bliss military reservation, is supplied from four bored wells, each 600 ft. deep, and is pumped from these wells into surface reservoirs by means of compressed air. From the surface reservoirs the water is pumped directly into the distributing mains by centrifugal pumps.

These wells, two of which are 10 in. and the other two 12 in. in diameter, are cased to the full depth with standard threaded steel casing. From the normal water plane to the bottom the casings are perforated with ½ x 10 in. vertical slots, the area of opening being 10 sq. in. per foot of casing. In the 10 in. wells drilled in 1913 the slots were cut by means of air operated hammers, while in the larger wells, drilled in 1917, they were cut by an oxy-acetylene torch. The latter method proved to be much more rapid and less costly than the former.

Following are the piping details of the several wells:

Well No. 1

Diameter 10 in.
Total depth 615 ft.

Water Discharge Piping

4 in. dia. 20 ft. below foot piece.
1 ft. 4 in. length of foot piece.

Piping Above Foot Piece

4 in. dia. 100 ft. 3 in.
4½ in. dia. 160 ft. 0 in.
5 in. dia. 253 ft. 5 in.
6 ft. dia. 23 ft. 3 in.

536 ft. total distance from foot piece to separator tank above the ground.

Well No. 2

Diameter 10 in.
Total depth 615 ft.

Water Discharge Piping

4 in. dia. 20 ft. 3 in. below foot piece
1 ft. 4 in. length of foot piece.

Piping Above Foot Piece

4 in. dia. 106 ft. 1 in.
4½ in. dia. 160 ft. 4 in.
5 in. dia. 274 ft. 7 in.
6 in. dia. 11 ft. 0 in.

553 ft. 4 in. total distance from foot piece to separator tank above the ground.

Well No. 3

Diameter 12 in.
Total depth 615 ft.

Water Discharge Piping

4 in. dia. 21 ft. below foot piece.
1 ft. 4 in. length of foot piece.

Piping Above Foot Piece

4 in. dia. 146 ft 4 in.
4½ in. dia. 169 ft. 9½ in.
5 in. dia. 92 ft. 6 in.
6 in. dia. 81 ft. 5 in.
7 in. dia. 61 ft. 5½ in.

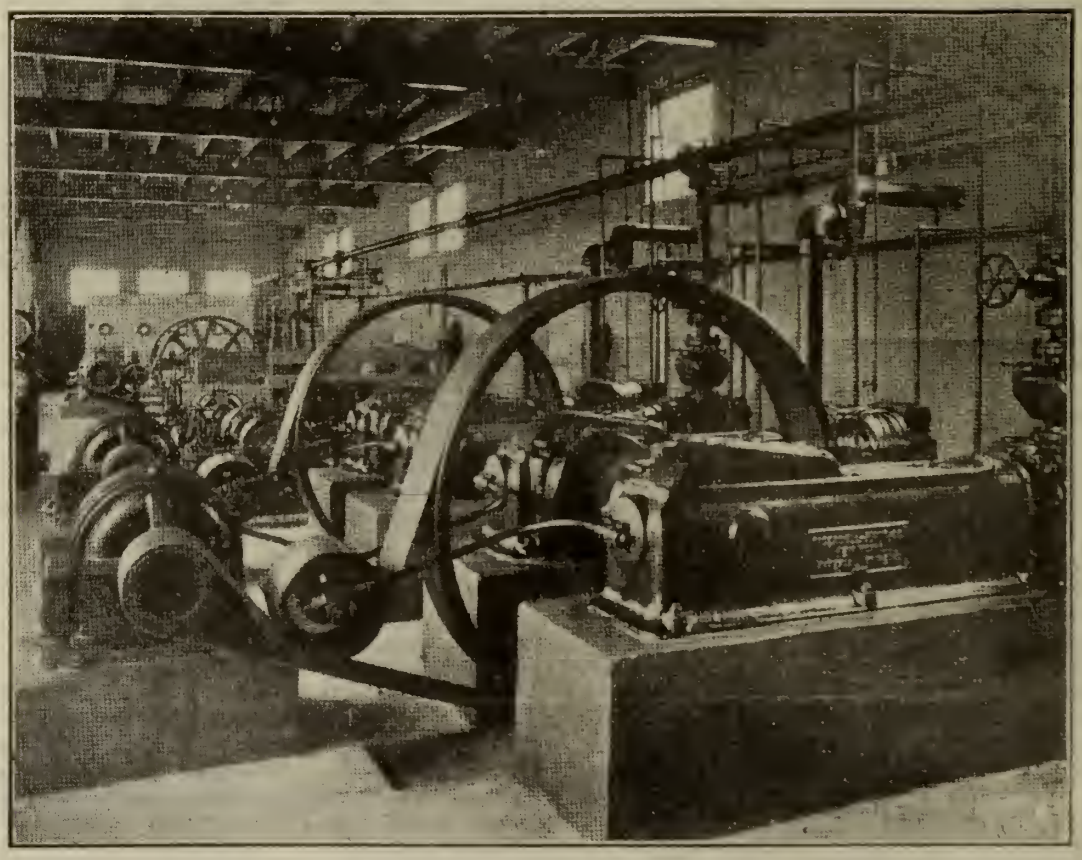


FIG. 1—POWER HOUSE WITH FOUR COMPRESSORS.

552 ft. 8 in. total distance from foot piece to separator tank above the ground.

Well No. 4

Diameter 12 in.

Total depth 615 ft.

Water Discharge Piping

4 in. dia. 20 ft. below foot piece.

1 ft. 4 in. length of foot piece.

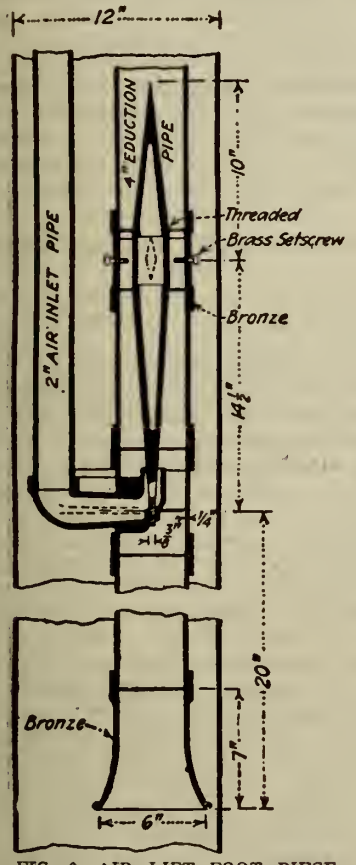


FIG. 2—AIR LIFT FOOT PIECE.

Piping Above Foot Piece

4 in. dia. 157 ft. 8 in.

4½ in. dia. 162 ft. 8½ in.

5 in. dia. 92 ft. 7 in.

6 in. dia. 104 ft. 6½ in.

7 in. dia. 40 ft. 9 in.

558 ft. total distance from foot piece to separator tank above the ground.

222 ft. depth to water level when not pumping.

234 ft. depth to water level when pumping.

135 lb. gage, air pressure, starting.

130 lb. gage, air pressure, running.

Air for operating the four wells is supplied by four Ingersoll-Rand duplex two-stage compressors, two of which are equipped with high and low-pressure cylinders 7½ in. and 14 in. dia., respectively, the other two having cylinders 7 in. and 12 in., and all having a 12 in. stroke. At the normal speed of 190 r.p.m. the two larger compressors deliver 320 cu. ft. per min. each, and the smaller 260 cu. ft. each, operating against a terminal pressure of about 150 lb.

All of the compressors discharge into a 6 in. header, at each end of which is an air receiver 3½ ft. dia. and 10 ft. long. From each receiver compressed air is distributed to two wells, the air supply line to each well being 3 in. At the well head the air line is reduced to 2 in. and extends into the well between the casing and the eduction column to a depth of approximately 540 ft., at each point it connects into a specially designed bronze foot piece.

The function of the foot piece, Fig. 2, is to facilitate the thorough mixing of the current of air and the rising column of water. This highly important feature of the installation differs radically from the well-known commercial types of foot pieces. It consists essentially of a double conical bronze casting supported concentrically within the eduction column, the apex of the lower cone extending just into the compressed air inlet. From this point the velocity of the rising column of water is increased, due to the decreased area of the section, until the throat section of the base of the cone is reached, at which point the velocities of the two currents are very nearly equal. In this portion of the foot piece there occurs the thorough mixing of air and water, the two fluids passing through the throat section in a thin sheet or film. The upper cone serves to provide a steadily increasing section, thus preventing a separation of air and water, which would be caused by the shock due to a suddenly increasing section. The eduction column was designed of such proportions that the maximum velocity of the rising column of water and air should not exceed 25 ft. per second at any point when the well was delivering at the normal rate, and increases in diameter from 4 in. at the foot piece to 7 in. at the top.

At the upper end of each eduction column is a cylindrical steel head tank, Fig. 3, 3½ ft. in diameter and 3½ ft. in depth, within which is supported, just above the end of the pipe, an umbrella-shaped cast-iron deflecting vane, whose function is to break the force of the rising column of water and air. The head tanks are closed at their tops by means of steel plates, bolted on over rubber gaskets to prevent the escape of air. From the head tanks water and air flow through 8-in. galvanized-steel pipe lines supported on angle-iron frames and concrete piers, to two covered rectangular reinforced-concrete reservoirs of 46,000 gal. capacity each. Each

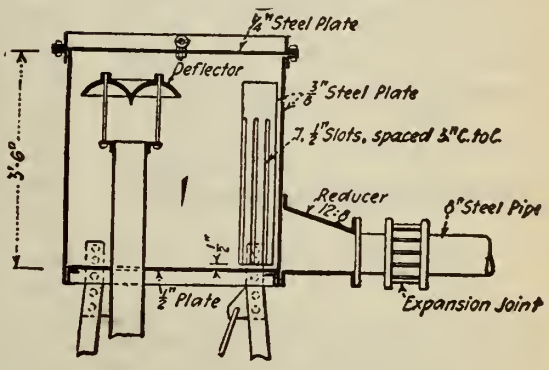


FIG. 3—AIR LIFT TANK.

reservoir contains a small settling chamber, in which the sand coming from the wells subsides, and a rectangular weir for measuring the rate of discharge from the wells. Fig. 4.

Horizontal, double-suction, single-stage, volute-type, centrifugal pumps are used for pumping the water from the surface reservoirs into the distributing mains. There are four of these pumps, each rated to discharge 600 gal. per minute against a head of 135 ft. at a speed of 1,760 r.p.m., although two of them have a discharging rate of about 1,000 gal. per minute when operating against that head.

All of the compressors and centrifugal pumps are driven by constant-speed, induction-type motors. The motors for the two larger compressors are rated at 75 h.p. each and operate at a speed of 580 r.p.m., while those for the two smaller compressors are rated at 61 h.p. each and operate at a constant speed of 1,150 r.p.m. Each centrifugal pump

Test No.	Actual Air Delivered Cu. Ft. per Minute	Water Delivered per Minute Gal.	Water Delivered per Minute Cu.Ft.	Air Pressure at Receiver Lb.	Pumping Head Ft.	Water Hp.	Air Hp. Isothermal	Input to Motors, Hp.	Efficiency % Air-Lift	Efficiency % Overall Wire-to-Water	Units Operating Compressors	Units Operating Wells
I. Input to motors from readings of watt-hour meters. Output from wells from weirs.												
2	468.5	554	74.1	133	239	33.6	68.9	130.1	48.7	25.8	3 and 4	2 and 3
3	473.9	566	75.7	133	239	34.3	69.7	127.4	49.2	26.9	3 and 4	2 and 3
6	521.4	614	82.1	132	239	35.6	76.6	153.0	46.4	23.2	2 and 4	2 and 3
7	6[illegible]5	663	88.6	130	239	40.2	90.6	159.0	44.4	25.3	1 and 2	1 and 4
8	6[illegible]6	668	89.4	131	239	40.5	90.8	157.0	44.6	25.8	1 and 2	1 and 4
9	602.5	680	91.0	132	239	41.2	88.6	161.0	46.5	25.6	1 and 2	1 and 4
11	553.5	622	83.2	132	239	37.6	81.3	145.0	46.2	25.9	2 and 3	1 and 4
12	311.3	412	55.1	132	239	24.9	45.7	75.2	54.5	33.1	2	4
25	776.1	889	118.8	135	239	53.8	114.3	204.0	47.1	26.4	2, 3 and 4	1,2 and 3
26	582.4	705	94.3	135	239	42.7	85.6	163.7	49.8	26.1	1 and 2	3 and 4
27	470.8	546	73.0	132	239	33.1	69.2	128.7	47.7	25.7	3 and 4	2 and 3
II. Input to motors from revolutions of disks of watt-hour meters. Output from wells measured volumetrically.												
28	618.3	745	99.8	131	239	45.2	90.7	159.7	49.8	28.3	1 and 2	1 and 4
30	618.0	735	98.3	133	239	44.5	90.8	159.3	49.0	27.9	1 and 2	1 and 4
32	310.0	338	45.2	130	239	20.5	45.6	78.6	45.0	26.1	1	1
34	302.4	399	53.3	131	239	24.1	44.4	79.5	54.2	30.3	1	4
36	308.2	399	53.3	132	239	24.1	45.3	81.5	53.2	29.6	2	4
38	226.4	314	42.1	133	239	19.1	33.3	63.7	57.3	29.9	3	2
40	480.4	652	87.2	133	239	39.5	70.6	128.4	57.0	30.8	3 and 4	2 and 3
42	226.4	275	36.7	133	239	16.6	33.3	63.3	49.8	29.3	4	3

SUMMARY OF AIR LIFT TESTS AT FORT BLISS

is direct-connected by means of a flexible coupling to a 40 h.p. motor, which operates at a constant speed of 1,760 r.p.m.

Upon completion of the original installation, consisting of the two larger compressors and two centrifugal pumps, a series of tests, or trial runs, was made to ascertain the efficiency of operation of the plant, particularly of that portion of the plant used for lifting water from the wells. During the past year the capacity of the plant has been practically doubled by the installation of additional compressors and pumps, and upon completion of this work a second and more comprehensive series of tests was made.

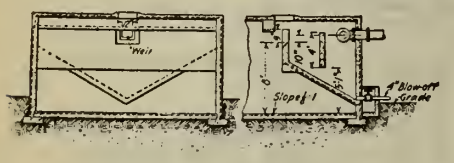


FIG. 4—RESERVOIR WITH SAND SETTLING COMPARTMENT AND WEIR.

In preparing the plans and specifications for the plant consideration was given to the desirability of making frequent operating tests of the different portions of the plant, with the result that it was determined to provide in the permanent installation such gages and meters as would be necessary in obtaining the desired data.

The series of tests, or trial runs, on the air-lift installations is divided into two sets. In the first set, the power input to the compressor motors was obtained from readings of the recording dials of the watt-hour meters on the switchboard; the speeds of the motors and compressors by means of revolution and stroke counters; the rate of delivery of compressed air to the wells from readings of the scale of the manometer of the air meter; the air pressure from gages on the air receivers and at each well head; and the rate of delivery of water from the wells from the weir gage. In the second set of tests the power input to the compressor motors was obtained by counting the number of revolutions of the rotating disks in the recording watt-hour meters, the rate of delivery of water from the wells from actual volumetric measurements by means of the surface reservoirs, and all other data as in the first set. The methods of obtaining the power input to the motors and the rate of delivery from the wells, as used in the second tests, are thought to be much more accurate than those used in previous tests, because unit rates are derived from totals for a given period of time rather than from direct observations.

Results calculated from data obtained during the tests described are given in the accompanying table. The average efficiency of the air-lift for the first set of tests was 48.1 per cent. and for the second tests, 51.9 per cent. The average overall efficiency (wire to water) for the airlift end of the plant for the first set of tests was 26.4 per cent. for the first and 28.66 per cent. for the second set of tests.

The average power requirement for lifting water from the wells to the surface reservoirs is 2.77 kw.-hr. per 1,000 gal. of water, and that for pumping the water from the surface reservoirs into the distributing system is 0.798 kw.-hr. per 1,000 gal., under average working conditions of pressure and rate of delivery. At an average cost of 1.5c per kilowatt-hour, the actual cost for power alone for delivering 1,000 gal. of water into the distributing system is 5.31c. The cost for the pumping station crew, consisting of a chief engineer and one assistant engineer and one laborer on each of three daily shifts, and also including the cost of incidental supplies, such as lubricating oil and waste, is 1.66c per 1,000 gal., making the total actual cost 7c per 1,000 gal. The actual outlay of funds for this plant is $101,767, the original installation, including the two 10-in. wells, having cost $42,700 and the addition to the plant, including the two 12-in. wells, having cost $64,067. Interest at the rate of 4 per cent. upon the cost of the installation, and depreciation of equipment at the rate of 5 per cent., are provided for by adding 2.63c per 1,000 gal., making the total cost for supplying water 9.63c per 1,000 gal., on the basis of a plant capacity of 1,000,000 gal per day. Prior to the completion of the plant, water purchased from the El Paso Water Co. to supply the needs of Fort Bliss cost 20c per 1,000 gal. At an average daily demand of 1,000,000 gal., the annual saving to the Government effected by the operation of this plant is $37,850. If the plant capacity is taken as 1,500,000 gal. per day, which is its normal working capacity, providing for the shutting down of one compressor and one well, the total cost of supplying water is 8.21c per 1,000 gal., and the annual saving to the Government is $64.550. Taking the plant capacity as 2,000,000 gal. per day, which is the ultimate capacity of the present installation, the total cost per 1,000 gal. is 6.74c, and the annual saving is $96,798.

SCIENCE BEHIND LABOR

Sir Richard Gregory, who is mainly responsible for organizing the British Scientific Products Exhibition in London, makes this claim on behalf of the national value of the man of science: "It is not generally understood how the work at British universities and other institutions for higher training is bound up with national welfare. When necessity demanded, our men of science showed that in every direction they could devise means of offence and defence superior to those of the foe against whom our armies had to contend. The way in which, during the war, the universities faced problems of an entirely novel character, and concentrated attention upon them until solutions were reached, is an earnest of what they can accomplish for industry in times of peace, and it is to be hoped that this factor of progress will continue to play an important part in national life. Great industrial developments depend upon new knowledge obtained by scientific investigation, and the exploitation of that knowledge in invention and industry. It is the business of the scientific investigator to discover new facts or principles, and of the engineer or inventor to recognize and apply the results achieved. Labor alone may build Pyramids, as it did four thousand years ago, but it cannot create new industries without new knowledge, and this is obtained by scientific research, whether secured in the laboratories of universities or of works."

BRITISH SCIENCE AND ENGINEERING

Professor J. C. McLennan, scientific adviser to the British Admiralty, recently read a paper before the North-East Coast Institution of Engineers and Shipbuilders on the application of science to marine problems. Incidentally the paper reveals the high standard which British scientific engineering reached in dealing with the special difficulties which had to be met durng the past few years. Conspicuous among the devices developed originally for anti-submarine purposes but certain to be invaluable to shipping under peace conditions is the hydrophone—an instrument which detects underwater vibrations set up by a moving vessel. Microphones and magnetophones of exceedingly high sensitiveness were employed, sometimes with attachments which enabled the listener to ascertain the direction from which the disturbance was coming. The "silent submarine" was, however, introduced to circumvent the hydrophone, and this development was countered by the "echo method" under which a beam of sound was sent out by the chasing vessel, sweeping the seas like a searchlight, and causing an echo when it strikes a solid object such as a submarine. Even more ingenious is the "leader gear," invented by the British for another purpose. If a cable laid on the bottom of the sea—say in the channel leading into a harbor—is traversed by alternating current, it is possible, by means of delicate devices installed on board ship, for the navigator to see or hear indications of the presence of such a cable. So perfect is the mechanism that a ship can proceed at 20 knots in fogs or darkness, feeling its way along the cable almost as precisely as a tramcar trolley follows the overhead wire. Professor McLennan states that "by leader gear law in such areas as the River St. Lawrence, the entrance to the Thames or Halifax Harbor, the Straits of Dover, etc., in and out lanes of traffic can be maintained with ease in fogs." The echo method can also be used for sounding, for locating icebergs, surface vessels, and rock-bound coasts in a fog. In fact, "under peace conditions many important technical systems and devices brought forward during the war will find immediate application as aids to navigation."

The Contraflo System of Utilizing Exhaust

By Means of This Arrangement All the Heat of Exhaust Steam From Engine Room Auxiliaries is Made Available and Less of the Heat in Main Engine Exhaust is Rejected

THIS system of condensing, vacuum producing, filtering, and feed heating apparatus which was primarily developed by Mr. D. B. Morrison, of Messrs. Richardson, Westgarth & Co., Hartlepool, England, a number of years ago, and has since been extended and further improved by the Contraflo Condenser and Kinetic Air Pump Syndicate, London, England, is now being manufactured in Canada under license by the Goldie & McCulloch Co., Limited, Galt, Ont.

The objects of the Contraflo system are:—

To return to the boiler by means of the feed water the entire heat in the exhaust steam from the auxiliary engines, thereby economizing coal.

To realize this thermal gain in all seas by means of a "Contraflo" condenser, which continuously maintains the highest economical vacuum with the least pumping power.

To increase the propelling power of the main engines without increasing the coal bill.

It has been established that with the "Contraflo" system of vacuum producing a higher vacuum can be obtained with smaller cooling surface than with the ordinary surface condenser, thus leading to greater power being developed in the main engine. Also by means of the steam ejector (which is part of the "Contraflo" system and is described hereafter), this higher vacuum is produced not only without cooling down the condensate (boiler feed water), as would be the case with an ordinary condenser when endeavoring to obtain higher vacuum, but the condensate is delivered to the air pump at a higher temperature than usual, thus leading to economy in the boiler room.

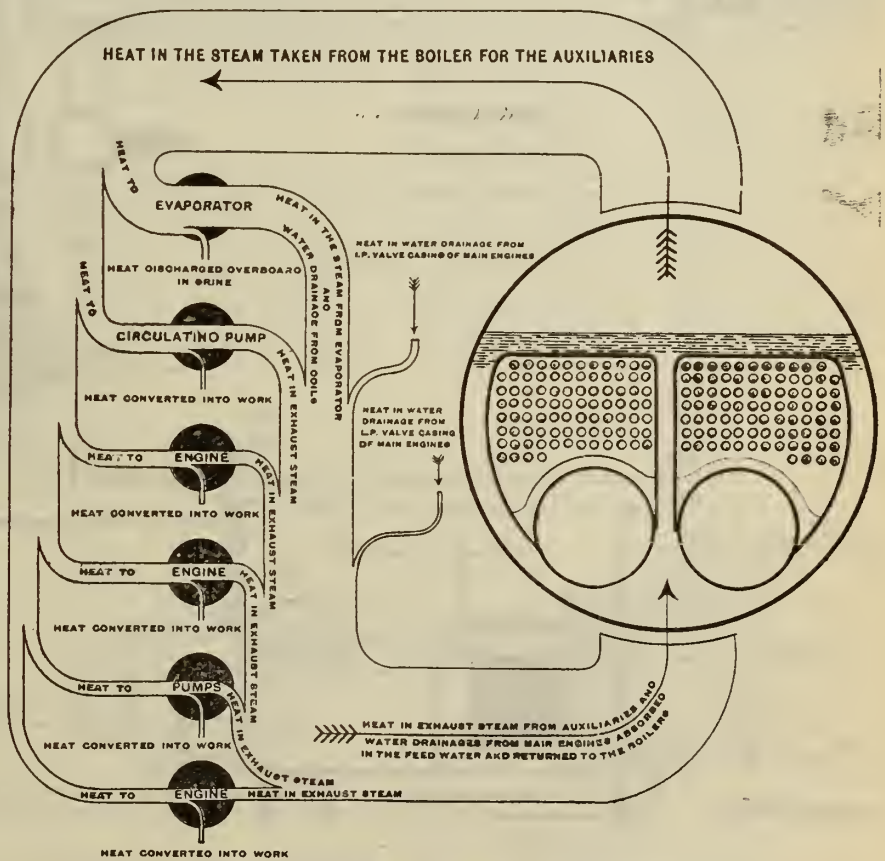
As regards the "Contraflo" system of auxiliary condensing and feed water heating and filtering apparatus, one of the principal features of this is the small size of the winch condenser required. The "Contraflo" winch condenser is usually fitted in connection with the "Contraflo" compensator heater and the "Contraflo" cascade feed water filtering, cleansing, and heating tank. The exhaust from the various auxiliaries is all utilized, partly in being condensed into boiler feed water and partly for the purpose of heating up the boiler feed water, but eventually ALL exhaust steam becomes boiler feed water and the system is so flexible that the temperature of feed can be regulated to almost any desired extent on either the suction or the delivery of the delivery side of the boiler feed pumps.

The "Contraflo" cascade filtering and heating tank receives the water discharged by the engine air pump, the drains from the I.P. and L.P. receivers, and all other drains from around the engine room and from the winch condenser and compensator heater; it also receives such exhaust steam as is not used in the compensator heater for heating feed water on its way to the boilers or which is not condensed in the winch condenser and returned from thence to the cascade tank as hot water. This steam can therefore be utilized for heating feed water on the "Cascade" tank on the suction side of the pumps. The tank is arranged with special heating nozzles and a system of filtering and baffling to separate oil and foul water from the cleansed and heated feed water.

The feed pumps, either engine driven or independently driven, receive this cleansed water and deliver it through the "Contraflo" compensator heater, where it is further heated by a portion of the exhaust from auxiliaries, as mentioned above. The portion of the exhaust steam not used in the heater will, as occasion arises, either pass partly to the winch condenser and thence back to the Cascade tank as hot water, or else go direct to the Cascade tank as already described; all these operations are practically automatically controlled once the regulating valves on the pipe lines are properly adjusted.

The "Contraflo" winch condenser is arranged with temperature control so that should the feed water coming from it to the Cascade tank and thence on to the suction side of the feed pumps, be too hot for the pumps to deal with, it can be regulated to a temperature the pumps can handle and the greater portion of the feed heating then is done in the Contraflo compensator heater, placed on the discharge side of the pumps.

By utilizing portion of the exhaust steam to heat the feed water in the Cascade filter tank the compensator feed heater can be made much smaller than is usual in ordinary practice where the whole of the exhaust steam is passed through the heater; also an effective device is fitted for collecting and removing air both from the steam chamber and the water heads, this generally being overlooked in ordinary practice.


HEAT IN THE STEAM TAKEN FROM THE BOILER FOR THE AUXILIARIES
HEAT TO
EVAPORATOR
HEAT IN THE STEAM FROM EVAPORATOR AND WATER DRAINAGE FROM COILS
HEAT DISCHARGED OVERBOARD IN BRINE
HEAT IN WATER DRAINAGE FROM L.P. VALVE CASING OF MAIN ENGINES
HEAT TO
CIRCULATING PUMP
HEAT IN EXHAUST STEAM
HEAT CONVERTED INTO WORK
HEAT IN WATER DRAINAGE FROM L.P. VALVE CASING OF MAIN ENGINES
HEAT TO
ENGINE
HEAT IN EXHAUST STEAM
HEAT CONVERTED INTO WORK
HEAT TO
ENGINE
HEAT IN EXHAUST STEAM
HEAT CONVERTED INTO WORK
HEAT TO
PUMPS
HEAT IN EXHAUST STEAM
HEAT CONVERTED INTO WORK
HEAT IN EXHAUST STEAM FROM AUXILIARIES AND WATER DRAINAGES FROM MAIN ENGINES ABSORBED IN THE FEED WATER AND RETURNED TO THE BOILERS
HEAT TO
ENGINE
HEAT IN EXHAUST STEAM
HEAT CONVERTED INTO WORK

THE DISTRIBUTION OF HEAT IN EXHAUST SYSTEM

It will be seen from the foregoing that ALL the heat in the exhaust from the engine room and deck auxiliary machinery and all drain water from main engine and auxiliaries is utilized in heating the feed water, also that ALL the exhaust eventually becomes feed water.

Another feature of the "Contraflo"

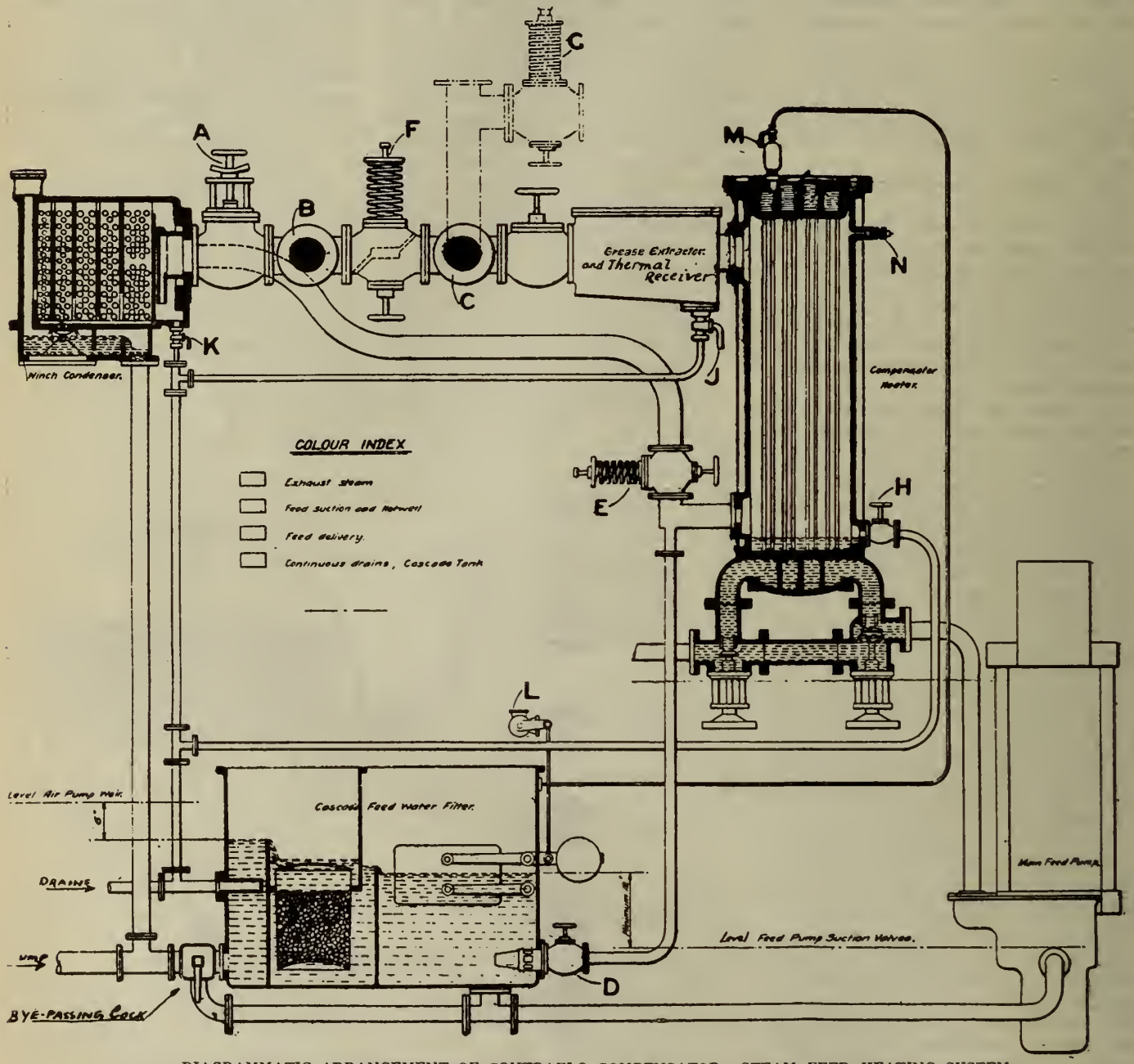
auxiliary system is the very complete method adopted of removing oil and grease from the exhaust steam and feed water, a special oil and grease separator being placed close to the compensator heater, and the winch condenser also having an oil extracting device; likewise the Cascade tank has an effective oil collecting and filtering medium and a system of baffling, all of which make for feed water very free from oil.

Regarding the main condensing system, the principal feature of this consists in combining a small auxiliary jet condenser or receiver tank in series with the main condenser and fitting an ejector or inducing nozzle on the main condenser to withdraw the comparatively richly air-laden vapor, which usually remains in a condenser despite the efforts of the air pump to withdraw it.

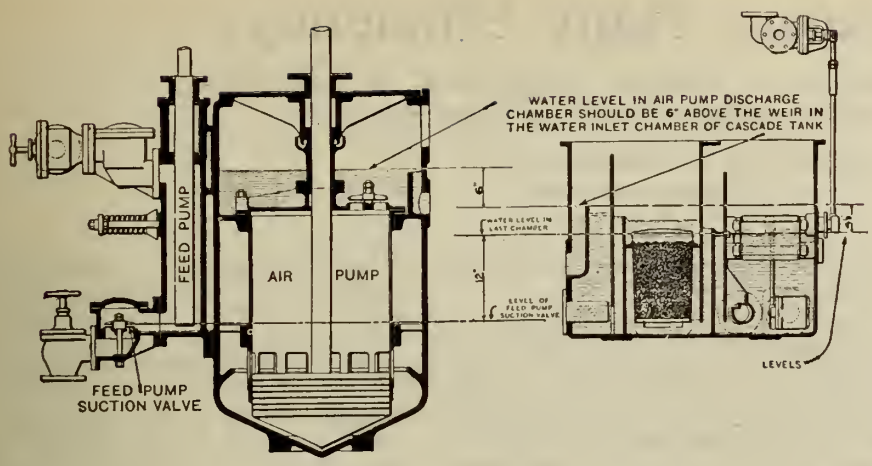
In an ordinary condenser the lower rows of tubes soon lose their efficiency due to oil being deposited on their surfaces and also on account of water dripping on to them from the upper tubes and preventing the steam from getting into close contact with the cooling surface. Every sea-going engineer knows that to maintain a vacuum of more than 23¼" or 24" in warm water entails the pumping of a large amount of circulating water, but in the Contraflo system, on account of the large volume of steam and air removed by the inducing nozzle it has been demonstrated that a vacuum of 27" can be maintained in the main condenser, with sea water at 80° to 85° F.; also that the cooling surface can be materially reduced.

The ejector receives its steam supply usually from the circulating pump engine exhaust and delivers the steam and air mixture to the small jet condenser, which is placed on the air pump suction pipe. The condensing water used in this jet condenser is simply a small amount of the condensate discharged by the air pump and is drawn back to the jet condenser and thence again passes back into the air pump, being in effect a closed system. A water seat or U leg is formed between main condenser and air pump on the air pump suction pipe, to prevent the air and water vapor discharged by the ejector returning back to the main condenser.

On account of the smaller condensing surface required in the "Contraflo" system due to the employment of the steam jet, etc., a lesser quantity of circulating water is required and therefore a smaller circulating pump; also less of the heat in the exhaust steam from the low pressure cylinder of the main engine is transferred to the circulating water and lost overboard, as the steam ejector replaces about one-fifth of the tube surface normally required and collects a large



DIAGRAMMATIC ARRANGEMENT OF CONTRAFLO COMPENSATOR STEAM FEED HEATING SYSTEM.


WATER LEVEL IN AIR PUMP DISCHARGE CHAMBER SHOULD BE 6" ABOVE THE WEIR IN THE WATER INLET CHAMBER OF CASCADE TANK
FEED PUMP
AIR PUMP
FEED PUMP SUCTION VALVE
LEVELS

volume of uncondensed steam and vapor from the main condenser and delivers it into the small jet condenser, where its heat is transferred to the condensate (or boiler feed water), as is also the heat in the steam passing through the ejector from the circulating pump engine exhaust.

The recognized best cargo steamer practice as recommended by the guidance specification of the North-east Coast Institution of Engineers and Shipbuilders provides for 1½ sq. ft. of condensing surface per normal indicated horse-power at sea; on this basis 2,000 h.p. would require 3,000 sq. ft., or, say, 15,300 lineal feet of brass tubing ¾ in. diameter. By installing the "Contraflo" system for main condenser about one-fifth of this tubing could be saved.

A test was carried out in England some time ago in the presence of representatives of the British Controller of Shipping, the North-east Institution of Engineers and Shipbuilders and other bodies, to determine the relative efficiency of the "Contraflo" winch condenser, as compared with one of ordinary circular shell type. The result showed that a "Contraflo" condenser of 250 sq. ft. could effectively perform the same duty as ordinary condenser of 600 sq. ft. surface, the duty in this case being to condense 15,000 lbs. steam per hour. The weight of the "Contraflo" condenser was 30% less; the saving in cost on 100 winch condensers supplied for British standard ships was $89,000. The "Contraflo" system has been largely adopted in the British mercantile marine and that of other countries and a contract has recently been entered into with the United States Emergency Fleet Corporation for the supply of this apparatus on 320 ships with the option of putting it on all they build. The system is also being fitted on a number of vessels building in Canada.

The cuts accompanying this article illustrate some of the "Contraflo" details.

Cut No. 1 illustrates diagrammatically the quantity of heat in steam taken from a ship's boilers for the auxiliary machinery, and also how much of this heat is returned to the boiler with the feed water under the "Contraflo" system.

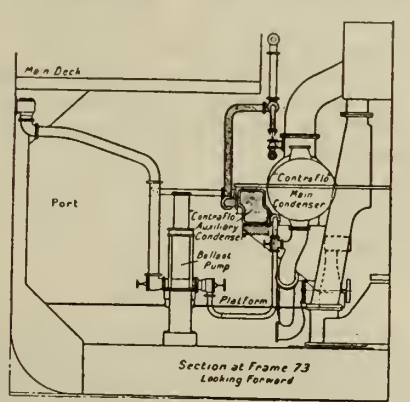
Cut. No. 2 illustrates the latest and simplest arrangement of the "Contraflo" auxiliary system and piping connections in diagrammatic form; this is the system that is now being fitted to the British standard ships. The letter press with this cut gives the setting and operation of the various valves.

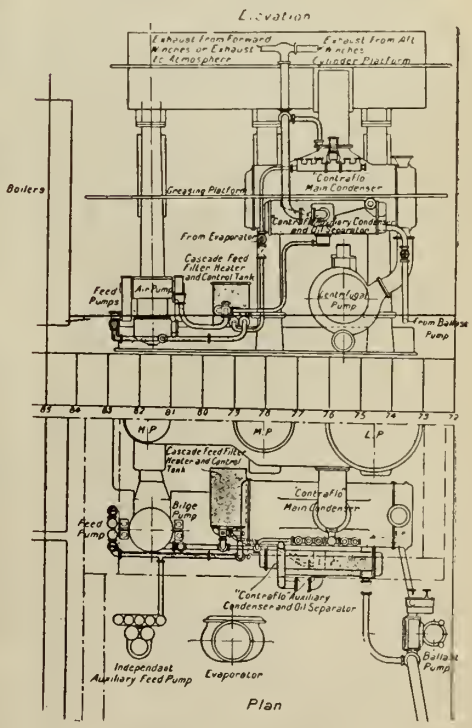
Cut. No. 3 shows the cascade filter tank in its proper relative position as regards levels in connection with feed pump valves of the main engine. For independent feed pumps the water level over the suction valves of the pumps should be the same as for engine-driven pumps.

Cuts Nos. 4 and 5 show a new arrangement of the main engine and auxiliary machinery covered by the "Contraflo" patents and being fitted to British standard ships. These are specially interesting as showing the centrifugal pump, cascade tank, and winch condenser all directly attached to the main engine, thus permitting the piping in connection with same being fitted and assembled in the shops, whereas with the ordinary arrangement most of this piping would otherwise have to be fitted aboard ship. The new arrangement results in both a saving of piping and of labor, because in the ordinary ship board arrangements of auxiliaries and piping only about 27% of the total piping in the system can be fitted in the shops, yet under the new "Contraflo" arrangement as illustrated it is possible to fit up to 60% of the piping in the shops and the piping is considerably shorter. Cut No. 5 also shows the auxiliary jet condenser fitted on the air pump suction pipe in conjunction with the steam ejector system.

There are various other arrangements of the "Contraflo" system to suit special requirements, one of these modifications being the elimination of the engine-driven air pump and its replacement by a small rotary kinetic air pump and condensate pump combined in one casing and driven by a small steam turbine; this is used in conjunction with the steam ejector system and is specially suitable for large powered vessels, resulting in a very appreciable saving in cost, weight and space.

The Navy Department has adopted an audio frequency signal for aviators which will enable them to land with safety in a dense fog or in the dark. This system of audio transmission which has been perfected has played a conspicuous part in the war and is now being applied to the uses of peace. It will be of advantage to navigators finding their way through fog into port, as well as to navigators in the air The difficulties encountered because of fog in the recent transatlantic flights of the NC-4's and the Vickers-Vimy airplane demonstrate the need of just such a device.





Refrigerating Plant Efficiency

Rules and Information on Correct Proportions as One of the Essentials for Maximum Operating Plant Economy

Reprinted from the "Refrigerating World."

By GEORGE NAYLOR

CORRECT proportions is one of the essentials for maximum operating economy in the refrigerating plant. Every machine, device, apparatus or piece of equipment will give its most efficient service at a certain load; above this, or below, the cost or effort of operation increases. Consequently it must be the aim of the man in charge of the plant to maintain this proportion as far as possible and run the plant at its maximum efficient point as near as possible.

Of course, the designer of the plant is largely responsible for the proportioning of the equipment when the plant is erected and there is nothing left for the operating man to do but to make the best of what is already installed, as far as this is concerned; on the other hand there is a large proportion of the equipment that can be changed or altered at small expense and there is considerable leeway in many plants in the manner in which it can be operated, all of which may radically affect the operating economy of the plant.

Oftentimes it will be found that where more than one boiler is installed, more boilers are run than are necessary, simply because the fireman can pile a heavy charge in both boilers at one time and reduce the number of firing periods. At the same time he will be shoveling more coal.

Run Boilers Partly Overloaded

Experience has demonstrated in practice that most boilers can be operated as efficiently, and sometimes at higher efficiency, by running them partly overloaded. In many cases it has been found that a boiler carrying 50 per cent. more load than its nominal rating would evaporate more water per pound of coal than when it was operated at normal load. If a boiler is underloaded it is seldom as efficient as at full load, and in most cases its efficiency is greatly reduced when running below full load.

This is due to the fact that the efficiency of the combustion process is increased at the higher ratings. In many cases the amount of coal burned per sq. ft. of grate surface is as low as six or seven pounds and it is impossible to burn the average run of bituminous coal efficiently at this rate. In a large number of cases the boiler efficiency can be radically increased by increasing the rate to 15 to 25 pounds per sq. ft. of grate surface. This may mean shutting down one or more boilers and a little more frequent firing by the fireman, but he will shovel less coal. Consequently the proportion of boilers to the load will bear considerable investigation in the average plant.

Oftentimes it will be found that the stack is too small for the load, or to maintain the proper intensity of draft for high rates of combustion. In this case the stack will be out of proportion for maximum efficiency, but this can be easily remedied by installing one of the many forced draft fans in the sides of the boiler settings, when almost any desired intensity of draft can be obtained. This is one case where the operator can do a little proportioning himself.

In case only a single boiler is operated and this is too large for the load, the efficiency can be considerably increased by bricking up a proportion of the grate, thus increasing the intensity of combustion on the remainder of the grate. This is another case where the proportioning is strictly up to the man in charge.

In the engine room one will often find two or more compressors dragging along at 30 or 40 revolutions per minute when by speeding up to 65 or 75 and even 85 revolutions for the smaller machines, one or more machines could be shut down, thus eliminating the friction and condensation losses of one or more units as well as the oil and attention required. At the same time the efficiency of the running units at the higher speed will be better than at the slow speed, up to the point where the action of the compressor valves is too slow for the velocity of the piston, which is considerably above the speeds given above.

The same can also be said in regard to brine and boiler feed pumps, water pumps, air compressors and every other apparatus around the plant, including the power engines. Keep them running as nearly as possible at their normal speeds and loads; this will result in maximum economy all around.

Pipes and Coils

When it comes to piping, condensers and expansion coils the man in charge has considerable latitude to demonstrate his ability. A radical reduction in condenser water and power or steam consumption can often be obtained by adding a few more stands to the condenser and prove a gold mine from an investment standpoint. This is especially the case where water is expensive and the fuel likewise; in this case liberal condenser surface is indispensable to commercially economical operation.

In many installations it will be found that many sections, especially of the suction piping, are entirely too small for the volume of gas that has to pass through them, resulting in excessive friction losses and reduced suction pressure, which, in the final analysis, results in reduced compressor capacity and increased cost of operation. Substitution of larger pipe in these cases will pay a handsome return on the investment.

The expansion coils, however, will give the man in charge of the average plant more opportunity to use his discretion and demonstrate his ability, than any other part of the plant. In a great many plants the proportioning of the expansion coils is radically defective and some good judgment in rearranging these, and adding more pipe in a number of cases, will make a marked showing on the operating economy of the plant. This is well illustrated in the article on "Improving a Refrigerating Plant" in the Sept., 1918, issue of "Refrigerating World" and an article by the same writer along similar lines in "Power" recently. Rearrangement and addition of more coil surface resulted in some almost unbelievable economies and brought the overload on the boiler room and compressors down below normal load. Surely a condition well worth striving for, and the condition of this plant was not by any means worse than is the case in hundreds of others all over the country.

Proper Adjustment

Once a plant is properly proportioned, as far as practicable under the existing conditions, the next problem is one of proper adjustment. This, in a way, is as important as proper proportion and entirely up to the man in charge of operation. In the boiler room the thickness of the fuel bed, the damper, or what is the same thing, the draft, the proper water level, and a number of other details should be adjusted to the load and kind of fuel used. Here the man in charge has every opportunity to demonstrate his ability and progressiveness, and make a radical difference in the cost of operation.

In the engine room the adjustment of engine valves, compressor valves, stuffingboxes, bearings, piston rings, as well as the numerous details of various other equipment, including the pumps and air compressors, will make a healthy difference at the end of the year if this is conscientiously attended to. This part of the equipment, however, probably receives more attention than that of the boiler room or those to be mentioned later.

Considerable discretion can be exercised in the adjustment of the condenser

water. In most cases the average man will turn on all the water available and imagine he is doing fine. Where water is expensive to get and fuel relatively cheap, this procedure is liable to prove to be very extravagant at the end of the season's run.

It is generally not a very complicated matter to determine the rate evaporation by the boiler and the amount of steam used by the engine. A simple evaporation test requires no particular skill and will give the relation of pounds of water evaporated to the pounds of fuel burned. The steam consumption of the engine can be approximated very closely from indicator cards, by the use of a steam meter if one is available, or by running the boiler on the compressor alone, on Sunday or some other day when it is not needed for other operations, and the actual coal consumption determined direct. A test can then be run with maximum condenser water running over the condenser and another at the minimum, consistent with highest permissible condenser pressure.

By the latter method, actual operation conditions will be duplicated, and the variations in the steam consumption of the condenser water pump, at the higher and lower output will also be taken into consideration. The cost of fuel can then be compared with the cost of water. If the cost of fuel at high condenser pressure is less than the cost of water to maintain a lower pressure, it evidently is good practice to run at the higher pressure and reduce the cost of operation.

Expansion Valves

It is in the readjustment of the expansion valves, however, that the average man can make some very radical improvements. Some very good articles along this line has appeared from time to time in the "Refrigerating World" and other power plant magazines, and the writer will therefore refrain from discussion of the details in this article. The main point is to keep every foot of expansion coil surface in contact with liquid ammonia and utilize every square foot of surface for evaporation of liquid, without at the same time flooding any one of the coils and throwing a large proportion into the suction line. Liquid in the suction gas simply increases the radiation loss through the suction line and greatly reduces the capacity of the compressor.

To judge the proper setting of the valves, one will have to take into consideration the temperature differences in the various rooms, if direct expansion is used, the size of the coils and their cleanliness. A coil with heavy frost on it will not evaporate the same amount of ammonia as a similar coil with clean surfaces. A heavy coating of oil will act in a similar manner.

However, it is only necessary to watch the suction pressure gauge and experiment with each coil until a point is found where the suction pressure will be maximum without an excessive amount of liquid being carried back into the suction line, as indicated by the frost line on the machine or the thermometer in the suction line, if one is provided. Under these conditions a man will have to keep on his toes in case the temperatures fluctuate in the rooms, as a drop in temperature in any room will reduce the rate of evaporation in the coils in this room and throw some of the liquid into the suction line. Consequently the valves must be pinched off as the temperatures drop and if the suction pressure comes down, in consequence some of the other valves will have to be opened a little more in order to keep them working at maximum capacity.

Cleanliness is another indispensable factor in efficient refrigerating plant operation. This means clean heating surfaces in the boiler room, the regular removal of the soot deposits, thorough washing out of the boiler as frequently as the quality of the water may demand, and the regular removal of scale. A water purifying system will be found a good investment in a number of cases and a turbine cleaner will be found a very good investment where water tube boilers are used.

The same also holds good regarding the condenser. Scale formation on the outside of the pipes on atmospheric condensers and on the inside of the pipes on double-pipe condensers should not be allowed to accumulate. A wire brush on the end of a piece of pipe, run over the pipes occasionally on atmospheric condensers, will wash off a large part of the accumulated sediment and prevent its baking on the coils. On double-pipe condensers, one coil at a time can be cut off from the water circulation and a tube scraper run through it the same as cleaning boiler tubes. Only one or two coils at a time need be cleaned in this manner and by taking a few coils this way every week, or twice a month, the entire condenser can be gone over two or three times every season, which will make a considerable difference in the water consumption and the fuel or power consumption at the end of the year.

The expansion coils in the average plant will require attention along this line more than any other part of the equipment. The dense frost one sees on the average expansion coil is an absolute detriment to efficient operation. Snow and ice is an excellent heat insulator, as arctic explorers will inform us when relating their experiences, and this is just the opposite of what we desire in the operation of an expansion coil.

Thorough cleaning of these coils should therefore be made regularly, depending on how fast and heavy the frost forms. Coils in hot meat coolers or where there is a large percentage of moisture present can be profitably cleaned every day. Others in dry rooms may require cleaning only once a week and in cases only once per month.

If no other method is available, scraping the coils with hook-shaped scrapers will do fairly well, but the hot gas method, described in various articles in the "Refrigerating World," is really the only business-like method of doing this work and the most effective, as it loosens up the oil and brings it out as well as removes the frost from the outside.

Oil should not be allowed to accumulate in any part of the system. For this reason some of the coils should be opened up occasionally for inspection and if any considerable amount of oil is present it should be blown out with steam and air. Any quantity of oil in the coils is just as detrimental as frost on the outside or scale in the boiler tubes.

Tightness of System and Insulation

It seems waste of space to mention here that pistons and valves, as well as the stuffingboxes on the valve stems and pistons of power and compressor engines should be kept tight. The same may also be said regarding air compressors. The fact remains, however, that in a large number of plants there is always a large amount of leakage at these points that would make a sizable coal pile at the end of the year, and the average plant can make some commendable improvements along this line. A steam meter in the line showing the steam consumption per 24 hours before and after making these changes would be an eye-opener for many operators.

Every effort must be made to eliminate ammonia leaks and so much has been said in the various power and refrigerating plant journals on this subject in recent years that it is not within the province of this article to describe the various methods used to locate the leaks and how to remedy them. Suffice to say that regular inspections should be made with litmus paper of the jacket and condensing water and with the sulphur stick on the ammonia joints, especially the discharge line, compressor or absorber and generator, and the condenser. Numerous small leaks, invisible and not noticeable by smell will be found in this manner that will waste large quantities of ammonia in a season's run.

Tight stop and expansion valves are another requisite for economical operation. At 125 pounds pressure a pinhole leak in a steam stop valve will waste a pound of steam every five hours. A few of these leaks in each valve all over the plant will mean an alarming increase in the coal consumption at the end of the season's run. Good valves in the first place, a good reseating machine and renewal of the discs the moment leaks are suspected will mean considerable money saved in the long run. Also considerable judgment can be displayed in selecting the proper disc for the service it is to be used. The discriminate use of every kind of disc for every service as practised in altogether too many plants cannot be too severely condemned; it is not fair either to the plant owner, the disc manufacturer or the maker of the valve. Discs unsuited for the purpose for which they are used will give out in a short time and at the same time ruin the seat of the valve in which they are used.

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The Trade and Technical Papers

THE position and business of the trade paper is coming to be more and more recognized by those who have occasion to dig beneath the surface in any particular line, and get down to real facts.

The trade press does not appeal to the mob. It is not a political organ, nor is its purpose merely to entertain. Its mission is to present information along specific lines, to publish the views of men who have succeeded, to give methods and schemes for doing mechanical things the best and most proficient way, to make a mechanic a better mechanic or a salesman a better salesman. In reality the trade paper is the medium through which the man who wants help can get it.

In the Ohio State University Department of Electrical Engineering there is a course in industrial lighting. The literature sent out by the University has the following in regard to the assistance the University authorities are getting from the trade press. Referring to the rapidity with which accepted theories and practices are being scrapped to make room for new ideas, the University letter says:

"One result of this rapid development is that the best available textbooks are to a large extent out-of-date before they are off the press. We are, therefore, confining the work of the course mostly to these letters and to that most up-to-date form of technical literature, the trade publications. We are fortunate in the large amount of good material that is available in the lighting field."

The above reference applies both to the engineering literature sent out by industrial and manufacturing firms and equally so to the technical press of to-day.

In other words, both sources of information are regarded by the Ohio State University as being of more importance than all the textbooks that are coming off the press, because it can keep up to the minute, while a textbook has to stand for certain stated beliefs, even while the procession passes along and leaves those beliefs old and without a following. Again, the University authorities can have no ulterior motive in stating their views on the matter. They are out to secure all the information they can along certain modern problems. They want to bring to bear on their problems every bit of worth-while knowledge they can secure, and their tried experience has been that they find this material in the trade press.

The trade and technical paper is the friend of the man who wants to go farther up, and then men who have succeeded in going farther up are the best friends and most constant readers of the trade and technical papers.

Mental Rust

DID you ever have your fireman, or someone else in your employ, come to you and ask you about some simple point in connection with the plant, or perhaps about some equally simple problem in engineering theory? Of course you have, and you have scratched your head and hemmed and hawed wondering what to say, trying to remember and being exasperated beyond measure at your inability to explain things satisfactorily. It is rather humiliating, isn't it? And yet did you ever count up the years, perhaps, that have elapsed since the textbooks have been opened that still lie on the shelves of the den, or in your office at the plant?

Man's mental equipment may be likened unto a piece of nicely polished shining steel exposed to the elements and with its ever-present tendency to rust and grow dull. And like steel, the only way to keep the memory bright and free from the blight of forgetfulness is to keep polishing, by reading texts, or better still, the more up-to-date contents of the technical press.

Ingenuity Displayed By Native Races

THE possession of a wonderful mechanical sense by more or less primitive races is referred to in an interesting manner by an editorial writer in *The Practical Engineer*, a British publication. Where native labor is employed on engineering works, cases arise where it is wise on the part of the supervising engineer to leave the overcoming of certain difficulties to the solution arrived at by the native mind. Interesting instances of the successful application of this policy are mentioned. There is the case of a dam in Egypt, which was giving trouble through leakage, though the exact spot where the weakness existed was not apparent. A native Egyptian employed on the job conceived the idea of coloring the water on the high side of the dam in order to detect the spot where the leakage appeared on the low side.

The engineering feat we hear of so frequently now of placing the centre span of a bridge by floating it on lighters to its place, and then raising it, was not unknown to the Chinese. In fact it is claimed that it was a Chinese who first utilized the buoyancy of lighters and the help of a tidal stream to place girders in this fashion.

Transporting a Lancashire boiler where there were no roads was encompassed by slinging it bodily on bamboo poles, and manning the poles with enough coolies to carry the weight. Naturally labor was cheap where this method was employed.

Transporting a vertical boiler up a hillside was done by the Chinese headman by means of what we would call parbuckling. The boiler was laid on its side and ropes were passed around it, one end of the rope being made fast to convenient trees, the other end being taken round the barrel of a winch. The winch being started winding in the rope, the boiler naturally rolled up.

This does not seem to us to be nearly so good an instance as the next one, which showed really excellent mechanical thought. This case was of a nine-ton flywheel, which had to be taken to the summit of a hill. Obviously such a wheel was too heavy to take any chances of rolling it up, as one slip would have meant disaster. The Chinese headman was told to get it up, and then left to his own devices. He immediately proceeded to drive strong stakes into the hillside at long intervals, leaving them about three feet above the surface. He then secured some screwed pipe, and screwed a flange on each end of a piece just long enough to fit over the stake. To the top flange he fitted long bars to act as capstan bars. The wheel was then raised by levers, and rollers fitted under it as it lay on its flat. The rope was attached, and the loose end passed around the improvised winch on the stake. Enough men were then placed on the capstan bars, and the order given to heave away. The men walked round and the flywheel came up the hill. When it had reached the stake it was chocked up, the rope let go, and the winch was taken bodily to the next stake. The distance apart of the stakes was limited by the length of the rope available. This was about as safe and quick a way as could have been devised by any one under the conditions prevailing, and was thought out and adopted by a man who had never heard of the principles of mechanics.

The Engineer's Pants

I READ a week or so ago what James E. Noble said about the shiny britches being like a hunk of lead, what's tied around some poor wop's neck to hold him on his job, when he might plan to hurdle out and pasture on green sod.

He says an engineer should have great patches on his knees from kneelin' down to find the cause of every leak and wheeze—that he should have his feet flat out and decked up with a corn, from chasin' round the plant until the blowin' of the horn.

I may be wrong, James may be right, but to my homely view, I love the man whose stern is clad in folds of shiny hue.

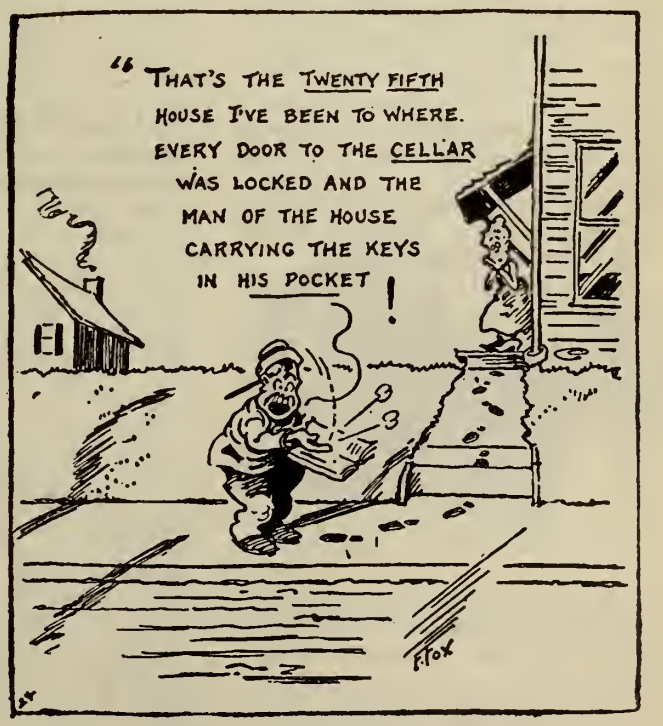
I love the man with skillful touch who knows the game all through, who knows just what his plant and coal and stokers three can do—who looks ahead and keeps things sweet like some great Christmas cake, to make them run like grease each day, a-scared, by heck, to break.

To me it is a goodly thing, it makes my heart go thump to hear the rythmed quiver of a nicely-runnin' pump—it makes my spine to have a thrill to see an engine run, without some jay a standin' there with pitchfork and with gun.

It likewise causes me to groan to enter in some place, where engineer has got a streak a campin' on his face. He's crawlin' round the floor, he is, he's camping in the oil. his temper's like a stormy night, it's startin' for to boil.

Sure he has patches on his knees, his feet are sore and flat, he talks like some quack doctor, too, what whispers through his hat. I cannot love this oily jay, nor hold him to my breast, for oil is oozing from his boots, likewise from out his vest.

When I go lookin' for a man to make power for my plants, I'll squint until I find the chap what has the shiny pants, the chap who sits and thinks a bit, who knows just what to do, without a-crawlin' on his knees or sweatin' like a stew. Ah, yes, I'll take him by the hand, and lead him to my place, a smile a-campin' in my soul and one hung on my face. I'll pay to him ten bucks a day, I'll feed him T-bone meat, this chap what has the shiny hue a-glowing from his seat.—ARK.


"THAT'S THE TWENTY FIFTH HOUSE I'VE BEEN TO WHERE. EVERY DOOR TO THE CELLAR WAS LOCKED AND THE MAN OF THE HOUSE CARRYING THE KEYS IN HIS POCKET!
E.Fox

THE METERMAN IN A DRY LAND.
—From the Youngstown (Ohio) "Telegram."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Before the House

80. At what pressure will a safety valve blow off, having a diameter of 4 inches, the weight of the valve and stem is 10 lbs., the lever is 20 lbs., and the ball 120 lbs.? The total length of the lever, which is straight, is 44 inches. The weight is 40 inches from the fulcrum, and the distance from the centre line of the valve to the fulcrum is 4 inches.

81. With a safety valve having the dimensions given in question one, what weight is necessary to have the valve about to blow off at a steam pressure of 100 lbs. per sq. inch?

82. What is the absolute pressure if the vacuum gauge indicates 19 inches, while the barometer stands at 26 inches?

83. Find the quantity of air required to completely burn one pound of fuel of the following composition:

Carbon	84 parts
Hydrogen	5 parts
Oxygen	7 parts
Ash	4 parts

84. How many B.T.U. will be produced by the combustion of one pound of coal of the following composition:—

Carbon	76.5 parts
Hydrogen	4.4 parts
Oxygen	3.0 parts
Nitrogen	1.1 parts
Ash	15.0 parts

85. How many pounds of water at 212 degrees Fah. can be evaporated by 1 pound of the coal mentioned in question 5?

86. A boiler shell 72 inches in diameter is constructed of material. 5 inches thick, which has a tensile strength of 60,000 lbs. per sq. in. What is the bursting pressure, taking no account of the weakening effect of the seam?

87. If the boiler shell whose dimensions are given in question 7 is constructed with a triple-riveted, double-strapped belt joint having an efficiency of 86 per cent., what is the bursting pressure?

88. Find the load on a stay when the pitch is 8 inches either way and the steam pressure 83 lbs. per sq. inch.

89. Staybolts 1¼ inches in diameter are placed 3½ inches from centre to centre. If the steam pressure is 100 lbs. per sq. inch, what is the stress per sq. inch in the stays?

90. A stayrod 2 inches in diameter is cut with a U.S. standard thread and has 4½ threads per inch. What is the diameter at the root of the thread?

91. What working pressure will be allowed on a solid rectangular steel girder 2.5 ft. long, 7 inches deep and 2 inches thick, fitted with three staybolts? The girders are spaced 7 inches centre to centre. The pitch of the stay-bolts is 7.5 inches and the combustion chamber is 30 inches wide.

92. A boiler shell 60 inches in diameter and ½ inch thick, with a tensile strength of 60,000 lbs. per sq. in., has a double riveted longitudinal lap joint, having a rivet efficiency of 68.3%. Under Canadian Marine Rules, what working pressure will be allowed? All rivet holes are punched before bending.

Questions Answered

Question.—64. Explain the difference between outside lap and inside lap of a D slide valve?

Answer.—The outside lap is the amount that the outside edge of the valve projects beyond the edge of the steam port when in mid-position. The inside lap is the amount that the inside edge of the valve projects beyond the edge of the steam port when in mid-position.

Question.—65. Explain the difference, if there is any, between piston clearance and clearance volume?

Answer.—The linear distance between the piston and the cylinder head when the former is at the end of its stroke is the piston clearance. The volume of this space added to the volume of the steam port leading to it is the clearance volume.

Question.—66. Is it possible to cut off with a D slide valve operated by an eccentric, having no outside lap and no lead?

Answer.—With an ordinary D slide valve, operated by an eccentric, there can be no cut-off, and therefore, no expansion of steam, unless the valve has outside lap.

Question.—67. Suppose you had a plain slide valve engine, and you wished to make the cut-off earlier, what would you do? The port opening is to be the same as before.

Answer.—Increase the outside lap, increase the valve travel and the angle of advance.

Question.—68. What is the effect of increasing the inside lap of a D slide valve?

Answer.—The exhaust port will be opened later and closed later.

Question—69. How can the valve be given a greater travel than the throw of the eccentric?

Answer.—By using a rocking arm.

Question.—70. How does the angularity of the connecting rod effect compression?

Answer.—The exhaust port will be closed later on the forward stroke than on the return stroke, and hence there will be more compression at the head end.

Question—71. A 14 in. by 28 in. engine has a clearance volume of 247 cubic inches. Express the clearance in per cent.

Answer.—The volume swept through by the piston is 14 squared, multiplied by .7854 × 28=4,310 cubic inches. Then the clearance is 247÷100: 4,310÷5.73%.

Question.—72. In a 36 in. by 60 in. engine the steam is cut off when the piston has moved over 21 inches of its stroke. The clearance being 2 per cent.; find the real cut-off.

Answer.—The apparent cut-off is 21×100÷60=35%. The real cut-off is (35×2)×100÷100+2=36.27%.

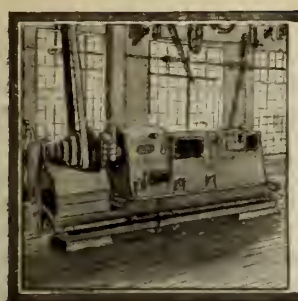
Question.—73. What is the ratio of expansion of the engine given in question 9?

Answer.—The ratio of expansion=100÷36.27=2.76.

Question.—74. A 44 in. by 80 in. engine is to run at 75 r.p.m. What actual diameter of steam and exhaust pipes should be used?

Answer.—The piston speed is 80÷12×75×2=1,000 ft. per min. The area of this piston is 442×.7854=1,520 sq. ins. Area of steam pipe =1,520×1,000÷6,000=233.3 sq. ins. The corresponding diameter for the steam pipe is: —√(233.3÷.7854)=18 in. nearly. The area of the exhaust pipe is 1,520×1,000÷4,000=380 sq. in. Diameter of exhaust pipe —√(380÷.7854)=22 sq. in.

Continued on page 426



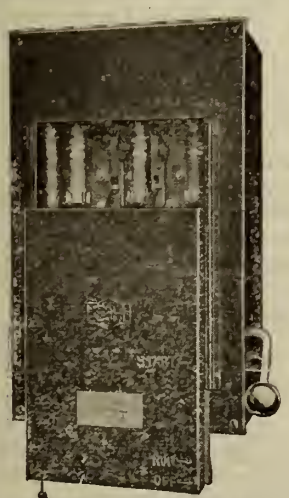
NEW POWER PLANT EQUIPMENT

TWO NEW ENCLOSED STARTERS FOR SQUIRREL CAGE MOTORS

PROTECTION for both the motor and the operator is the main feature of design in the new enclosed starting switches, Bulletins 9117 and 9118, manufactured by The Cutler-Hammer Mfg. Co., Milwaukee.

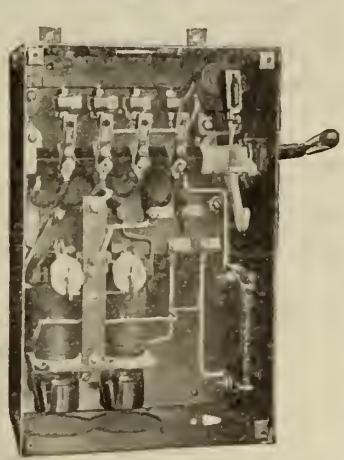
The Bulletin 9117 switch contains an overload protection unit, which is so designed that the circuit is not interrupted by a high initial starting current or by momentary overloads, yet gives protection against the continuance of harmful overloads. This inverse time element action is obtained by the retardation of a plunger in an oil dashpot. The time required for the relay to operate on any given overload condition may be varied by turning an adjusting screw.

The three pole fused starting switch, known as Bulletin 9118, is especially adapted for those motors which cannot be connected directly across the line when starting. A resistor with two sets of terminals allows the motor to be started on either 60% or 75% line voltage. When the motor has reached normal speed, the resistor is cut out of the circuit and the fuses inserted, which is accomplished without breaking the motor circuit. Therefore, the fuses do not carry the heavy starting current, and need be of no greater capacity than to insure proper motor protection.



LOWERING THE PANEL OF THE BULLETIN 9118 STARTER DEADENS THE FUSES AND MAKES THEM ACCESSIBLE FOR RENEWABLE. THE SWITCH CANNOT BE CLOSED WHILE THE PANEL IS LOWERED.

Both types of starters are completely enclosed and are so designed that it is impossible to touch any live parts either while operating or while renewing fuses and making adjustments. The enclosing cases, which are arranged for conduit wiring, prevent the accumulation of dust and grease on the contacts besides protecting the workmen from



BULLETIN 9117 STARTER WITH FRONT COVER REMOVED SHOWING CONTACTORS, DUPLEX RELAY AND LOW-VOLTAGE COIL.

live parts. All contact posts and fingers are of standard C-H drum construction, easily inspected and renewed. Both types of switches are provided with low voltage protection coils.

To operate either type of starter, it is only necessary to raise and lower the handle, which can be locked to prevent unauthorized operation. The starters are made in various capacities for operating squirrel cage motors on potentials not exceeding 550 volts.

SULLIVAN "WAFER" AIR COMPRESSOR VALVES

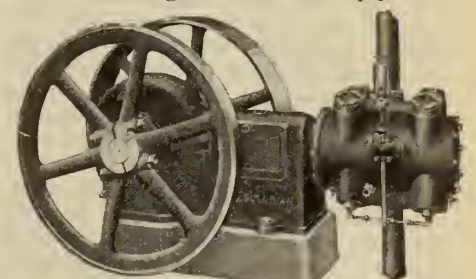
Sullivan Single Stage Belt-Driven Compressors, type WG-6, and the corresponding steam-driven type, "WA-6," are now being supplied with the new improved plate valves, developed by the company's engineers at Claremont, New Hampshire Works. This valve, known as the Sullivan "Wafer" Valve, is shown in the accompanying illustration on this page. The small size, light weight and compactness of the valve and its spring and seat are strikingly illustrated by the other illustration on page 426

As indicated, the "Wafer" Valves seat in cages arranged radially to the axis of the cylinder and close to the two ends of the cylinder, the inlet valve being situated at the bottom and the discharge valve at the top. These valves are held to their seats by flat annular springs of the same material as the valve itself, which is the finest tempered spring steel obtainable. The valves open against specially designed guard plates intended to give a wide port opening with a minimum of clearance volume, and without restricting the admission or charge of the air to or from the cylinder. The valve, spring and guard are easily accessible by the removal of a screw plug.

The simple construction and short compression distance of the springs permit the valves to be located much closer to the bore of the cylinder than is generally permissible with valves of this type, with a corresponding reduction in clearance losses. The light weight of the valves and the superior quality of the material result in long life, and when renewals are necessary, the cost of new valves is a trifling matter. The question of repair stock is simplified because the same valves, springs and guards are used for both inlet and discharge.

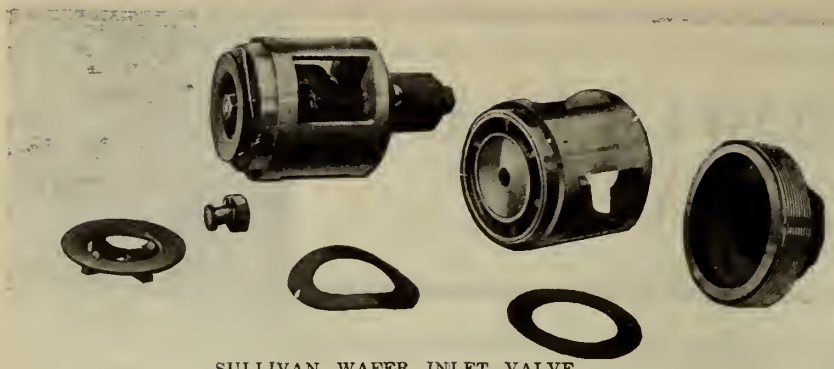
The valves are employed in multiples of relatively small size, rather than using one or two valves of large diameter, the objection to the large valves being the large clearance pockets required and the likelihood of more noisy action and greater breakage.

Compressors equipped with these valves are unloaded in essentially the same manner as the compressors equipped with automatic poppet valves. There is an airpipe connection from the receiver which is controlled by a pilot valve at the side of the air cylinder. When the receiver pressure rises to the unloading limit, the pilot valve admits air pressure through branch pipes to



SULLIVAN "W G-6" WAFER VALVE AIR COMPRESSOR 50-470 CU. FT.

small plunger pistons located in the valve plugs. The other end of the piston carries a three-pronged extension, which raises the inlet valve from its seat until the receiver pressure falls the required amount, upon which the plunger piston falls, the valve seats and the compressor resumes its operation. While the valve is raised and the unloader in



SULLIVAN WAFER INLET VALVE.

action, no air is compressed, the piston of the compressor simply carrying the air at atmospheric pressure through the cylinder and open valves.

Sullivan "Wafer" Valves have been in use for several years with great success on high pressure compressors supplied the United States Navy for charging torpedoes at pressures ranging as high as 2,500 pounds per square inch. In this service their durability, power economy and ability to maintain a tight seat after long use and the reliability of the special springs, which have been developed for this service, have all been amply demonstrated.

STEAM ENGINE VALVES

By R. S. Wright

By keeping the following rules handy they will help to solve many of the problems applying to the steam engine:

1. With an ordinary D slide valve, operated by an eccentric, there can be no cut-off and therefore, no expansion of steam, unless the valve has outside lap.

2. Increasing the outside lap means an earlier cut-off and an increased expansion, while decreasing the outside lap means a later cut-off and a diminished expansion.

3. Increasing the inside lap causes the compression to begin earlier in the stroke and causes the release to take place later. On the other hand, diminishing the inside lap causes the compression to begin later and the release to begin earlier in the stroke.

4. When the valve rod and the eccentric rod moves in the same direction with an ordinary slide valve, the eccentric is set ahead of the crank, and the angle between the crank and eccentric is 90 degrees plus the angle of advance. This law is true whether the engine runs over or under.

5. In the case of the plain slide valve, if a rocker-arm is so pivoted as to make the valve rod and eccentric rod move in opposite directions, the eccentric must be placed behind the crank, and the angle between them is 90 degrees, minus angle of advance.

6. When an indirect valve is used, set the eccentric behind the crank and make the angle between them equal 90 degrees, minus the angle of advance. If a rocker-arm is used that makes the valve rod and the eccentric rod move in opposite directions, set the eccentric ahead of the crank, and make the angle between them equal to 90 degrees, plus the angle of advance. This applies whether the engine runs over or under.

The Effects of the Connecting Rod on Steam Distribution

7. It will cause the valve to cut-off and release the steam, as well as close the exhaust port later on the forward stroke of the piston than on the return stroke.

8. To find the real cut-off, add the clearance volume expressed as a per cent. of the stroke, to the apparent cut-off expressed in per cent., and multiply the sum by 100, divide the product by 100 plus the clearance volume in per cent.

9. To find the area of the steam pipe leading to an engine or pump, multiply the area of the piston by the piston spread in feet per minute, and divide the product by 6,000.

10. To find the area of the exhaust pipe, or exhaust port, for an engine or steam pump, multiply the area of the piston by the piston spread in feet per minute and divide the product by 4,000.

11. To find the area of the steam port, multiply the area of the piston by the piston speed in feet per minute; divide the product by 7,000 if the port is short and direct, and by 6,000 if the port is long and tortuous.

Questions Answered

Continued from page 424

Question.—75. About what scale of spring is usually selected for a given boiler pressure?

Answer.—About equal to one-half boiler pressure.

Question.—76. What is the principal objection to the lazy-tongs and pantograph reducing motions?

Answer.—Their joints are apt to become loose and thus distort the diagram.

Question.—77. What is meant by the vacuum line on an indicator diagram, and how is its position located?

Answer.—The vacuum line is the line of no pressure and is located below and parallel to the atmospheric line at a distance equal to the atmospheric pressure divided by the scale of the spring used to make the diagram.

Question.—78. In plain slide valve engine, how would you remedy too early admission, and what effect would this have on the other events of the stroke?

Answer.—Decrease the angular advance of the eccentric. This would cause cut-off, release, and compression to take place later.

Question.—79. If one end of a cylinder with a slide valve is found to be doing more work than the other, how can the fault be remedied?

Answer.—Change the length of the valve stem so as to make cut-off earlier on the end doing the greater amount of work.

NEW UNION OF STATIONARY ENGINEERS AND FIREMEN

The Canadian Brotherhood of Stationary Engineers and Firemen has recently been organized in Edmonton, with J. Antrobis general secretary. This new organization is very broad in its scope and includes oilers, pumpmen and helpers as well as others connected with the craft.

SULLIVAN WAFER DISCHARGE VALVE.

A Dominion charter has been applied for, and it is expected that headquarters will be in Edmonton.

The Department of Electrical Engineering, Ohio State University, have issued a series of technical letters on Industrial Lighting. These letters have been developed in connection with an extension course carried on by the university. While the earlier technical letters are of an elementary character, making their greatest appeal to those who are not familiar with the science of illumination, most of the letters of the series contain information of value to the illuminating engineer. A departure has been made from the practice of using the standard text book as a source of inspiration, and recourse is had to the medium of trade literature and the columns of the technical press for up-to-date information on the various subjects studied. For those wishing to make a study of the science of illumination the extension course, of which these letters form a part, is to be commended.

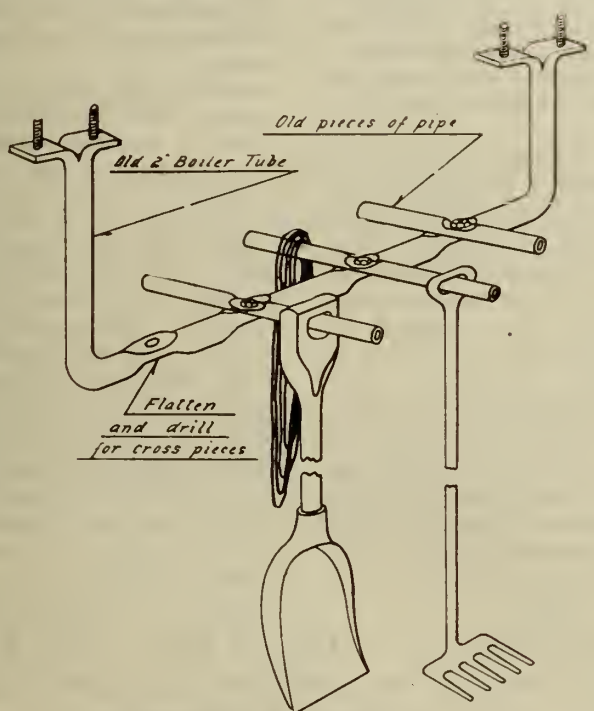
The Yarnall Waring Co., Chestnut Hill, Philadelphia, have issued a new list of users of the Yarway (formerly the Simplex) Seatless Blow-off Valve.

The Operators' Point of View

BOILER ROOM TOOL RACK

By CHAS. H. WILLEY

Old junk and spare time are easily turned into useful contrivances that make into the boiler room of a small plant in the plant more attractive and a better place to work in. Recently, I stepped Boston, Mass., and noticed the water tender has constructed a very handy fire



BOILER ROOM TOOL RACK.

tool rack. I sketched it out roughly and pass is along. It was made from an old 2-inch boiler tube and some short lengths of 1 inch. The hanger feet were made by splitting the ends of the tube, flattening out and bending back. The cross pieces are secured by flattening a section of their centre and drilling for bolts.

BOILER WATER TREATMENT

In POWER HOUSE of August 20 there is an article on the above subject which appears to contradict the results of other experiments, although the apparent contradiction may be explainable.

It is stated in the said article that soda ash, after a long series of experiment, has apparently been shown to produce brittleness in boiler steel, but it is not stated who conducted the experiments.

A series of experiments conducted by the University of Illinois Engineering Experiment Station on the embrittling action of sodium hydroxide (caustic soda) on soft steel, resulted in the following finding: "In general there seemed to be sufficient data for concluding that: (a) Caustic soda of sufficient strength attacks iron with the generation of hydrogen. (b) Hydrogen in the nascent state, whether generated by alkali or acid, enters into the texture of the iron in a way to modify its physical properties. (c) The hydrogen effect, at least in its first application, is transient, and after a period of rest or freedom from the hydrogen action, the iron reverts to its normal condition. (d) Sodium carbonate (soda ash or sal soda) is without action on iron; there is, therefore, no generation of hydrogen."

It would appear, from these experiments, that soda ash is perfectly safe to use. It is explained, however, that by the use of soda ash sodium hydroxide may be formed under certain conditions.

These conditions may be removed by the use of an open feed water heater in which the water will be heated to 212° Fah. with the result that carbonic acid gas is eliminated, and if the filtering capacity of the heater is sufficient, the carbonates of lime and magnesia will also be removed.

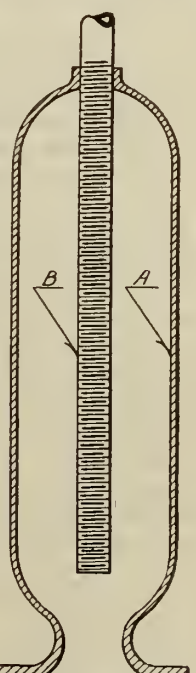
In connection with the open feed water heater, it might also be stated that the proper place to introduce the compound is after the water has passed the heater, when there will be only the sulphates to treat.

Possibly some other reader of POWER HOUSE has ideas on the matter, and can help us to learn more and earn more.

R. McLaren,
160 Dovercourt Rd.

CONNECTION TO AIR CHAMBER

This sketch indicates how someone connected the water discharge pipe to the air chamber of a pump. What the idea was I do not know, unless it was to economize in space or reduce the number of pipe fittings used or else avoid the friction of sending the water through one or two elbows as the water was being delivered to a point directly above the pump. By putting a long thread



PUMP AIR CHAMBER.

on the discharge pipe it was possible to insert it far enough into the air chamber to still have the advantage of an air cushion therein.—J.E.M.

A STUDY IN FUEL ECONOMY

Showing the Saving Possible by Proper Insulation

Steam production is essentially a wasteful process. At the very best,

we cannot hope to get anywhere near 100 per cent. efficiency out of the coal we burn. And without modern appliances for correct firing we cannot hope to approximate anywhere near this figure.

This is all the more reason why we should take care of this costly heat, every step of the way, from the time it is fed as coal into the hopper of the underfeed stoker until the last few B.t.u. are used up in the feed water heater.

Heat is far more evasive than gas. It leaks through a steel boiler plate or steam pipe, like water through a sieve. It leaks through unprotected valves, flanges and fittings—always seeking to level up its temperature to that of the surrounding air.

Steam at only 100 lbs. pressure has a temperature of 388° Fahrenheit, while even the hottest summer day will rarely exceed 90°, so that it takes only a moment's thought to realize the enormous leakage that can take place from even a few feet of uncovered or imperfectly covered pipe.

Steam Pressure.	100 lbs.	150 lbs.	200 lbs.	200 lbs. 100° Superheat
B.T.U. loss per hour per sq ft. bare pipe	802	937	1058	1735
B.T.U. saved per hour, pipe covered with proper insulation	676	795	905	1525
Tons coal saved per year, per 1000 feet of pipe so covered	270	218	362	565

Coal efficiency 14,000 B.T.U. per lb. Boiler efficiency 70%. Thickness of insulation 1 inch. 1 ton = 2240 lbs.

Above are some startling figures recently compiled from tests by the Mellon Institute of Industrial Research. Pittsburgh. They show in graphic form the actual fuel loss on bare pipes as compared with pipes covered with a good insulation.

Following are some figures compiled by the engineering department of one of the largest manufacturers of insulation in America. A 6" pipe conveying steam at 100 lb. pressure through even a hot boiler room with air between 80° and 90° Fahrenheit, will lose, if bare or uninsulated, 1,278 B.t.u. per lineal foot per hour. When the proper insulation is applied, two inches in thickness, on a 6" pipe, there is a saving in B. t. u. of 91.3%. This saving amounts to 1,166 B. t. u., or in other words, the loss by applying two inches of insulation is reduced from 1,278 to 112 B. t. u.

The subject of heat insulation is somewhat imperfectly understood, even by many of our best engineers.

The real object of insulation is to prevent the flow of heat to the outside air from the pipe through which it is being conveyed. The efficiency of an insulation is expressed by a percentage, which is the per cent. of heat saved by using the insulation as compared to what would be lost if no insulation were used and the pipe left bare or uninsulated. The efficiency of all insulations varies according to the size of pipe to which they are applied and according to the difference in temperature between steam in the pipe and air surrounding the pipe, as well as according to thickness of insulation.

It cannot be too strongly emphasized that every unprotected piece of metal in a steam system is a heat thief. Thus "one pair of ten-inch flanges will waste a ton of coal a year." It doesn't take much figuring on that basis to prove that there is an enormous amount of valuable heat going to waste.

Not every "pipe-covering" is a good insulator. There are some that are effective at low pressures, but useless for the higher temperatures. Others are good when first applied but soon deteriorate with the constant heat. Others again are frankly "made to sell." The trouble is, they all look alike on the pipes.

Whereas, in the early days of steam, hay, hair, wool, feathers and other materials of animal and vegetable origin, were freely used, the choice to-day for high temperatures is limited to a few non-organic materials of which perhaps the best known are the two described below.

The first, consists specifically of a mass of crystalized magnesium carbonate, in the substance of which is securely enmeshed a myriad of microscopically small dead air cells.

The second, is made up of layers of thin felt composed of asbestos fibre and particles of finely ground, spongy material, which contain a large number of very small enclosed air cells. These layers form an extremely cellular felt, built up like a book in laminated form, thereby confining a large volume of minute dead air cells both in the felt and between the layers.

It is this basic principle of "dead air" in microscopic subdivision that is vital to the efficiency of any heat insulation.

Air that circulates is an uncommonly good conductor of heat. Stagnant air is one of the poorest conductors. Thus, the more dead air cells per cubic inch of the covering, the greater its efficiency.

The test of the weight alone will always decide this question, always remembering that large air spaces, permitting heat loss by convection, are not suited for any but low pressure heating systems.

Never wrap a pipe with asbestos paper before applying insulation as it is a waste of time and money. If the insulation is any good at all it will safely withstand all the heat it can get.

It is well worth while finding out not only that your pipes, valves, flanges and fittings are covered, but that the covering is ample for the service demanded. If they are hot outside the covering, it is certain they are losing heat, and your covering is either unsuitable or insufficient.

Cover your feed lines as well as your exhaust. Protect your boiler walls and breechings as well as the tops. There is no real reason why your engine room or boiler house should be excessively hot at any period of the year. It merely means you are warming "all outdoors" instead of carrying your heat where it is most needed.

Heat leakage spells total loss, just as surely as does poor firing. It spells unnecessary overhead costs that may some day help to lose you a big order. It is as unnecessary as any other form of waste and just as easy to cure.

In selecting an insulation, be sure and pick a covering that is pliable, will readily conform to the surface it covers, stand pipe, vibration, expansion, and contraction, will not pulverize or break away, and when subjected to excessive moisture. will dry out and regain its initial efficiency. This and its heat resisting qualities. mechanical ability to withstand everyday wear and tear, cover the important points which should be taken into consideration when selecting the proper insulation.—"The Combustion Chamber."

Some Notes on the Theory of Heat

By T. H. FENNER, Extra Chief Engineer, M.I. Mar. E., London.

AS the steam engine, the Diesel engine and the steam turbine are all heat engines, is is necessary for the student of marine engineering to get a firm grasp of the theory of heat. When this is understood its application in the various forms of marine and other engines can be readily understood.

To begin with, the student must learn to disassociate the terms temperature and heat. To the average man, the one term means the same as the other, but to the engineer there is a distinct meaning to each.

Sensible heat, or temperature, is heat that is capable of being measured on a thermometer, or in other words, that can be appreciated by the sense of sight. The temperature of a room, the water that we drink, or the flame of a fire can be felt, and can be read on the scale of a thermometer, but heat itself can neither be seen nor felt.

Before the present scientific theory of heat was accepted, heat was supposed to be a substance, but research and experiment have proved that heat is a form of energy or motion.

Since heat is a form of energy, and as such can be employed to do useful work, we must have definite units by which it can be measured. The unit of work is a foot pound and is the amount of work which is performed when a weight of one pound is raised one foot. This is not affected by the rate at which the work is perfomed. It does not matter if it takes one second, one hour, or one year. The actual work is one foot pound.

The unit of heat, or, as it is commonly called, the British thermal unit, is the amount of heat required to raise one pound of fresh water one degree in temperature when at its maximum density, that is from 39 degrees to 40 degrees Fahrenheit.

Now, clearly, if there is a definite relation of work to heat there is a definite relation of the units of one to the units of the other.

Although many investigations and experiments have been made, the unit determined by the famous Joule is the accepted one, though it has been modified slightly by later experiments. He found that the mechanical energy required to raise one pound of water one degree was 772 foot pounds. This has since been modified to 778 foot pounds, which is the accepted standard at the present day The student can find the experiment described in detail in almost any good book on elementary mechanics or steam. This unit has been named Joule's equivalent, in honor of the investigator.

The Nature of Heat

Heat can be transferred from one body to another, and in so doing affects the body to which it is transferred in one of two ways—it either increases the temperature of that body or changes its state, and the body from which it is transferred is lowered in temperature or has its state changed. It may both raise the temperature and change the state of the body, but the one effect precedes the other, and between the two we get the phenomena of latent heat.

Latent Heat

Latent heat is so called because its effect is not apparent to the senses, but is absorbed in the substance which it enters, its only effect being to change its state. It is this latent heat which is the most important to engineers, because it is the energy stored up in it that enables them to utilize the expansion of steam to perform useful work in an engine or turbine. It is also the latent heat of ammonia, carbon dioxide, and sulphur dioxide which makes refrigeration a commercial possibility. It is most important that the properties of latent heat should be thoroughly understood.

If we take an open saucepan and fill it with water, and hang a thermometer over it with the bulb in the water and place it over the fire, the temperature as shown by the mercury will rise. This rise will go on until the mercury shows 212 degrees on the Fahrenheit scale. If the water had a temperature of 40 degrees when we placed it on the fire the amount of heat transferred to the water would be 212 —40=172 units for every pound of water in the pan. Suppose the pan held 10 pounds of water, we should have 720 heat units. or British thermal units. commonly called B.t.u.'s. Now if we allow the water to boil away, keeping the bulb of the thermometer in the water as it goes down until none remains, we should still find that the thermometer reads 212 degrees. Clearly, if the heat has been going into the water all this time we must have added a considerable number of heat units. but all we have to show is the same reading. All the heat added since our themometer reached 212 degrees has been absorbed in making the change from water into steam. It has become latent heat, and the number of heat units required to change one pound of water to one pound of steam at atmospheric pressure is 966.6, therefore the total number of heat units required to change our 10 pounds of water at 40 degrees Fahrenheit and at the pressure of the atmosphere to 10 pounds of steam at 212 degrees and the same pressure would be (212—40+966.6) +10=10,386 B.t.u. This amount of heat represents a mechanical energy of 10386×778=8,080,308 foot pounds. If this work was done in one minute the equivalent horsepower would be 8,080,308÷33,000=244.8 h.p. Let us take a further illustration. Suppose we have a block of ice weighing ten pounds, and we place it in a refrigerator, the temperature of which is above the freezing point, 32 degrees Fahrenheit. Instead of allowing the water to drip away as the ice melts, catch it all in a pan, and when the ice has finally melted, read the temperature of the water. It will be found to be immediately after melting the same as the ice was before melting, but the temperature of the refrigerator will have lowered. What is it that has lowered the temperature? It is the heat that has been absorbed into the ice to change its state from a solid to a liquid, and is 140 B.t.u.'s for every pound of ice changed into water. In other words, if this amount of ice had been melted over a fire you would have had to transfer 1,400 B.t.u.'s into the ice at 32 degrees to get ten pounds of water at 32 degrees. From this we get the latent heat of ice and water at atmospheric pressure, 140 and 966.6 respectively.

The foregoing constitutes what is known as the first law of thermo-dynamics, and is stated as follows:

Heat and work are naturally convertible, and heat requires for its production and produces by its disappearance. mechanical energy in the proportion of 778 foot pounds for each unit of heat.

MORE POWER PLANT AND OTHER KINKS

By J. E. MacCormack

For making small mechanical drawings or rough shop sketches, as for instance of a broken or worn unnumbered part which is to be replaced, a two-foot four-fold drawing rule (the type which is six inches long when folded, can sometimes be used to serve the purpose of an absent T-square. On a sheet of paper 8½ by 11 a fair sketch of 6 by 6, or even larger, may be made on one corner by means of the rule and a pencil. The rule is opened to right angles by setting it to the angle of the corner of the paper. Then for drawing lines, hold the rule by the same sections you are using as a ruler and keep the other sections even with one side or one end of the paper. This gives parallel lines two ways and to some extent the figures and graduations on the rule may be made use of in determining the distance apart and the length the lines should be to give the required proportions. If the rule is stiff in the joints it will keep its right angle position, or, if loose, a pin or tack flattened and pushed into the hinge may tighten it enough to hold so long as the rule is not held by one leg while the pencil is bearing against the other in lining.

For drawing ink lines with a common pen this also serves better than a ruler lying flat, since the pen nib need not touch the ruler and therefore does not ink it, and the six-inch projection at right angles prevents any tendency to the rolling motion that would be present with a flat ruler held on edge for the same purpose.

In the event of an engine running away because of an accident to the governor belt when the engine is equipped with only a slow-acting screw throttle, or a globe valve for a throttle, and is not equipped with an automatic engine stop, then a few seconds difference in the time of getting acceleration prevented may make the difference between little harm done or having a wreck. The operator may sometimes save a few seconds by giving attention to the governor first and utilizing it as a sort of lever throttle to prevent further acceleration until he can get the slower screw throttle closed. With the ball and lever type of governor he can raise the lever arm until the valve comes to a position where it will shut off most of the steam, thus preventing further acceleration. With the smaller sizes of engine he can generally reach the throttle and close it while holding the governor. If the engine does not permit of this it should certainly be equipped with a reliable automatic engine stop. With the ball and lever governor it will not do to raise the lever too lest the valve be passed too far past its seat and there be difficulty in getting it back again. To avoid this, something could be firmly fixed above the engine and extending downward in such a way as to nearly touch (within ½ in. or 1 in. if the valve will permit without catching) the governor lever when the engine is running at normal full speed. The object of this is to prevent the operator raising the lever too far by hand. With the globe valve type of throttle, if the hand wheel be replaced by a heavier wheel having a balance wheel action, the valve may be closed more quickly in an emergency, but there is some danger of jamming the valve face. If the operator practices the above-suggested method of shutting off steam when he is stopping, anyway, he will be less apt to get confused in attempting it in emergency.

The town of Hanley, Sask., want tenders which will be received up till Sept. 24th, 1919, for the supply of the following machinery One internal combustion engine, generator, exciter, switchboard, transformers, meters. The supply and delivery of poles, erection of pole lines, and erection of power house. Plans and specifications can be obtained from the consulting engineers, Murphy & Underwood, Saskatoon, and the Secretary-Treasurer, Hanley, Sask.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A 20% on list; class B and C, net list. Cast iron fittings, 26% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..		7 50
Premier, 10¾ oz.....		7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard .....30.	10%
Cut leather lacing, No. 1....$2	20
Leather in sides 1	75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above..	8 40
Wood screws, flat, bright....	76
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly 0	34
Solder, guaranteed 0	39
Babbitt metals ..... 18 to	70
Soldering coppers, 3 to 6 lbs. 0	58
Putty, 100-lb. drums..... 6	75
White lead, pure, cwt..... 17	80
Red dry lead, 100-lb. kegs, per cwt. 16	50
Glue, English 0	35
Gasoline, per gal., bulk 0	33
Benzine, per gal., bulk.... 0	30½
Pure turpentine, single bbls., gal. 1	03
Linseed oil, raw, single bbls. 1	95
Linseed oil, boiled, single bbls. 1	98
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D," per lb. 0	03
Rosin "G," per lb. 0	03½
Borax crystal and granula. 0	14
Wood alcohol, per gallon.... 1	80
Whiting, plain, per 100 lbs., 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..$0	34
Sheets, 24 oz. and heavier base 0	42
Brass tubing, seamless 0	46
Tubing, I.P.S., 1" base..... 0	48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING.

Standard	10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper $22 00		$21 00
Electro copper 21 00		20 75
Castings, copper 21 00		18 00
Tin 55 00		55 00
Spelter 9 25		8 50
Lead 7 25		6 50
Antimony 9 50		9 50
Aluminum 36 00		35 00

Prices per 100 lbs.

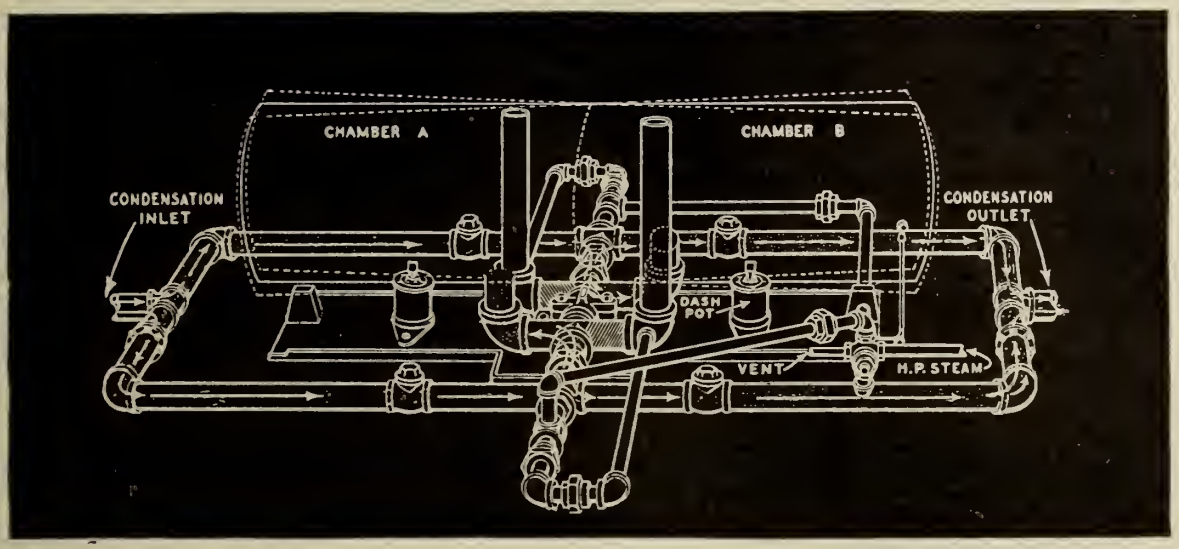
ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12 00		$13 25
Sheets, 3½ lbs..... 12 00		13 25
Sheets, 4 to 6 lbs.... 10 00		12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.



Farnsworth Condensation Pumps

Farnsworth Condensation Pumps offer a double saving through their closed system of keeping the Condensate under pressure and returning the maximum number of heat units to the boiler at the same time operating on a small friction of steam required to operate a reciprocating pump.

This feature of Condensation Pumps is sufficient to recommend them for your consideration when making a replacement. This type of pump and steam trap are fast gaining favor in plants where pumps are employed.

Let us tell you how these pumps are operating in other large Canadian Plants.

The Canadian Fairbanks-Morse Co.

Limited

"Canada's Departmental House for Mechanical Goods"

St. John Quebec Montreal Ottawa Toronto Hamilton Windsor
Winnipeg Saskatoon Calgary Vancouver Victoria

MARINE BOILER LOGIC

The Heine Safety Boiler Co., St. Louis, Mo., has just completed the printing of "Marine Boiler Logic," a 69-page booklet dealing with the fundamental design of marine cargo carriers. The booklet was written by Chas. H. Stoddard, consulting marine engineer of the Heine Company.

The main part of the booklet relates to the design and construction of Scotch and water tube boilers for marine purposes. Evaporative capacities are worked out for the two types, using coal or oil as fuel, with natural or forced draft. The booklet contains also a discussion of power and speed of cargo vessels, formulas being developed showing the relation between boiler and prime mover capacity, and the dimensions of the hull. In making these computations, the method developed by Rear-Admrial D. W. Taylor of the United States Navy has been used with certain modifications suggested by Mr. Stoddard's experience.

The last part of the booklet is devoted to a description of the construction and operation of the cross-drum type of water tube boiler developed by the Heine Company for marine service.

Folder on Ash Conveying

"Have you ever counted the cost of moving ashes from boiler plant to bin or pile?"

That is the "pertinent ash pile" question the American Steam Conveyor Corporation, of Chicago, are asking their prospective customers in the latest folder put out by this concern.

This folder advances in a logical way arguments favoring the use of an American Steam Ash Conveyor in power plants, and shows the savings that can be accomplished through its use.

McCutcheon, Ferguson and McCutcheon, Sarnia, have ordered from the Frick Ice and Refrigerating Co., Montreal, one nine-ton refrigeratring machine of the enclosed type, belt driven. This, with the room piping also ordered, will be used in their cold storage plant.

Trade Commissioner H. G. McLean, at Rome, writes of new metal alloy of zinc and copper which has been given name of Biakmetal. This alloy quickly demonstrated its usefulness in Italian industry, and by reason of its special qualities promises to attain similar success throughout world. It is stronger than steel and less corrosive than copper.

TRADE GOSSIP

Finished Shop.—In St. Thomas the M.C.R. have just completed new shops of very fine construction.

Grant to New Industry—The property owners of Cobourg have voted in favor of a by-law to grant the Douglas Packing Company $5,000 towards securing an adequate supply of water for their new plant. The plant consists of five new buildings erected on the site of the old steel works.

Coal Mine Re-Opens.—The Dominion Coal Company has opened the New Victoria Mine at Sydney, N.S. This mine was closed down as far back as 1902, and was re-opened in 1913, but was closed down again at the outbreak of war in 1914. At the time it was closed down in 1902 the mine had a capacity of 1,800 tons per day and employed about 400 men.

Ottawa Employment Statistics.—According to reports from the Employment Service of Canada at Ottawa, there is no serious unemployment in the Dominion. The Government employment officers all over the country were placing on an average of 10,000 workers per week, and during the harvesting rush this number was increased to 12,000. The total number of applications from March 1 to August 23, was 190,455. During the same period 201,785 positions were offered by employers, and 139,492 persons were placed in positions. The service moved 15,000 workers to the West for the harvest, and made it unnecessary to import labor for this purpose.

PERSONALS

The death is announced from Trenton, of Robert Weddell, the prominent harbor contractor. Mr. Weddell was well-known in Toronto, and was the contractor for the Western entrance to Toronto harbor. He also was successful in bringing in the intake pipe after the Works Department had made several unsuccessful attempts. He was a personal friend of Mayor Church and George Wright of the Walker House. He leaves a son.

Mr. Ignace Schilowsky, consulting engineer with the Youroveta Home and Foreign Trading Co., 165 Broadway, New York, has been spending some days in this district. Appointed by the first provisional government following the revolution in Russia in 1917, Mr. Schilowsky came to America with the Russian ambassador. Of course the present Government in Russia does not recognize any of these appointments, and so it is that the Russian legation of that time is now interesting itself in preparing for the development of mineral deposits in Russia as soon as conditions there will permit. "Before the war," stated Mr. Schilowsky, in discussing Russian mineral wealth, "the country was supplying much of its own copper, using up-to-date methods, although financed by foreign capital. Iron ore in Southern Russia is also found very near to large deposits of suitable coking coal. The development of these deposits was undertaken largely by French and Belgian capital." The new developments will take place in Siberia, where there is potential wealth. The Irtysh Corporation, financed by English people, has already done much here, and will proceed again as soon as the people in control there decide in which direction they are going. During his stay in this country Mr. Schilowsky has visited the Shawinigan plant, Montreal, asbestos mines in Quebec, Ottawa, Sudbury, Toronto and Niagara, being especially interested in water power development and the various methods that are used in treating metals in this country.

DRAUGHTSMEN'S ASSOCIATION

It is not, perhaps, generally known that there is in Canada an organized Draughtsmen's Association with headquarters in Toronto.

This society was organized on May 16, and on the second and fourth Friday of each month hold regular meetings in the Sons of England Hall at 6.30 p.m.

We understand that the main objects of this association are to promote the economical and intellectual welfare of the class, to encourage intercourse between all draughtsmen, to facilitate the acquirement and interchange of professional knowledge among the members, also to bring about a better understanding between employers and employees, and to procure the means of securing employment and supplying help. The president of the association is Mr. Geo. H. Rix, of the Canadian National Railways; the secretary is Mr. Arthur E. Fetherstonhaugh, architect, 234 Kingswood Road, Toronto, to whom all communications should be addressed.

The Belt Grip Pulley Company of Canada, Ltd., has been incorporated to carry on business as manufacturers of all kinds of pulleys and wheels. The capital stock is $200,000, divided into 20,000 shares of $10 each, the head office being in Toronto.

Japs Have Trouble:—T. Hiroto, managing director of Ocean Transport Co. of Kobe, Japan, announced in San Francisco that owing to excessive costs of ship construction in Japan, and the inability of Mikado's builders to accept and turn out orders, Japanese are planning to come to San Francisco to have additional tonnage constructed.

CANADA HAS 26 958,411 CUBIC FEET COLD STORAGE SPACE

The following, from a summary of an address on the subject of Cold Storage Facilities in Canada, delivered by Mr. J. A. Ruddick, Dairy and Cold Storage Commissioner, Department of Agriculture, before the select standing committee of the House of Commons on Agriculture and Colonization, is taken from the August issue of the Agricultural Gazette of Canada, published monthly by the Department of Agriculture:

"There should be ample storage facilities for the handling of dairy produce and meats in the localities where these articles are produced. The abattoirs of the country provide their own facilities for the chilling or freezing of meats as the animals are slaughtered. The largest cheese factories and creameries are also fairly well equipped in this respect. There is also required good refrigeration car services with a sufficient number of cars of the right type to carry the products in proper condition. For the export meat trade there are also required terminal warehouses where refrigerator

cars may discharge their freight close to the ocean berths. We also require suitable refrigerator space on the steamers if our overseas trade in perishable food products is to be fully developed.

Cold Storage Warehouses

"There are about 190 cold storage warehouses in Canada. All of these warehouses are equipped with mechanical refrigeration, except a few very small ones in which the crushed ice and salt system of refrigeration is used. Not including the smaller plants used in connection with retail shops, we have in Canada a total of 26,958,411 cubic feet of refrigerator space. There are also quite a large number of smaller private storages running from about 2,000 cubic feet to as high as 20,000 cubic feet capacity. These provide about 758,000 cubic feet of space, making a total of 27,717,211 cubic feet available for cold storage of meat, fish, dairy, and other products.

Refrigerator Cars

"The several railways of Canada have a combined total of 4,459 refrigerator cars, made up as follows:

Railways	Ordinary cars.	Brine tank cars
Canadian Pacific	504	1,931
Grand Trunk	965	200
Grand Trunk Pacific	39	195
Canadian National	*625	
Total		4,459

*Kind not specified.

"The Canadian Pacific Railway has also 100 cars equipped for use on express trains.

Terminal Warehouses

"The cold storage warehouses at Montreal, Que., and other places fill the requirements to some extent. They meet the needs of the dairy produce trade fairly well except in the matter of economical handling. A large cold storage warehouse now under construction by the Harbor Commissioners at Montreal will be situated on the docks, will have track connections with all the railways, and will have at least one steamer berth where goods can be loaded direct. The location is very central, being close to present produce district. Provision will be made for unloading directly from the cars into the warehouse and from the warehouse direct to the steamers. This warehouse will have a total capacity of 2,000,000 cubic feet, and will cost in the neighborhood of $1,500,000.

Ocean Refrigeration

"Until overseas transportation becomes normal again there may be some shortage in refrigerated space for trans-Atlantic shipments. Before the war there were forty-five steamers with refrigerated space sailing from Canadian ports to the United Kingdom and four to South Africa, with a total refrigerated capacity of 1,072,476 cubic feet. There were also eighteen steamers equipped with 800,000 cubic feet of cool air space suitable for cheese, bacon and apples. For the current season the indications are that there will be only twenty steamers as against forty-five going to the United Kingdom and one against four to South Africa, having a total refrigerated capacity of 375,212 cubic feet of space which is less than one-half of what was available before the war. Ten steamers are equipped with cooled air compartments, with a total of 159,800 cubic feet capacity, as against 800,000 cubic feet before the war. The shortage is accounted for by the sinkings by submarines and the present use of boats carrying large accumulations of meats and dairy produce from Australia and New Zealand.

"The Department of Agriculture, through the Dairy and Cold Storage Branch, undertakes the inspection of refrigerated cargo on ocean steamships sailing from Canada. This service has been in operation since 1900. A number of inspectors are stationed at Montreal to watch ships being loaded with perishable products, chiefly of those kinds that are carried in refrigerated space. Thermographs are placed in different parts of the ship where perishable products are carried. These instruments automatically record the temperature continuously during the voyage. When a ship arrives at a United Kingdom port another inspector secures the charts and thermographs and returns them to Montreal. Copies of the charts are made available to any person interested in the shipments. The Dairy and Cold Storage Branch has records covering practically every shipment that has been made for the last twenty years."

ENGINEERS WANTED

To sell locally for firm of mechanical and electrical engineers, and secure inquiries for firm handling pumps and general power apparatus, on commission basis. Address

MACLEAN & BARKER
128 Bleury St. Montreal

WANTED — A FIRST-CLASS EXPERIENCED operating engineer, to take full charge, and be capable of managing Water Works Plant in Ontario City, with High Duty Pumps, also Steam Turbine and Electrically Driven Motor Pumps, with Staff of Operating Engineers and Firemen. None but thoroughly competent man need apply stating experience and reference. Address Box 150, Power House, Toronto.

BOILERS FOR SALE

ALL IN EXCEPTIONALLY GOOD CONDITION —17 Atlas Horizontal Tubular Boilers (Babcock & Wilcox), 60 inch by 16 feet, with Jones Underfeed Stokers: Boilers lying at Kitchener. 1 350-H.P. Erie City Boiler. 4 250-H.P. Scotch Marine Boilers with wet heads, now lying at Wallaceburg plant.

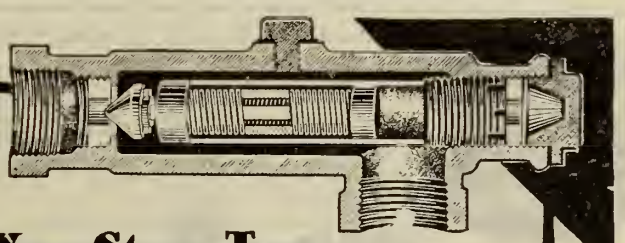
Dominion Sugar Co., Limited - Chatham, Ontario

The J. C. Wilson Mfg. Co., Limited
BELLEVILLE, ONTARIO

Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.

Makers of the "Little Giant" Turbine.

Put your water wheel proposition up to us



Save ⅔ Your Steam Trap Costs with a SARCO !

For about one-third the price of a bucket or float type of steam trap, you can get the Steam Trap Sarco—a compact, simple trap of improved type that does the same work as the more cumbersome and expensive kinds.

It has only one moving part. No levers, gauges, stuffing boxes, etc., to get out of order or need constant adjustment.

The Sarco operates automatically and dependably by the opening and closing of a valve controlled by a sensitive, but *absolutely reliable* expansion element. It allows no condensation to gather in the pipe. It wastes no steam. It does not leak.

Because of its small size, you can install a Sarco in the most limited space at any point on the line, at any angle, without change of piping. Requires no building up, no supports, no floor space.

It is guaranteed for any given pressure up to 200 lbs. Made in sizes ⅜" to 3".

Don't pay three times as much as you need to for a steam trap.

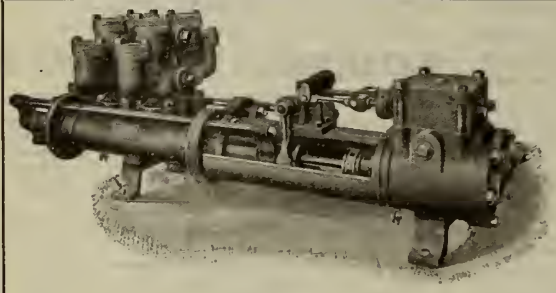
Let us send you the Steam Trap Sarco for a 30 days' trial, free of cost or obligation. Booklet "J" on request.

SARCO COMPANY, Inc.

239 Broadway New York City

Ellicott Square, Buffalo Drexel Bldg., Philadelphia.
Monadnock Block, Chicago. Majestic Bldg., Detroit.
And representatives in all principal cities.
Canada: Peacock Bros., Montreal.

HINTS TO BUYERS

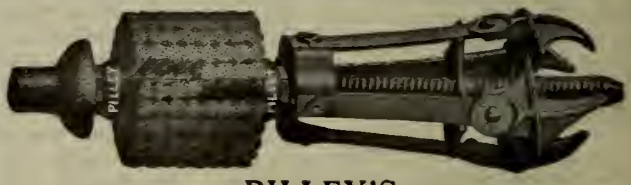


PUMPS that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited
Hamilton, Canada

The Simplest and Best Cleaner on the market is



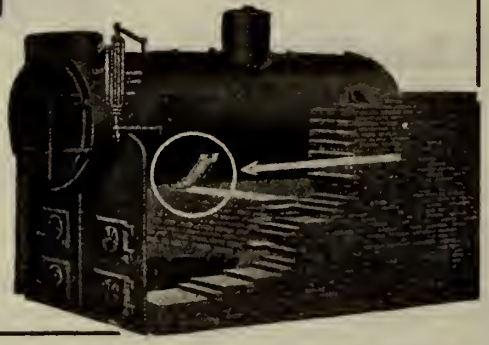
PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

NATIONAL Boiler Girth Seam Protector

Protection means longer life and greater efficiency

If your Boiler is not Fire-cracked it eventually will be. Prevent this by putting on a National Boiler Protector. You will save cost in repairs and prolong life of the boiler. All new boilers should be protected. If your girth seam is giving you trouble at the present time, have the seam caulked up, attach one of these proteotors and the seam will remain absolutely dry thereafter.



Guaranteed for one year. We make protectors for patches and all styles of boilers. For full particulars, write—

National Boiler Protector Co.
Room 24
Lombard Building
TORONTO
Main 2623

LADD WATER TUBE BOILER

The Ladd Water Tube Boilers are designed throughout to withstand heavy firing. Built in any size and for any of the many methods of firing.

Our catalogue will interest you.

GEORGE T. LADD COMPANY
Farmers Bank Building
PITTSBURGH - - PENN., U.S.A.

LANCO BALATA BELTING

FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

REMEMBER
Power House Subscription Price is still only $1.00 per year. Tell the other fellow.

Public Finance Disaster of Early Canadian Days

The almost forgotten experience of our forefathers, of which, to quote Sir Oliver Mowatt, "The effect was to diminish the value of municipal securities generally, and to corrupt the moral sense of the people with reference to moral obligations," makes a fascinating and thought-stimulating article as presented by Dr. J. Murray Clark in recent issues of THE FINANCIAL POST.

Dr. Clark, dealing with this Municipal Loan Fund of the fifties, says of its author, Sir Francis Hincks:

> He had in some respects genuine ability and, in matters which he understood, rendered considerable useful public service, but he was an idealist and a theorist without any practical grasp of the rigorous laws and unyielding facts of finance. He was patriotic and well-meaning, but his patriotism and good intentions did not save the country from the inevitable consequences of his scheme which those able to think clearly on matters of finance perceived from the beginning. He possessed in an eminent degree that fatal fluency of persuasive speech with which so many of our politicians are endowed, and swayed the people, for whom he expressed and probably felt sincere devotion, with superficial catchwords and glittering generalities not founded on the stern realities of economic laws. The confidence he inspired only enabled him to do infinitely more mischief than would otherwise have been caused by his scheme, and did not protect the people from the losses and distress resulting from disregard of sound business principles.

There is more here than an interesting story of early days. Here is a marking on the map of Canada's history by which all interested in the country should make their reckonings, should chart their course of action.

THE FINANCIAL POST is continually presenting such articles. Consider some which appeared in the early issues of August:

Grain Growers Condemned by a Retailer.
Bolshevism and Public Morals.
Some Alberta Oil Wells Are Showing Profit.
Bright Outlook for Canadian Pulp & Paper.
Why Henders Fell Out With Grain Growers.
Sawyer-Massey on the Road to Better Times.
Sir Adam Gets in Some Fine Work at Guelph.
Dominion Loan Campaign to Start Oct. 27.
Frank A. Vanderlip Continues His Vivid Survey of War-ridden Europe.
Make Maturities of Loans as Short as Possible.
Tariff Action by Liberals Step in Dark.
Canners' Head Gives Answer to Prof. Jackson.
Small Retailer Renders Service to the Community.
Reorganization of the Standard Reliance Corporation.
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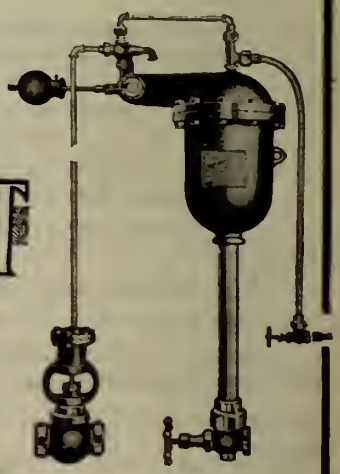

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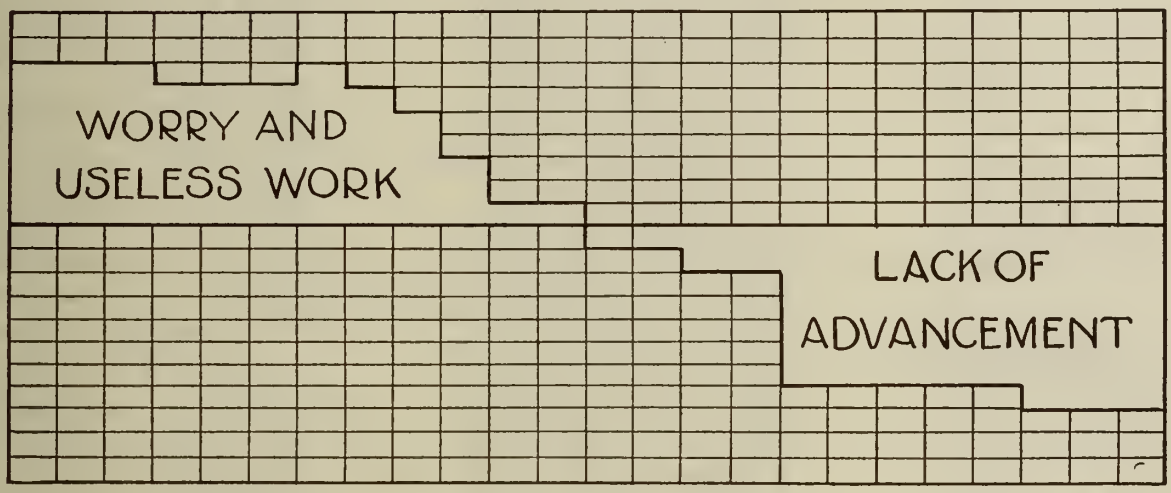

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Williams Machinery Co., A. R., Toronto.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que
Beveridge Paper Co., Ltd., Montreal, Que.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, South Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, GAS.
E. J. Philip & Sons, Toronto, Ont.

METERS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Company, Limited, Toronto, Ont.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OIL METERS
S. F. Bowser Company, Limited, Toronto, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OIL PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OILING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo

OVERALLS
R. G. Long & Co., Toronto, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.

PACKING ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durahla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durahla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING PISTON
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINT OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont

PROPELLOR BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.
PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Works, South Norwalk, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GAS
Norwalk Iron Works, South Norwalk, Conn.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Antomatic Regulator Co., St. Louis, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
S. F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
RAGS
Shell Bar Boico Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Limited, Toronto, Ont.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
REGISTERING MEASURES
S. F. Bowser Company, Limited, Toronto, Ont.
RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
RECORDING INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.
REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Norwalk Iron Works, South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.
REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.
ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.
SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal Que.
SHAFTING
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
Waterous Engine Works Co., Brentford.
J. C. Wilson Mfg. Co., Belleville, Ont.
SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.
SMELTER LININGS
Beveridge Paper Co., Montreal, Que.
SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.
SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.
SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass
SPROCKETS, COMPENSATING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal
Cole, Ltd., Geo. W., Toronto.

Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Mason Regulator & Engineering Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

SWIVELS, HOOK
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The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

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Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

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In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

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Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

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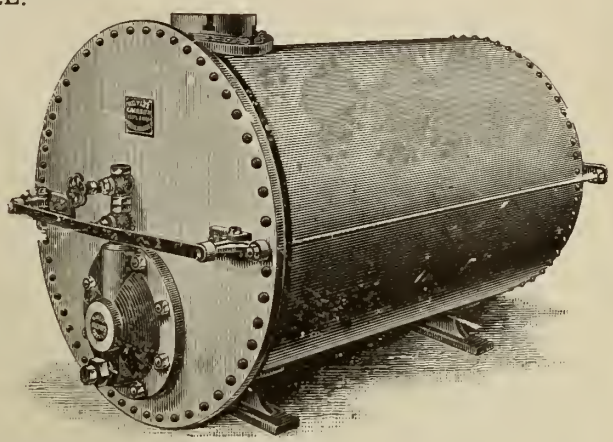
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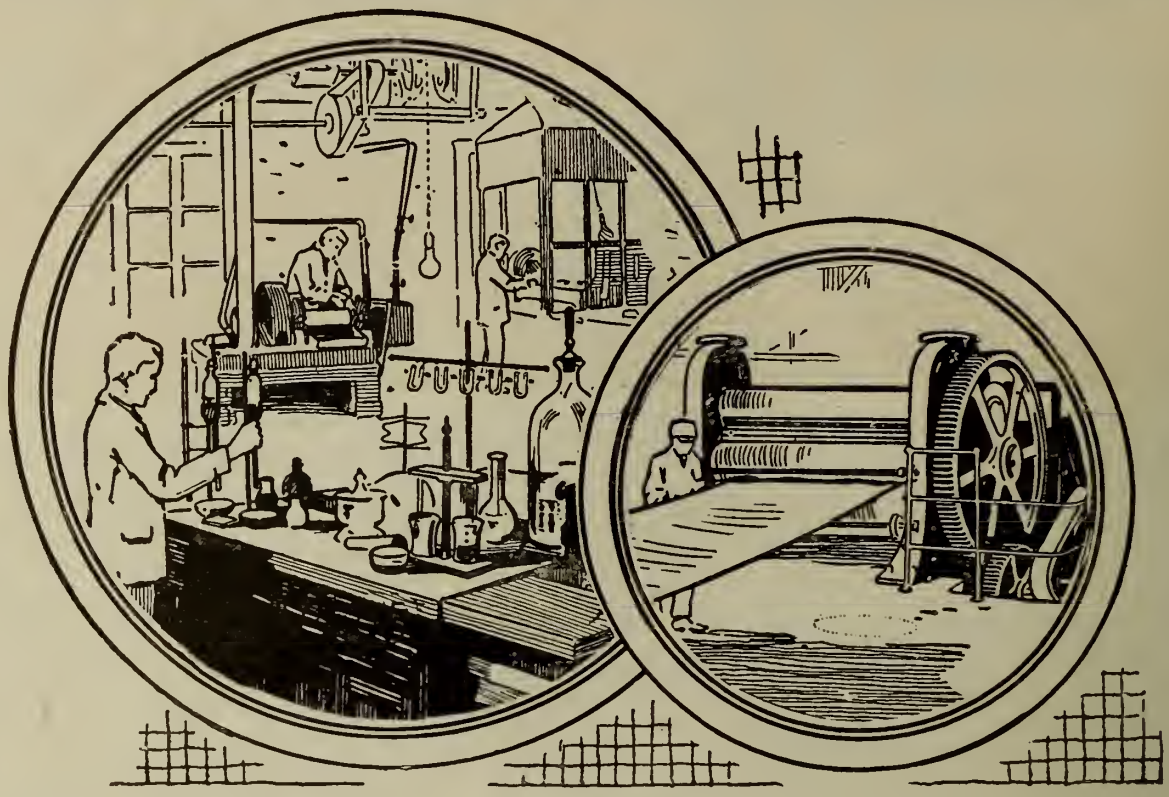

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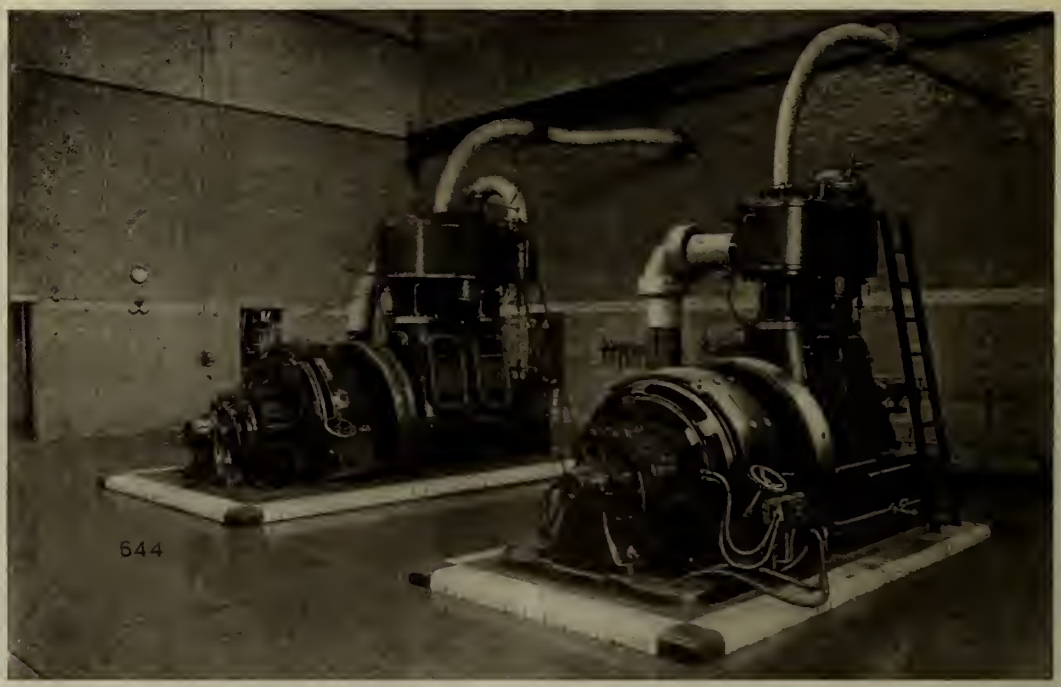


Belliss Engines at McGill University Power House

Steam and Exhaust Turbines
Diesel Engines, Air Compressors
Condensing Plants, Steam Engines

Heanan Refuse Destructors
Air and Water Coolers
Dynamometers

Paterson Water Softening Plants

Centrifugal Pumps

LAURIE & LAMB

Engineers

211 BOARD OF TRADE BLDG. - - MONTREAL

POWER HOUSE, October 5, 1919, Vol. XII., No. 16. Published semi-monthly at 143-153 University Ave., Toronto, Canada. Subscription price in Canada, $1; in United States, $1.50. Entered as second-class matter at the Post Office Department, Ottawa, Canada. Entered as second-class matter July 1, 1912, at the Post Office at Buffalo, under the Act of March 3rd, 1879.

THEY ARE NOT GOING TO BE DENIED THE SHOWER NOW

A 932—Nickel plated Shower with rain shower head, rubber tubing faucet connection and round curtain ring, with white duck curtain and wall hook.

THEY met it first in the training camps —it was part of their treatment in the convalescent hospital—it was included in the routine of the demobilization camps.

So the best of Canada's young men have become educated to the Shower—they know what it means to their health.

It is up to you to see that they get a Shower in their homes—the kind of shower that will give satisfaction—an EMPIRE SHOWER.

Let them know that you can supply the Portable Shower illustrated here.

It is specially adapted for use when a permanent shower is not practicable in a rented house, an apartment, or other places where space is limited. It is all that a shower should be.

Empire Permanent Showers in the latest and improved designs will be in demand as well.

You are going to be called on for Shower estimates.

Write for our catalogue and order direct from us.

Empire Manufacturing Co., Limited

London Toronto

Canada

TALBOT
Contra-Flow Steam Boilers
(Equipped with Crude Oil Burners)

Reduces Steam Cost

The cost of operation is cheaper than any known power product.

Require one-seventh the space of the ordinary boiler.

No brickwork is necessary.

Feed water and fuel burners are automatically controlled to adjust the boiler to varying demands for steam.

Tubes easily replaced under high steam pressure.

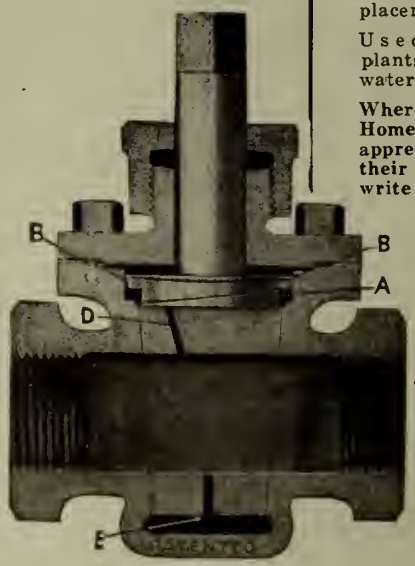
May we send you the full details?

Canadian Manufacturers and Sales Office:

Montreal General Tool Co., Limited

675 Notre Dame, Maisonneuve
MONTREAL, P.Q.

HOMESTEAD
QUARTER-TURN
VALVES



Stop Leaks
and Cut Your Replacement Costs in Half

Instead of globe and gate valves use Homestead Quarter Turn Valves. They will not only keep your pipe lines free from leakage, but by their long and satisfactory service cut your replacement costs in two.

Used by leading power plants on steam, oil, air, water and acid systems.

Where the service is severe Homestead Valves are best appreciated. Let us explain their features in detail — write to-day.

Homestead Valve Mfg. Co.
Homestead, Penn.

Homestead Three-Way Type

UEHLING WASTE METER
COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO_2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO_2 Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

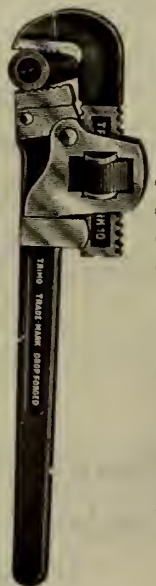
CO_2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

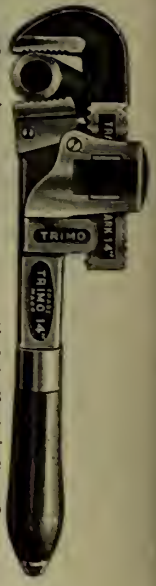
Uehling Instrument Company
2008 Empire Building **New York City**

TRIMO
THE WORD TRIMO



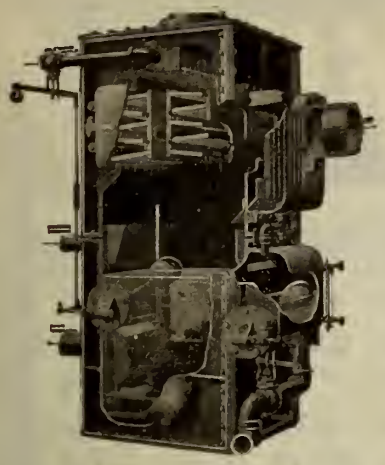
Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)



The four good points that make **Trimo** Pipe Wrenches superior are the Spiral Spring always in place—Steel Frames that will not break—Nut Guards that protect adjustment nut—and the Inserted Jaw in handle that can be replaced when worn —Save Money and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston), Mass.



5,000 series Cochrane Open Heater for back pressure service, used in connection with heating systems

SAVE A PILE OF COAL

BY using exhaust steam you may reduce your fuel consumption ten to fifty per cent. Where exhaust steam is used in heating, drying, etc., the cost of power is practically nothing, as it becomes a by-product. If you have more exhaust steam than you can utilize for heating, drying and similar purposes, turn it into the intermediate stage of the main turbine or into a low-pressure turbine. To prevent the vacuum from the turbine backing up into the engine exhaust line, and drawing in air, to the detriment of the condenser vacuum, install a Cochrane Multiport Flow Valve in the engine exhaust connection.

Use exhaust steam for heating water for boiler feeding, washing,dyeing, scouring, paper making, hot water heating, etc. In the Cochrane Open Heater the water comes into actual, immediate contact with exhaust steam and is heated to the full steam temperature. There is no loss of temperature due to transmission through metal plates or to accumulations of grease or scale upon heating surfaces. The exhaust steam condensed in heating the water is added thereto, so that one pound of exhaust steam and six pounds of cold water produce seven pounds of water at 210 degrees F., or hotter, depending upon the back pressure carried.

Heating the boiler feed from hot well temperature, say 90 degrees F. to 210 degrees F., will reduce the amount of fuel required under the boilers by at least ten per cent. If your feed water is colder than 90 degrees F., larger savings are possible.

If large quantities of hot water are used intermittently, as in textile mills, paper mills, laundries, etc., a Cochrane Heater of the extra storage type can be used both for heating and storage.

Fig. 1000 — Multiport Back Pressure Relief Valve "Note Multiple Disks"

For regulating the pressure upon the exhaust steam system, use the Cochrane Multiport Safety Exhaust Outlet Valve. In this valve, noise, clatter and injury to valve and seats are avoided by the use of a number of small disks instead of one large disk. Each disk is provided with an independent dash pot and held to seat by an independent spring, the tension of all the springs being adjusted simultaneously by a pressure plate. The motion of this plate is limited, so that a predetermined back pressure cannot be exceeded. The adjustment of the back pressure is controlled by a hand-wheel on the outside of the casing, or from a distance by means of chains, rods or levers. The pressure can be changed quickly with little effort.

Ask for Bulletins 710 on Heaters, 601 on Multiport Valves

Canadian Allis-Chalmers, Limited

HEAD OFFICE, - - TORONTO

Branch Offices: Montreal, Quebec, Halifax, Sydney, St. John, Ottawa, Hamilton, London, Windsor, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Nelson, Vancouver and Victoria

GARLOCK PACKINGS

BETWEEN THE COAL PILE AND THE ENGINE

At this time more than any time in the history of engineering, highest efficiency is demanded. A blown out gasket can shut down a plant just as surely as a broken piston rod. Every leaking manhole joint or pipe flange represents a distinct loss, and it has been demonstrated by scientific experiment that there is no limit to the loss caused by undue friction on piston rod and valve stem packed with an inferior packing, and the constant use of a wrench in attempting to stop leaks at rod glands. Let Garlock No. 950 Gasket, cut from No. 900 Sheet Packing, reduce the loss between coal pile and engine.

THE GARLOCK PACKING CO.
HAMILTON, ONT.

SPARE THE ROD

Is the ash barrow the hearse for your boiler settings?

SLICING of brickwork away from setting walls along with the clinker is expensive but readily understood when you stop to think that—under the high temperature of the fire box—the clinker welds to and frequently penetrates into the pores of the fire brick.

By coating the flame-exposed brickwork with Johns-Manville No. 32 High Temperature Cement, a surface is obtained that does not allow the clinkers to anchor themselves into the fire brick and enables them to be removed without tearing the brick surface away.

Joints between fire bricks in boiler settings, when laid up in No. 26 or No. 31 High Temperature Cements, absorb expansion and contraction stresses, and prevent spawling, cracking and air leaks. Furnaces so treated require minimum attention and give maximum service. Read about Johns-Manville Heat Treatment in the booklet that any branch will send at your request.

CANADIAN JOHNS-MANVILLE CO., LIMITED
Toronto Montreal Winnipeg Vancouver
London Hamilton Ottawa

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

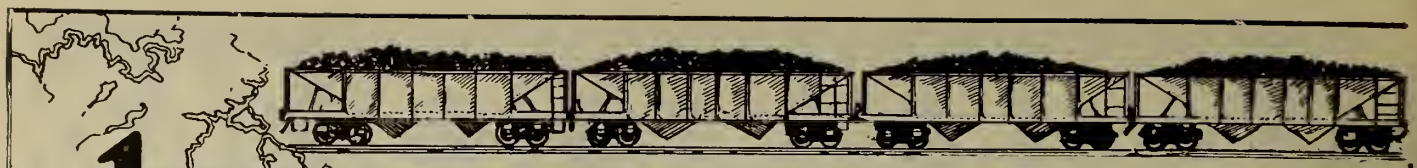
Asbestos

and its allied products

JOHNS-MANVILLE
Serves in Conservation

Heat Insulations, High Temperature Cements, Asbestos Roofings, Packings, Brake Linings, Fire Prevention Products

JOHNS - MANVILLE
POWER PLANT MATERIALS



1/4

of the coal mined is wasted in burning

Save ONE Carload in Every FOUR

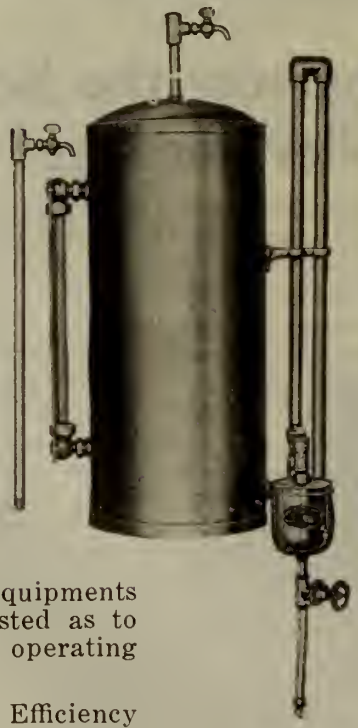
Reduce Your Steam-Cost 25 Per Cent.

Improper draft, holes in fire, leaky settings, improperly timed firing periods and other common *causes of fuel waste* can be easily detected when you have the records of

"HAYS" Combustion Apparatus

before you. And knowing is the first necessity of taking corrective measures.

Hays Improved Gas Analyzer
For testing boiler furnace gases, producer gases, casing head gas, exhaust from internal combustion engines, gases from sulphur burners, nitric acid gases, chlorine gas, etc., etc.



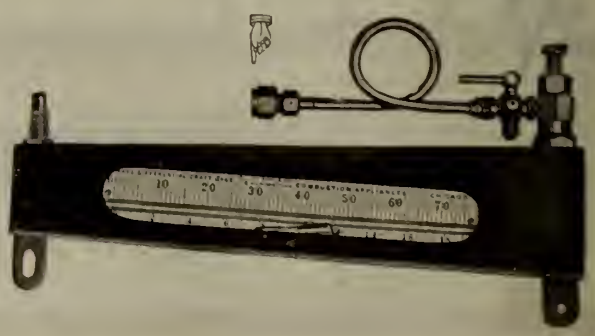
Gas Collector with water-flow regulator.

Hays Automatic CO_2 and Draft Recorders, Automatic Gas Collectors, Draft Gages and other Hays Equipments installed on your boilers keep you posted as to just what conditions your boilers are operating under.

In hundreds of plants, Hays Combustion Efficiency Appliances are leading the way to increased efficiency in boiler firing, a most effective way in **offsetting high coal prices.**

May we send you our Book "HOW TO BUILD UP FURNACE EFFICIENCY." It tells how fuel is wasted, how to stop that waste and keep it stopped.

The Hays Differential Draft Gage indicates the draft over the fire or the drop in draft through the boiler.



The J. W. Hays Corporation

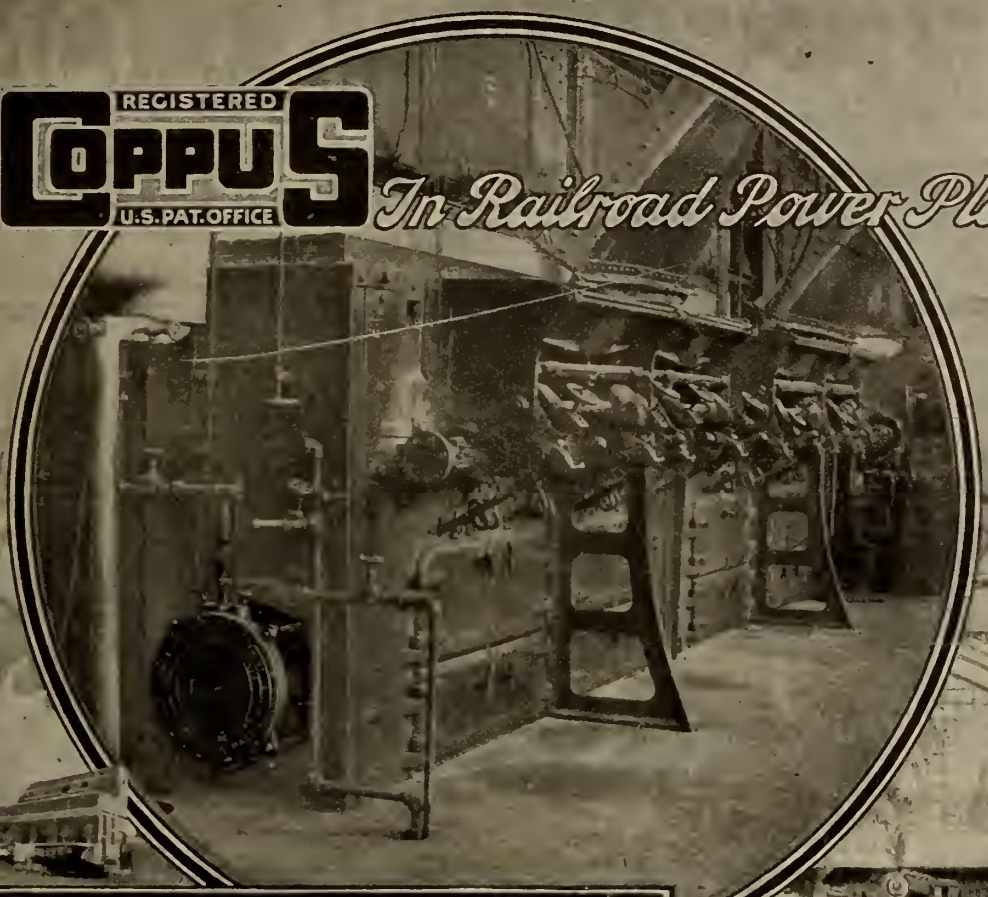
Michigan City, Indiana, U.S.A.

General Representatives for Canada:
Stephen H. Payne, 30 Church St., New York

REPRESENTATIVES IN CANADA:
Arthur S. Leitch Co., 1002 Kent Bldg., Toronto
Edward A. Robinson Co., Limited, 228 Craig St. West, Montreal

REGISTERED COPPUS U.S. PAT. OFFICE

In Railroad Power Plants



Railroads are sticklers for efficiency. Equipment approved by them must produce results—save money—earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers **pay.**

Every one of this big battery of blowers—one of which is shown above—has cut coal costs — reduced labor charges — and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peak loads quickly—and burn cheap fuel.

COPPUS Blowers **pay a profit** to the Central Railroad of New Jersey. **They can do as much for you.** Why not put them on the job? Catalog H-16 will show you how

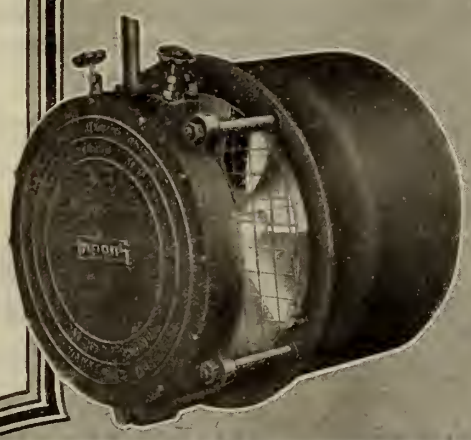
"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfgs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal: Mason Regulator and Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Bldg. Agents for Toronto: Arthur S. Leitch Co., 1001 Kent Bldg.



COPPUS TURBO BLOWER

LINDE

Modern

Refrigerating and - - Ice Making Machinery for all purposes

100 ton Linde Refrigerating Plant in Operation.

Leading Canadian firms use Linde Refrigerating Equipment. There's a reason. Linde machines possess indisputable constructional advantages, combining as they do the best of the generally accepted features of design along with certain LINDE features not seen in any other make of refrigerating machinery. Thus LINDE equipment is more economical and more efficient.

This Linde Plant was made in Canada

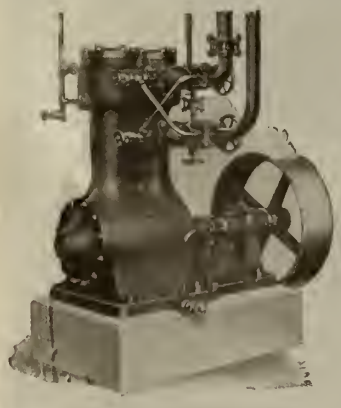
The Linde Canadian Refrigeration Co., Limited

37 St. Peter Street, Montreal, Que.

Toronto Winnipeg Vancouver

Makers of Quality Refrigerating Machinery Since 1896.

There's a Linde System for Every Need.



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Every Part of Every FRICK INSTALLATION Must Be Perfect in order to maintain

FRICK SUPERIORITY

That is why Frick Refrigerating and Ice Making Equipment proves a profitable investment wherever installed.

The entire Frick line, from the smallest to the largest plant, from the smallest part to the largest part in each plant, is designed to meet our strict standard of Durability—Efficiency—Economy. Every part must be perfect in order to maintain the well-known FRICK Superiority.

Therefore, when you purchase FRICK Equipment you are assured of perfect service regardless of the unforeseen overload demand that might be placed on it sometime—assured of continued operation without danger of breakdowns in the midst of a busy season—assured of economical operation at all times—and a long life. Frick Equipment has been standing up under the above conditions for nearly a half-century, day after day, year after year, under the most severe conditions.

You can't go wrong when you specify "Frick Equipment." **Catalog on request.**

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

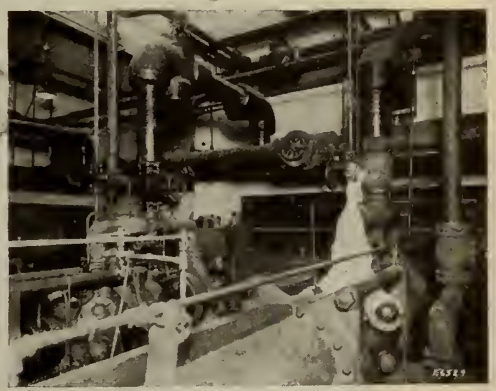
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

A Covering for Cold Pipes That Will Last

IF you consider durability a factor of importance when buying insulation for cold pipes, here is a rule that it will be well to follow: *Be sure that the covering you buy will not absorb moisture.* For moisture, always present in the atmosphere, is the greatest enemy of cold pipe insulation. Because of the peculiar nature of cork,



Nonpareil Cork Covering on the ammonia lines in the plant of the Chicago Cold Storage Company, Chicago, Ill.

Nonpareil Cork Covering

For All Cold Pipes

has the necessary qualities that enable it to stand up under hard service conditions. In the first place, cork is cellular in structure—not fibrous—and does not suck in moisture from the air by capillary attraction. In the second place, it is coated inside and out with a waterproof mineral rubber finish, and when applied, all joints are sealed with waterproof cement. Given a reasonable amount of attention, Nonpareil Cork Covering will last for years, and will pay for itself many times over in refrigeration saved.

Before you contract for cold pipe covering, read the 64-page illustrated book, "Nonpareil Cork Covering for Cold Pipes." A copy will be sent you, free of charge, on request.

Armstrong Cork & Insulation Company, 504 McGill Building, Montreal, Quebec, Canada

Also manufacturers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings; Nonpareil Cork Machinery Isolation for deadening the noise of machines; and Circle A Cork Brick for cold storage room floors.

York Refrigerating Machinery

QUALITY—SERVICE

From the very beginning we have been building **quality** and **service** into our Refrigerating Machines. This has resulted in increasing sales of our products and increasing satisfaction on the part of our customers.

With a York Refrigerating Plant you can improve the quality of **your** product as well as the measure of service **you** render to your trade.

Any firm that installs a Refrigerating Plant is looked upon by the trade it serves as a progressive firm. Give MECHANICAL REFRIGERATION a chance. In these days of keen competition it is the progressive owner who survives and profits.

Write us for information and prices.

York Manufacturing Company

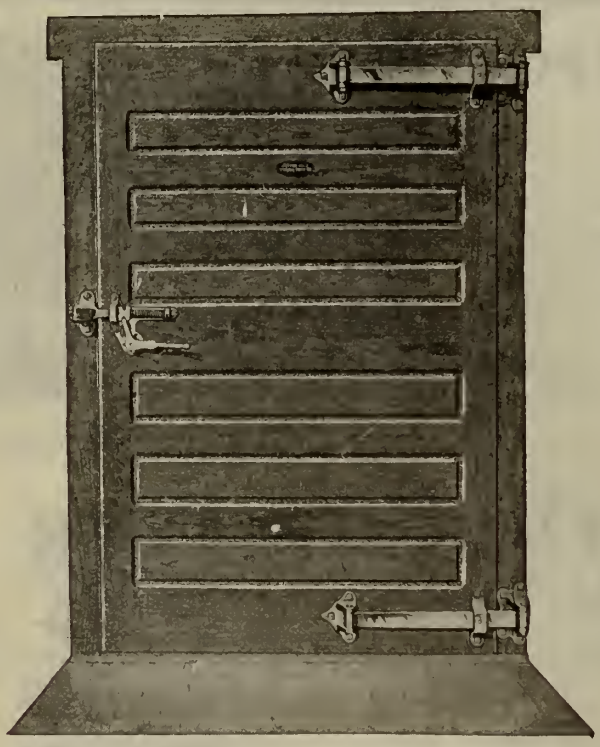
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. TORONTO, 82 Chestnut St. MONTREAL, 324 Craig St. West CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant*, as we find *them substantially made* and the *insulation perfect*. We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant*. We would not be warranted in throwing out the doors but would like the type hardware you supply."

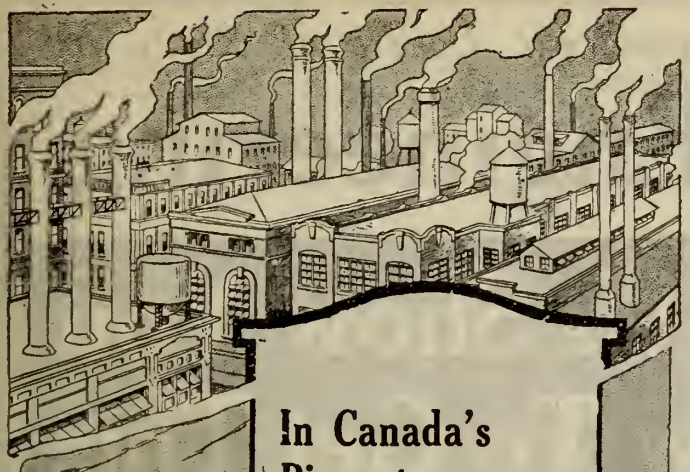
THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you*, in use at both plants, *have been in every way satisfactory*, and we think the *Jamison door is the best on the market*."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 8.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, M.D., U.S.A.



In Canada's Biggest Industries

Where absolute certainty must be counted upon at all times, no chance can be taken with equipment.

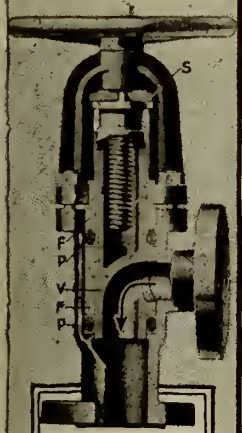
In the big industries, especially must every detail be efficient—the blow-off valve as well as the boilers, pumps and engines.

So, when the big Canadian corporations such as the following instal Yarway (formerly the Simplex) "Seatless" Blow-Off Valves, their choice becomes an endorsement of the very highest character.

Canadian Explosives Co., Ltd., have 11.
Dominion Iron & Steel Co., Ltd., have 20.
Canadian Pacific Railway Co., have 24.
Bathurst Lbr. Co. have 8.
Montreal L., H. & P. Co. have 24.
International Eng. Wks., Ltd., have 13.

And there are many others. With the Yarway (formerly the Simplex) "Seatless" Blow-Off Valve there can be no sudden opening and closing to injure tubes; the operation is simple, certain and safe; the valve does not leak; it requires but little attention, as there are no weak places such as seats or discs to cut and scar; even the packing lasts for years. You can verify each of these claims by testing the Yarway on one of your boilers for 60 days. Return it if not satisfactory.

Write to-day, stating size of line, and whether screwed or flanged, angle or straightway.



Operation: In closing valve shoulder "S" on plunger "V" engages the lose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

Yarnall-Waring Co.
7604-20 Queen Street
Chestnut Hill Phila.

A. McLELLAN,
103 St. Francis Xavier St.,
Montreal, Que., Canada.

YARWAY
Seatless Blow Off Valve
formerly the
SIMPLEX

Something New for Stoker Users

You have often needed a Fuel Control Device that would build up that thin spot—or burn down that heavy spot without poking, levelling or slicing.

The RILEY 2-SPEED GEAR BOX is the control you have long wished for. It is almost a magic tool—it is like being able to drop a shovelful of coal here or there without opening the fire door or disturbing the conditions of the furnace.

A single throw of the shifter lever operates the 2-speed Gear Box. There is nothing to get out of order—nothing that is complicated—nothing that is hard to understand. Even the inexperienced can manipulate the fires or balance the load among any number of stokers with mechanical certainty that will save your coal, utilizing the last B.T.U. in the fuel.

Riley Underfeed Stokers

equipped with the 2-SPEED GEAR BOX with either engine or motor drive give the ideal equipment for Central Station or Industrial Service.

If you want to pick up your load from banked fire to 200 or 300% of rating almost instantly or drop it just as quickly without wasting coal—then you need the RILEY 2-SPEED GEAR BOX. Publication No. 40 tells you how it does it.

For information on Murphy Automatic Furnaces for smaller boilers, see advertisement in last issue or send for Murphy Catalog H-M 10.

Sanford-Riley Stoker Co.
Worcester, Mass.

British Licensees: Erith's Engineering Co., Ltd., London
French Licensees: Erith Leroy & Cie., Paris, France

A Complete, Practical Correspondence Course of Study in

Stationary Engineering

ONTARIO DEPARTMENT OF PUBLIC WORKS

STATIONARY ENGINEER'S CERTIFICATE

THIS IS TO CERTIFY THAT

SPECIMEN

IS ENTITLED UNDER THE ACT RESPECTING STATIONARY AND HOISTING ENGINEERS R.S.O. 1914 [illegible] TO OPERATE AND HAVE CHARGE OF A STATIONARY STEAM PLANT OF FIFTY HORSE POWER OR OVER IN THE PROVINCE OF ONTARIO DURING THE YEAR 1919 UNLESS THIS CERTIFICATE IS SOONER REVOKED CANCELLED OR SUSPENDED

1919.

DATED AT TORONTO THIS [illegible] DAY OF [illegible]

NOTICE—THE HOLDER OF THIS CERTIFICATE MUST KEEP IT EXPOSED TO VIEW IN THE ENGINE OR BOILER ROOM IN WHICH HE IS EMPLOYED

Let Us Show You How To Get This License FREE

We Trained Last Year 1000 Men for U.S. Government

Up-to-Date Stationary Engineers are in Demand

This modern course of study covers every branch of power-plant work, including Steam Engineering, Practical Mathematics and Electric Wiring—all the principles of practical electricity. The Course has been prepared by a staff of experts working under the personal supervision of Joseph G. Branch, B.S., M.E., author of many standard books and for many years Chief Engineer of the City of St. Louis and a member of the Examining Board of Engineers for that city. Although complete in every detail, the Course is written so simply and clearly that anyone can understand it. No useless theory—but all the straight **facts** you need to pass the Engineer's Examinations and hold down a good job. You can substitute **Mechanical Refrigeration** for **Electrical Wiring** at the same price for the course.

All Text Books Furnished FREE

Five text books, handsomely bound, printed in large, clear type on fine quality paper, are furnished absolutely FREE with this course. They are sent to you at once. You do not have to wait several weeks or months, you get all the books **immediately.** Besides the books you get all necessary stationery and envelopes for answering questions and making recitations. There are no extras of any kind.

We Assist Our Students in Getting Good Positions

THE COURSE YOU WANT IS HERE

Complete, Practical Correspondence Courses in

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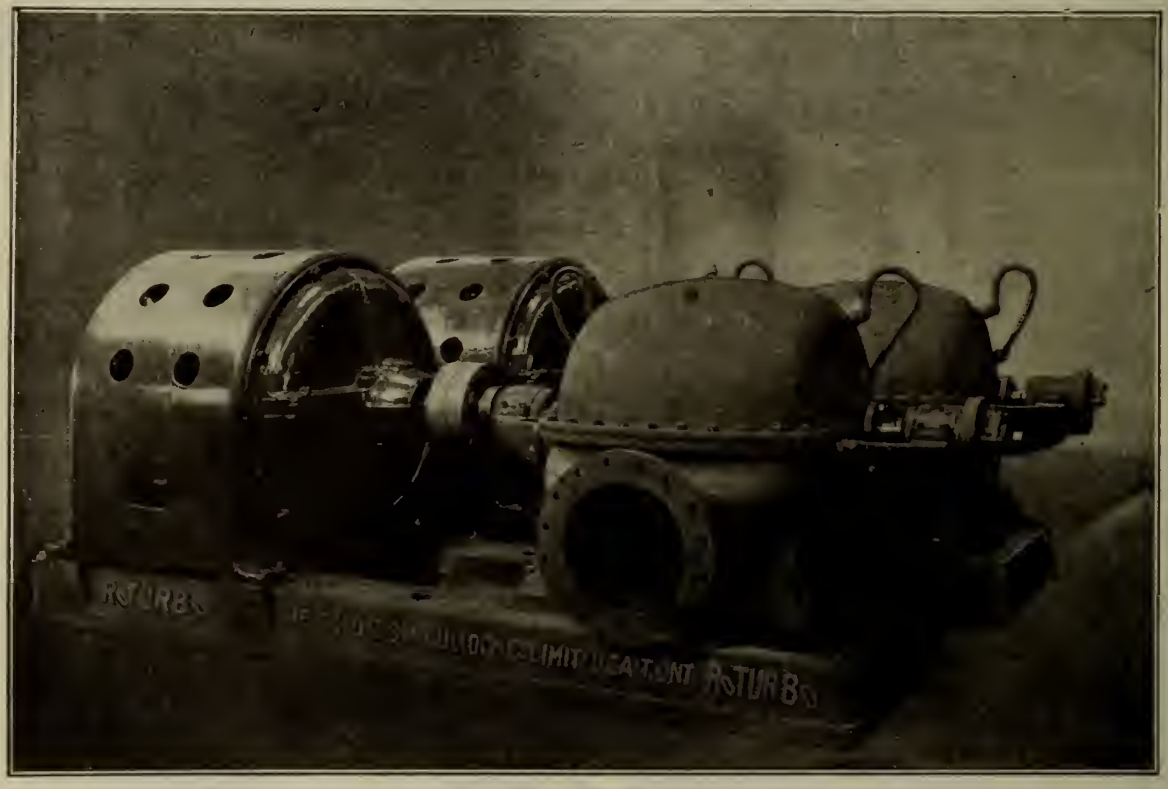

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Graded Certificates for Ontario Engineers

The Following Set of Regulations Make Provision for Carrying Out of the Act by Which Certificates Will Be Graded in Ontario, Beginning January, 1920—These Regulations Are Worthy of the Closest Study by Operating Engineers and Firemen.

Regulations Set By Order-in-Council Respecting Stationary Engineers

NO person who is not the holder of a certificate of qualification issued by the Minister of Public Works of Ontario, shall operate in this Province any stationary steam boiler or engine of fifty B.H.P. or over, or any steam heating plant operating at a pressure of over twenty pounds. Every person who operates a steam plant as the engineer in charge thereof, contrary to the above regulation, and every person employing him or permitting him so to do is subject on summary conviction to a penalty of not less than ten dollars.

This provision shall not apply to firemen who are taking their required six months' training under a certificated engineer, but it shall apply to all firemen who have had six months' experience, and to all night watchmen who are employed at plants of 50 B.H.P. or over, carrying over 20 pounds steam. At the expiration of this six months' initial training all firemen must make application of a Fourth-class Certificate. Anyone omitting to comply with this regulation shall be subject to the penalty set forth in Section 15 of the Act.

Any engineer who fails to keep his certificate exposed to view at all times in the engine or boiler room in which he is employed, shall be liable to a fine of ten dollars.

Certificates by Examination

Certificates are of four grades, viz.:—
First Class,
Second Class,
Third Class and
Fourth Class.

Fourth-class Certificates

Any person who desires to operate under a certificated engineer, a stationary steam plant of 50 B.H.P. or over, which carries over 20 pounds steam, must hold a Fourth-class Certificate. (Application forms for this certificate will be supplied on request).

A candidate for a Fourth-class Certificate shall be required:—

(a) To be at least 19 years of age;
(b) To furnish sufficient proof that he has had the required six months' initial experience;
(c) To satisfy the Board as to character and sobriety;
(d) To answer orally the questions on the examination paper, and secure at least sixty per cent. of the marks;
(e) To pay a fee of five dollars at the time application is made for examination. (This fee shall not be returned to the applicant should he fail to pass the examination).

Examinations shall consist of questions upon the construction of steam boilers and steam pumps, and upon hydraulics.

In the event of a candidate failing in his examination, ninety days shall elapse before he becomes eligible for re-examination.

Candidates shall be examined in Toronto during the first week of each month by appointment at the office of the Board of Stationary and Hoisting Engineers, Parliament Buildings, or at such other places as may be designated by the Board; and the Board may also conduct examinations twice in each year on such dates as may be determined:—

(a) In the City of London;
(b) In the City of Kingston;
(c) In the City of Ottawa;
(d) In the City of Port Arthur;

and at such other times and places as may be considered desirable by the Board.

Notice of the time and place of holding the examinations shall be sent to each candidate living in the district where the examination is held.

Third-class Certificate

Any person who desires to take charge of a stationary steam plant of between 50 and 150 B.H.P. must hold a Third-class Certificate. (Application forms for this certificate shall be supplied on request).

A candidate for a Third-class Certificate shall be required:—

(a) To be at least 21 years of age;
(b) To be the holder of a Fourth-class Ontario Certificate or its equivalent from one of the other Provinces of the Dominion;
(c) To furnish evidence to the effect that he has had at least two years' experience as fireman, oiler, or assistant to the engineer;
(d) To answer the questions on the examination paper and secure at least sixty per cent. of the marks;
(e) To pay a fee of five dollars at the time of making application for examination. (This fee shall not be returned to the applicant should he fail to pass the examination).

Examinations shall consist of questions upon the construction and operation of steam engines, steam boilers, and steam pumps, and upon hydraulics.

Examination questions shall be furnished only at the time of examination, and under no circumstances shall they be furnished by mail.

Examinations shall be written but should the Board

deem it necessary it may subject the applicant to an oral examination on the questions contained in the examination paper and may have him demonstrate his knowledge of the operation of a steam plant in an engine or a boiler room.

In the event of an applicant failing in his examination, ninety days shall elapse before he becomes eligible for re-examination.

Candidates shall be examined in Toronto during the first week of each month by appointment at the office of the Board of Stationary and Hoisting Engineers, Parliament Buildings, or at such other place as may be designated by the Board. Also, examinations may be conducted by the Board twice in each year on such dates as may be determined:—

(a) In the City of London;
(b) In the City of Kingston;
(c) In the City of Ottawa;
(d) In the City of Port Arthur;

and at such other times and places as may be considered desirable by the Board.

Notice of the time and place of holding the examination shall be sent to each candidate living in the district where the examination is held.

Second-class Certificates

Any person who desires to take charge of a stationary steam plant between 150 and 300 B.H.P. must hold a Second-class Certificate. (Application forms for this certificate shall be supplied on request).

A candidate for a Second-class Certificate shall be required:—

(a) To be the holder of a Third-class Certificate or its equivalent from one or the other Provinces of the Dominion;

(b) To furnish evidence to the effect that he has had at least five years' experience;

(c) To answer the questions on the examination paper, and secure at least sixty per cent. of the marks).

(d) To pay a fee of five dollars at the time of application is made for examination. (This fee shall not be returned to the applicant should he fail to pass the examination).

Examinations shall consist of questions upon the construction and operation of steam engines, steam boilers and steam pumps, and upon hydraulics, refrigeration, and the care of electric motors and generators.

Examination questions shall be furnished only at the time of examination, and under no circumstances shall they be furnished by mail.

Examinations shall be written, but should the Board deem it necessary it may subject the applicant to an oral examination on the questions contained in the examination paper, and may have him demonstrate his knowledge of a steam plant in an engine or a boiler room.

In the event of an applicant failing in his examination, ninety days shall elapse before he becomes eligible for re-examination.

Candidates shall be examined in Toronto during the first week of each month by appointment at the office of the Board of Stationary and Hoisting Engineers, Parliament Buildings, or at such other place as may be designated by the Board. Also, examinations may be conducted by the Board twice in each year on such dates as may be determined:—

(a) In the City of London;
(b) In the City of Kingston;
(c) In the City of Ottawa;
(d) In the City of Port Arthur;

and at such other times and places as may be considered desirable by the Board.

Notice of the time and place of holding the examination shall be sent to each candidate living in the district where the examination is held.

First-Class Certificates

Any person who desires to take charge of a stationary steam plant of unlimited capacity must hold a First-class Certificate. (Application forms for this certificate shall be supplied on request.)

A candidate for a First-class Certificate shall be required:—

(a) To be the holder of a Second-class Certificate or its equivalent from one of the other Provinces of the Dominion;

(b) To furnish evidence to the effect that he has had at least ten years' experience, showing seven years as chief or operating engineer;

(c) To answer the questions on the examination paper and secure at least seventy per cent. of the marks;

(d) To pay a fee of ten dollars at the time application is made for examination. (This fee shall not be returned to the applicant should he fail to pass the examination.)

Examinations consist of questions upon the construction and operation of steam engines, steam boilers and steam pumps, and upon hydraulics, refrigerating, generators, steam heating and ventilating, and the care of electric motors, together with questions on the general management of the plant.

Examination questions shall be furnished only at the time of examination, and under no circumstances shall they be furnished by mail.

Examinations shall be written, but should the Board deem it necessary it may subject the applicant to an oral examination on the questions contained in the examination paper, and may have him demonstrate his knowledge of a steam plant in an engine or a boiler room.

In the event of an applicant failing in his examination, ninety days shall elapse before he becomes eligible for re-examination.

Candidates shall be examined in Toronto during the first week of each month by appointment at the office of the Board of Stationary and Hoisting Engineers, Parliament Buildings, or at such other place as may be designated by the Board. Also, examinations may be conducted by the Board twice in each year on such dates as may be determined:—

(a) In the City of London;
(b) In the City of Kingston;
(c) In the City of Ottawa;
(d) In the City of Port Arthur;

and at such other times and places as may be considered desirable by the Board.

Notice of the time and place of holding the examination shall be sent to each candidate living in the district where the examination is held.

As to Certificates

A certificate of any grade shall be good only until the 31st day of December of the year for which it is issued, and shall lapse at that time. Any engineer who fails to renew his certificate shall not be allowed to continue in charge of a steam plant.

Every certificate holder who intends to renew his certificate shall register with the Board not later than the FIRST DAY OF DECEMBER of each year, on a form which will be supplied. A certificate holder who has not registered by the FIRST DAY OF FEBRUARY next en-

suing shall be granted a renewal only on the payment of a fee of five dollars.

On receipt of his certificate the engineer to whom it is granted shall sign the same in ink in the space provided for that purpose on the margin of the certificate, and shall at all times keep his certificate exposed to view in the engine or boiler room where he is employed.

Any person who was the holder of a Stationary Engineer's Certificate issued by the Board of Stationary and Hoisting Engineers of Ontario, before the enforcement of this Act (January 1st, 1920), shall be allowed to continue in his present position, but should he make any change in his position he must inform the Board of all particulars of the plant which he desires to operate, as to B.H.P., size of boiler or boilers, steam pressure, etc., and qualify for and obtain the certificate which applies to said plant, provided he is not already the holder of such a certificate.

As to Grading Certificates

Application forms shall be forwarded to every engineer who held a Stationary Engineer's Certificate for the current year previous to January 21st, 1920. Upon receipt of same the Board shall pass upon and grade the applicants accordingly into Third or Second-class. A First-class Certificate shall be granted by examination only.

As to Night Watchmen

Anyone desiring to act in the capacity of night watchman must hold at least a Fourth-class Certificate from this Board.

As to Returned Soldiers

Any returned soldier, who has completed a vocational course in Stationary Engineering at any recognized school in the Dominion of Canada shall, upon submitting sufficient proof to this effect, be granted the privilege of writing on the examination for a Third-class Certificate.

As to the Absence of the Chief Engineer

In the temporary absence of a Chief Engineer, an engineer holding a certificate of one grade lower may take charge and operate in his stead for a period not to exceed thirty days.

An extension of this period may be granted under special circumstances upon application to the Board.

Where a plant is operated in two or more shifts under a Chief Engineer, said Chief shall arrange that an engineer holding a certificate of the same grade as his own, or one grade lower, take charge of same in his absence; and when a plant is operated in two or more shifts and no Chief Engineer is employed, each shift shall be in charge of an engineer holding a certificate of the grade required by the Act.

Partial Operation of Plants at Night

In a case where a plant is partially operated at night, said plant may be operated by an engineer holding a certificate of one grade lower than would be required by the Act if the same was in full operation.

Ao to Provisional Certificates

Any engineer, who is the holder of a certificate of qualification from any other Province of the Dominion of Canada, and who furnishes satisfactory evidence as to character and sobriety, together with the prescribed fee of five dollars, shall, upon presenting his certificates to the Board for verification, be granted a Provisional Certificate of a corresponding grade, to take charge of a stationary steam plant in the Province of Ontario for one year only from date of issue. It will then be necessary for the application to try the prescribed examination in order to obtain a certificate entitling him to take charge of a steam plant coming within the provisions of the Act respecting Stationary and Hoisting Engineers in the Province of Ontario. This regulation does not apply to a First-class Certificate, as no certificate of this grade shall be issued provisionally.

As to Fees

The fee for the Fourth-class Certificate is five dollars.
The fee for the Third-class Certificate is five dollars.
The fee for the Second-class Certificate is five dollars.
The fee for the First-class Certificate is ten dollars.
The fee for re-examination (any grade) is five dollars.
The fee for renewing a Fourth-class Certificate is one dollar.
The fee for renewing a Third-class Certificate is one dollar.
The fee for renewing a Second-class Certificate is one dollar.
The fee for renewing a First-class Certificate is two dollars.
The fee for renewing any certificate, where the holder has failed to register by the first day of February, is five dollars.
The fee for issing a duplicate certificate is one dollar.
The fee for issuing a Provisional Certificate is five dollars.
The fee for re-examination (any grade) is five dollars.
The fee for re-registration of plants is one dollar.

As to Cancellation of Certificates

The Minister of Public Works, on the recommendation of the Board, may, at any time for misconduct or infraction of the provisions of the Stationary and Hoisting Engineer's Act, or of any regulation thereunder, suspend or revoke any certificate, and during such suspension, and until any revocation shall be cancelled by the Minister of Public Works, no further or other certificates to such person shall be issued.

As to Duplicate Certificates

In case a certificate is lost, stolen or destroyed, a duplicate shall be issued on presentation to the Board of a statutory declaration, or other satisfactory proof, setting forth the facts, together with the required fee.

As to Registration of Steam Plants

It shall be the duty of the owner of every plant of fifty B.H.P. or over, which carries over twenty pounds steam, to advise the Board as to the exact dimensions of his steam plant, on a form which shall be supplied upon request.

As to Registration Certificate

A registration form shall be supplied on request to any plant owner or engineer. Upon return of this form with the necessary fee, a Registration Certificate shall be issued by the Board, such certificate to be exposed to view at all times in the boiler or engine room of the plant. Any change made in a steam plant shall necessitate a re-registration.

Failure to comply with this regulation will necessitate the enforcement of sub-section (b), section 15, of the Act repecting Stationary and Hoisting Engineers.

Inspectors of factories are employed to assist in the enforcement of the Act respecting Stationary and Hoisting Engineers.

NOTICE:—It is necessary for a certificate holder to at once notify the Chairman of the Board of any change in his permanent address.

The Stationary Engineer's Certificates issued by the Board of Stationary and Hoisting Engineers are of four grades, viz., Fourth, Third, Second and First-class. Successful candidates are granted certificates, valid for one year dating from January 1st of the year in which they are issued. Certificates are renewable yearly and renewal application forms are sent to all certificate holders by the Board.

How to Obtain Certificates

Those who wish to present themselves for examination for Stationary Engineers' Certificates should apply for an application form to the Chairman of the Board, 15 Queen's Park, Parliament Buildings, Toronto. This should be filled in in detail and returned with the required affidavit and fee.

Candidates desiring theoretical information regarding

the operation of steam plants may obtain same by studying any recognized text-book on the boiler and steam engine.

Candidates will be notified of the date set for the examination and they must appear at the examination room punctually at the time appointed.

No person is allowed in the examination rooms during the examinations, other than those whose duties require them to be present.

Examination questions are furnished only at the time of examination, and under no circumstances can they be furnished by mail.

Any candidate who, because of deficient education, cannot write the answers to the questions himself, may be allowed to secure the service of a person (not an engineer) who will write answers to the questions exactly as instructed by the candidate. In case it is impossible for the candidate to secure the services of such a person, the examiner will write the answers for him or select some one to do so.

Fourth-class Certificates

A candidate for examination for a Fourth-class Certificate must be at least 19 years of age, and must furnish proof of at least six months' experience. He must satisfy the Board as to character and sobriety and pay a fee of five dollars at the time application for examination is made.

The examination for this certificate is oral and based on the candidate's practical knowledge of steam boilers, steam pumps and hydraulics.

The fee is five dollars and should be enclosed when the application form is forwarded to the Board. It will not be returned should the candidate fail to pass the examination.

An affidavit must accompany each application.

Third-class Certificates

A candidate for examination for a Third-class Certificate must be at least 21 years of age, and hold a Fourth-class Ontario Certificate issued by this Board, or its equivalent from one of the other Provinces of the Dominion. He must have had two years' experience as fireman, oiler or assistant to an engineer and must produce testimonials as to such time, the same to be signed by his employer in the case of shop time, and by his employer or the chief engineer in the case of engineer's or fireman's time. These testimonials must state the kind of work the candidate was employed on, and for how long; and give evidence as to his experience, ability, sobriety and general good conduct for at least twelve months preceding the date of application for examination.

The questions on a Third-class examination paper are almost entirely practical in character and may be described as follows:—

(a) Questions relating to the origin of steam and its uses;

(b) Questions relating to the different kinds and manners of constructing boilers to generate steam, including the strength of material used in making boilers;

(c) Questions regarding the different kinds of safety valves for controlling the pressure in steam boilers and other necessary fittings;

(d) Questions regarding the proper methods of raising and maintaining steam in boilers and the care necessary to keep them in good order; and when repairs are necessary, the method of making such repairs;

(e) Questions regarding the kind, construction and operation of the different appliances used to feed and supply boilers with water during operation.

The questions are made as clear and concise as possible, and every effort is made to have them cover such practical knowledge as should be possessed by every engineer charged with the care and operation of steam boilers and engines.

The fee is five dollars and should be enclosed when the application form is forwarded to the Board. It will not be returned should the candidate fail to pass the examination.

An affidavit must accompany each application.

Second-class Certificates

A candidate for examination for a Second-class Certificate must hold a Third-class Ontario Certificate issued by this Board, or its equivalent from one of the other Provinces of the Dominion. He must have had five years' experience acting in the capacity of engineer, assistant engineer, oiler or fireman and must produce testimonials as to such time and employment, the same to be signed by his employer in the case of shop time, and by his employer or chief engineer in the case of engineer's or fireman's time. These testimonials must state the kind of work the candidate was employed on, and for how long; and give evidence as to his experience, ability, sobriety and general good conduct for at least twelve months preceding the date of application for examination.

The questions on a Second-class examination paper are mostly of a practical nature, a few only being based on technical work and may be described as follows:—

(a) Questions relating to the origin of steam and its uses;

(b) Questions relating to the different kinds and manners of constructing boilers to generate steam including the strength of material used in making boilers, and the proper proportion in sizes and thickness of materials to be used, together with proper areas of grate, etc.;

(c) Questions regarding the different kinds of safety valves for controlling the pressure in steam boilers and other necessary fittings;

(d) Questions regarding the proper methods of raising and maintaining steam in boilers and the care necessary to keep them in good order; and when repairs are necessary, the method of making such repairs;

(e) Questions regarding the kind, construction and operation of the different appliances used to feed and supply boilers with water during operation.

(f) Questions regarding the different kinds of boilers and engines used in developing power, including their construction and the methods of calculating their capacity and the proper methods of caring for and operating such boilers and engines.

The questions are made as clear and concise as possible and every effort is made to have them cover such practical and technical knowledge as should be possessed by every engineer charged with the care and operation of steam boilers and engines.

The fee is five dollars and should be enclosed when the application form is forwarded to the Board. It will not be returned should the candidate fail to pass the examination.

An affidavit must accompany each application.

First-class Certificates

A candidate for examination for a First-class Certificate must hold a Second-class Ontario Certificate issued by this Board, or its equivalent from one of the other Provinces of the Dominion. He must have had ten years' experience, during seven years of which he was employed as chief or operating engineer, and must produce testimonials as

to such time and employment, the same to be signed by his employers in the case of shop time, and by his employer or the chief engineer in the case of engineer's or fireman's time. These testimonials must state the kind of work the candidate was employed on and for how long; and give evidence as to his experience, ability, sobriety and general good conduct for at least twelve months preceding the date of application for examination.

The questions on a First-class examination paper are of a practical and highly technical nature and may be described as follows:

(a) Questions relating to the origin of steam and its uses;

(b) Questions relating to the different kinds and manners of constructing boilers to generate steam, including the strength of material used in making boilers, and the proper proportion in sizes and thickness of materials to be used, together with proper areas of grate, etc.;

(c) Questions regarding the different kinds of safety valves for controlling the pressure in steam boilers and other necessary fittings;

(d) Questions regarding the proper methods of raising and maintaining steam in boilers and the care necessary to keep them in good order; and when repairs are necessary, the method of making such repairs;

(e) Questions regarding the kind, construction and operation of the different appliances used to feed and supply boilers with water during operation;

(f) Questions relating to the calculation of safety valve pressure, boiler shells, stays, riveting, feed pumps, indicator diagrams;

(g) Questions relating to the taking off of indicator diagrams, surface and jet condensation, superheating, and the working of steam expansively;

(h) Questions relating to the construction of air-compressors, ammonia-compressors, and dynamos of ordinary types;

The candidate's knowledge of arithmetic must include addition, subtraction, multiplication and division; methods of extracting square and cube root; and the application of arithmetical rules to questions relating to the power, duty, and economy of engines and boilers, and to stresses in rods, shafts, and levers of the engine. He will also be required to make an intelligible hand-sketch or a working drawing of some one or more principal parts of a steam engine, and to mark in, without copy, all necessary dimensions in the figures, so that the sketch or drawing could be worked from. Fine drawing is not expected, and a wide margin will be allowed in the proportions of the parts, but the drawing must be a practical working design, giving a sufficient number of views to show the parts fully, sections, plans, or elevation, just as the candidate would require them to be supplied to him if he had to make the part to the design of another person.

The questions are made as clear and concise as possible and every effort is made to have the questions cover such practical and technical knowledge as should be possessed by every engineer charged with the care and operation of steam boilers and engines.

The fee is ten dollars and should be enclosed when the application form is forwarded to the Board. It will not be returned should the candidate fail to pass the examination.

An affidavit must accompany each application.

How to Obtain Graded Certificates by Application

The Stationary Engineers' Certificates issued by this Board for the year 1919, will be divided for 1920, into two classes, viz., Third and Second-class.

The holders of such certificates, upon making application, will be placed in one of these classes, according to percentage made on examination; length of experience, and testimonials covering same; kind and size of plants they have handled, etc. This application will cover the usual yearly renewal form, the fee being one dollar. Applicants failing to make application for renewal before the 1st of February, 1920, will be granted a renewal only upon the payment of the fee of five dollars; and they will be granted a Third-class Certificate only, irrespective of their qualifications.

Those who were granted Stationary Engineer's Certificates issued by this Board previous to 1919, may renew same upon application and the payment of five dollars. If such application is made previous to February 1st, 1920, they will be graded in the same manner as those who held 1919 certificates.

An affidavit must accompany each application.

How to Obtain a Registration Certificate

The owner of every steam plant of 50 B.H.P. or over, which carries over twenty pounds steam, must hold a Registration Certificate. This certificate is obtained by application, said application form being supplied by the Board, on request. Any change made in a plant will necessitate a re-registration of same, the fee for each registration being one dollar.

An affidavit must acompany each application.

General Information

All correspondence in connection with this Act should be addressed as follows:—

The Chairman,
Stationary and Hoisting Engineers' Board,
Parliament Buildings,
Toronto, Ont.

In the event of any candidate being discovered referring to any book or paper, or copying from another or affording any assistance, or giving any information to another or communicating with another, during the time of examination or copying any part of a question for the purpose of taking the same out of the examination rooms, he will subject himself to the penalties of failure, and will not be allowed to be re-examined for a period of six months.

If the holder of a Stationary Engineer's Certificate for the year 1919 is in charge of a stationary steam plant of 150 B.H.P. or over, he will be entitled under this Act to continue in operation of same under the certificate which will be granted to him from his 1919 certificate, irrespective of the grade issued; but should he change his position he will at once be required to obtain the certificate covering the operation of the plant of which he is desirous of taking charge.

The certificates of any other Province of the Dominion are interchangeable provisionally with those of this Province, with the exception of a First-class Certificate.

THE German mark is so severely discounted now that it pays European firms handsomely to do their purchasing in Germany. In other words, they can make quite a big mark with the little German mark.

* * *

CARUSO has an offer to go and sing in Mexico at $10,000 per night. Without going to the extent of disclosing names we know of several folks who will holler themselves hoarse for a whole month for that figure.

Act Grading Certificates for Ontario Engineers

The Act Given Below is Reprinted from April 25 Issue of Power House Owing to the Publication of Regulations Respecting It in This Issue—The Two, Regulations and Act, Should Be Read Together for a Clear Understanding of Each

IN the Act to consolidate and amend the Acts respecting Stationary and Hoisting Engineers, passed April 17, 1919, by the Ontario Legislature, provision was made for the grading of certificates. The Act is given in full below together with explanatory matter. In this Act:—

Act Re Graded Certificates

(a) B.H.P. shall mean boiler horsepower or the equivalent to the evaporation of 34 lbs. of water per hour from and at 212°—15 sq. ft. of heating surface for return tubular boilers—12 sq. ft. heating surface for locomotive type boilers—10 sq. ft. heating surface for water tube boilers;

(b) "Board" shall mean the Board of Examiners appointed as hereinafter provided;

This clause defines what is meant by boiler horsepower in so far as the Act is concerned.
See Section 4.

(c) "Hoisting plant" shall mean and include a steam boiler and steam engine and every part thereof, working at a pressure of twenty pounds or over irrespective of horsepower and used for hoisting in structural operations or excavating purposes;

This clause defines what is meant by a hoisting plant and includes practically all steam hoists with the exception of those in use at mines or quarries, which latter are exempted by Clause (3) below.

(d) "Minister shall mean member of the Executive Council charged by the Lientenant-Governor-in-Council with the administration of this Act;

(e) "Steam plant" shall mean and include a steam boiler, a boiler and a steam engine and every part thereof and thing connected therewith or used with reference to any such boiler or engine or under the care of an engineer. R.S.O. 1914, c. 170.

(3) Nothing in this Act shall apply to the operation of any steam plant having a capacity of less than 50 horsepower, nor to steam heating plants operating at a pressure of twenty pounds or under, nor to the operation of a locomotive engine or a steamboat or a steamship engine or a hoist at a mine or quarry, nor to boilers used for agricultural purposes. R.S.O. 1919, c. 170.

Clause (3) above defines the exemptions to which the Act does not apply and to which of course graded certificates are not applicable. Power plants having a capacity of less than 50 boiler horse power (determined as in subsection (a) are exempt. Heating plants operating at twenty pounds or under are exempt. Locomotives and steamships are also exempted and boilers for agricultural purposes; threshing engines, etc., also do not come under the provisions of the Act. It should be noted, however, that only hoists which are used at mines or quarries are exempted, all other hoists being subject to the operation of the Act. This clause is re-enacted from the former Act.

(4) The Lieutenant-Governor-in-Council may appoint a Board of Examiners consisting of three competent and independent engineers practically conversant with construction of boilers and the operation of steam plants, who shall hold office during pleasure and who, subject to the regulations mentioned in the next following section shall prescribe the subjects in which candidates for certificates of qualification as stationary or hoisting engineers shall be examined and shall conduct or provide for and supervise the examination of candidates and report thereon to the Minister. R.S.O. 1914, c. 170.

Clause 4 above is the same as that in the former Act and provides for the setting up of the board by which the examinations are conducted. In itself it effects no changes, but in the provisions for setting up regulations which follow important changes have been made which apply to the gading of engineers and to the carrying out of the law.

(5) The Lieutenant-Governor-in-Council upon the recommendation of the Ministry may make regulations for:

(a) The examination of candidates, the granting of certificates, the classifying of these certificates into their respective grades, and the evidence to be furnished by candidates as to previous training or experience and sobriety and good character; and the recording of changes made in engineer's positions;

This section makes provision for the grading of certificates and also for the recording of changes which may be made from time to time in the positions held by engineers.

(b) Determining the time of duration of certificates and their renewal;

(c) Fixing the fees to be paid by candidates upon examination and for certificates and their renewal;

(d) Prescribing the causes for which a certificate may be revoked, cancelled or suspended and for

(e) Fixing the fees or other remuneration to be paid to the members and officers of the board. R.S.O. 1914, c. 170.

(f) Fixing the fees to be paid by plant owners for certificates of registration.

(6) No person shall be eligible for examination unless he is a British subject, or has resided in Canada for at least one year. R.S.O. 1914, c. 170.

7—(1) On the recommendation of the board and on payment of the prescribed fees, the Minister may issue certificates of qualifications to stationary or hoisting engineers, and certificates of registration to plant owners.

(2) Subject to the regulation a certificate may be revoked, cancelled or suspended by the Minister on the recommendation of the board at any time.

(3) Every stationary or hoisting engineer shall, during the continuance of his certificate, register with the board on or before the 1st day of February of each year on a form to be furnished by the board, and any stationary or hoisting engineer who fails to do so shall not continue in charge of a steam plant unless by special permission of the board. R.S.O. 1914, c. 170.

(4) It shall be the duty of all owners of steam plants to advise the board, on a printed form supplied by the board on application, of the B.H.P. and steam pressure of their plants, on receipt of which, together with the prescribed fee, the Minister will issue a registration certificate. Any change made in the plant subsequent to registration will necessitate a re-registration of same.

(5) It shall be the duty of all engineers and firemen who come under this Act to report annually to this board,

on a form which will be supplied, the B.H.P. and steam pressure of the plant which he is operating.

(8) A person who is not the holder of a certificate shall not operate or have charge of any steam or hoisting plant except in case of emergency, when he may be employed in operating any steam plant for a period not exceeding thirty days at any one time. R.S.O. 1914, c. 170.

9. The board at its discretion may grant a provisional certificate to be good for a period not to exceed one year to any person who holds a stationary or hoisting engineer's certificates from the board of examiners or other duly constituted authority of any other Province of Canada. R.S.O. 1914, c. 170.

10. The certificate shall at all times be exposed to view in the engine or boiler-room in which the holder thereof is employed. The registration certificate to be exposed to view in the engine or boiler-room also. Failure to keep such certificate exposed shall be "prima facie" evidence of the lack of qualification under this Act. R.S.O. 1914, c. 170.

11. This Act shall not apply to firemen, who have had less than six months' experience, or other workmen acting under the personal direction or supervision of any engineer holding a certificate under this Act, who is actually in charge of a steam plant, or to the employees of engine builders or steam plant contractors engaged in installing, setting up or testing a boiler or steam plant. This section shall not apply to hoisting engineers. R.S.O. 1914, c. 170.

12. Any person who deems himself aggrieved by the decision of the board may appeal therefrom to the Minister, upon giving such notice as the Minister may prescribe and the decision of the Minister shall be final. R.S.O. 1914, c. 170.

13. The board shall on or before the 15th day of November in every year make to the Minister a report in writing for the year ending on the 31st day of October of the previous year, showing:

(a) The number of certificates granted;

(b) The number of applications for certificates refused and the causes for refusal;

(c) The number of certificates revoked, cancelled or suspended, and the causes for the same;

(d) The amount of fees received from candidates or holders of certificates;

(e) The number of boilers registered during the year;

(f) The amount of fees received from plant owners for registration purposes;

(g) Such other matters as may be directed by the Minister or the Lieutenant-Governor-in-Council. R.S.O. 1914, c. 170.

14—(a) Any member of the board, or inspector, on presentation of authority in writing, signed by the Minister, may enter any premises wherein he has reason to believe there is a steam or hoisting plant and make such inspection as may be necessary to determine whether the provisions of the Act are being complied with.

(b) Any person who interferes with or obstructs a member of the board in the exercise of the powers conferred on him, shall incur a penalty not exceeding $100.

15. Every person who

(a) Except as provided in section 8, operates steam or hoisting plant as the engineer in charge thereof without the certificate required by this Act, or employs or permits any person to operate a steam or hoisting plant as the engineer in charge without such certificate; or

(b) Is guilty of a contravention of subsection 4 of section 7, shall incur a penalty of not less than $10, nor more than $25. R.S.O. 1914, c. 170.

16. It shall be the duty of the inspectors of factories to assist in the enforcement of this Act, to report to the board any violation thereof, and to furnish to the board such information as they may have as to the conduct and capability of any person holding or applying for a certificate. R.S.O. 1914, c. 170.

17. The penalties provided by this Act shall be recoverable under 'The Ontario Summary Convictions Act."

18. "The Stationary and Hoisting Engineers' Act" being chapter 170 of the Revised Statutes of Ontario, 1914; the Act passed in the 4th year of His Majesty's reign, chapter 28; and section 17 of "The Statute Law Amendment Act," 1915, are repealed.

19. This Act shall come into force on the 1st day of January, 1920.

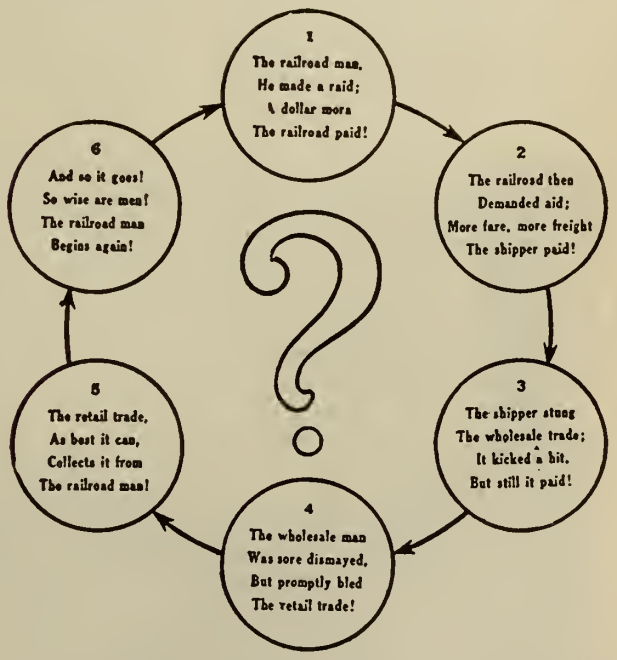
Explantory

Subsection (d) above is to be read in connection with Clause 7, Section 4 below, and applies to the registration of power plants by their owners.

It will be seen that this Act sets up the machinery for the grading of certificates, the registering of plants which come under the Act and the making of regulations for the carrying out of the Act.

That the state may have a sufficient number of tractor drivers to cultivate the maximum amount of land, and so increase the food supply, the California State Board of Education has been conducting emergency classes in tractor operation in the rural districts. The course given lasts three weeks and costs only $2.50. The first week, the students are taught the theory and principle of gas engines; the second week, the assembling and disassembling of tractors, their operation and repair, and the third week they drive tractors in the field.

A service of genuine worth is rendered to its patrons by one automobile manufacturing company. When it is reported to the central factory that a car has been lost or stolen, the factory history is consulted and the car's secret markings collected. In bulletin form these markings are then sent regularly to the company's dealers and garage men, who know that a thief always erases the engine mark but usually overlooks the number on some small, inconspicuous part. In this way the company has been able to recover hundreds of stolen cars in the last few years.



"The vicious circle is infinite; increased wages are over-capitalized for inflated profits, and the cost of goods mounts faster than the wage level."—Statement of the Four Brotherhoods of Railroad Employees. From the New York *Evening Post.*

A Boiler Explosion in a Creamery

The Following Article Reprinted From "The Travelers' Standard" Gives an Interesting Account of a Boiler Explosion. Low Water and Dynamite Are Conjectural Causes for the Accident

THE views presented herewith illustrate a boiler explosion which occurred on June 3, 1919, in a creamery at Hopkins, Michigan. Three men were killed by this accident and four other persons were injured—one of them seriously. The boiler-house was practically demolished, and windows were broken in many buildings throughout the village. The engineer of the plant was one of the men killed, and his death eliminated an important source of information concerning conditions that may have brought about the explosion. Various causes have been conjecturally assigned—among them being the possibility of low water, and the presence of dynamite in the coal bin. So far as we have learned, however, there is not sufficient evidence to support either of these views. Low water is the first explanation that occurs to the average explosion theorist, and if the explosion was violent the opinion that dynamite was present in the coal often finds equal favor.

The information that we have at present is to the following effect: The boiler plant consisted of two horizontal tubular boilers, one of which was 10 years old and the other (the one that exploded) was 35 years old. The exploded boiler was 42 inches in diameter and 10 feet long. The shell was ¼ inch thick and composed of a single course, and the tube heads were ⅜ inch thick. The boiler contained 40 tubes, each 3 inches in diameter. The longitudinal seam was of the double-riveted lap-joint type, with ¾ inch rivets (13-16 inch rivet holes) pitched 2¾ inches between centres. There was no fusible plug in the boiler. The safety-valve was set at 85 pounds, and it is said there was a steam pressure of 55 pounds on the boiler just prior to the explosion.

FIG. 2—ILLUSTRATING THE COMPLETENESS OF THE WRECK.

At about 7.30 a.m. on the day of the accident, an employee went into the boiler-room to see if there was sufficient steam pressure to start the machines, and finding that there was, he returned to the creamery, and was in the act of setting the machinery in motion when the boiler burst. The exploded boiler was thrown about 30 feet to the right of its original position. The tubes from the upper two rows could not be found, with the exception of one tube which lodged in a tree about 400 feet from the original boiler site. The manhole plate was blown about 600 feet. The other boiler in the battery was practically undamaged.

Upon examination it was found that the boiler shell was torn from the top manhole frame down in a diagonal direction to one side of the front tube-sheet, and that this tube-sheet broke across the tube ligaments to the lower handhole opening. The boiler was almost entirely free from scale, and the only evidence of corrosion was about the lower handhole in the front tube-sheet, at which point there had evidently been a long-continued leakage due to a poorly-packed handhole joint. We are told that the metal in the tube-sheet about the handhole was very thin. It is possible, therefore, that the rupture started at this place. In the absence of more definite evidence, however, it is important to remember that when the primary line of rupture runs through the manhole opening, it is often found that this opening was not properly reinforced, or that it was poorly designed or unwisely located. The data at hand do not justify any expression of opinion on these points in the present case.

At the time of the accident several farmers were about the creamery, having delivered cream there, and two of them were killed. The engineer was also killed, as previously stated. In addition, the manager of the creamery had his left leg broken and received internal injuries. Two farmers, and a boy

FIG. 1—GENERAL VIEW OF THE RUINS.

FIG. 3—SHOWING THE FRONT TUBE SHEET.

about fourteen years old, were also cut and bruised by flying debris.

It is stated that the boiler was inspected a short time before the explosion, and found to be in good order. We do not know whether it was insured or not.

TRAINING FOR COMBUSTION ENGINEERS

Undoubtedly, the efforts of the Fuel Administration of the United States during the war to conserve fuel by splendidly organized appeals for greater plant efficiency is bearing fruit in many ways. There seems to be an almost universal interest in the subject of "combustion efficiency" and a growing dissatisfaction with the old regime of indifference to what are now recognized as unnecessary wastes in the boiler room. Everyone recognizes that such conditions were not due primarily to any fault of the men operating the plants. High standards of boiler efficiency were comparatively a new thing. Boiler rooms, as a rule, were in charge of a steam engineer, and his training certainly specialized in the engine room operation to the detriment of the boiler room. Gradually during recent years, through the efforts of consulting engineers and certain pioneers in the combustion field, standards of efficient boiler room practice have crystallized so that principles are as well understood and methods as clearly defined as at the other end of the steam plant. It is seen that the subject of combustion must be studied and mastered by itself as a specialty; that there is a place for the combustion engineer just as for the steam engineer. In fact, every steam engineer should be a combustion engineer.

The principal reason that there have been so few combustion engineers has been the lack of adequate courses of training, the subject having been handled only as part of courses in steam engineering.

The demand for a training in combustion engineering has been recognized by Joseph W. Hays, whose contributions on combustion subjects have frequently appeared in these columns. It has remained for him to organize the Hays School of Combustion, with offices at 190 North State Street, Chicago. The purpose is to give a complete training in combustion efficiency through the mails and to graduate combustion engineers from the ranks of steam engineers and boiler room men who are able to do the necessary reading without interfering with their regular work.

The Hays school is also laying stress on the possibility of advanceent for any young man who is not afraid to tackle the disagreeable features of the job of fireman, taking up at the same time the correspondence course in combustion. The boiler room is the best place for him to apply and work out what he learns along combustion lines, and when he graduates as a combustion engineer he has a fine outlook ahead to pay him for the apprenticeship he serves, shoveling coal and wheeling ashes.

Mr. Hays has associated with him, as reviewing and advisory editors, some of the best talent among combustion men in the country, who have contributed their services and endorsement to the course for the good of the cause. The names of Joseph Harrington, Ferd R. Low, David Moffat Myers, Professor S. W. Parr, and Arthur L. Rice would seem to promise everything for the success of the school and the high standard of its teaching.

An enormous gas cloud gathering on the sun forms an arc 340,000 miles long on the edge of that body, astronomers say. It is about 125,000 miles away from the edge, and the distance from the sun to the top of the cloud is estimated to be 200,000 miles.

GENERAL MITCHELL AT ELECTRIC CLUB

In his talk at the Electric Club luncheon, Toronto, on Friday, Sept. 26, Brigadier-General C. H. Mitchell dealt with the importance of the engineer in warfare. The man who had engineering, mechanical or electrical experience had the advantage over all others; not only because of the application of his training to engineering problems, but also because of the fact that his type of mind and the training it had received, fitted him for the handling of men and the solving of problems in everyday warfare. The speaker felt sorry for the lawyer chap, for he had nothing in his daily work similar to what he had been accustomed to. The engineer, on the other hand, had an experience which prepared him for all the hard work, long hours, intense application, particularly on staff work, which made him valuable.

In opening his address, the speaker paid tribute to the telephone and telegraph systems in use in the army. In Sir Herbert Plumer's Second British Army, of which General Mitchell was head of the intelligence staff, the normal number of telegrams received at headquarters daily was 2,000, while the telephone service was so greatly used that it was necessary at times to limit the service. The psychology of the German was one of the most interesting things in the whole war to the speaker, and the game of matching wits with the foe was fascinating beyond measure.

The enemy artillery before the war had been located by observers, but this was soon got away from when the great war settled down to trench warfare. It became a steady everyday business. Even if a gun was down below a hill the rays of the flash could be seen rising above the hill. The synchronization of these flashes by several observers was useful under certain weather conditions, but the French evolved a method whereby with microphones, equidistant on a long arc, acting like telephone receivers, when a gun started to fire, the first microphone picked it up, registered it on a film, and so on through the series, so that the length of time elapsing gives him the several triangular bases. This method worked better in a fog, but not in adverse winds, and would locate a gun within 25 yards at a distance of 6,000 yards.

Further experiments in these methods will be carried on at the University of Toronto by two officers who have had experience in France and are now on the staff.

Practically all the munitions made in Italy were manufactured by Hydro-Electric power. The Austrians captured some of the largest installations on the Venetian plain when the line broke. The Italians are most expert electricians, but since 1906, when he first visited Italy, he had seen many things in Italy which had been adopted from developments brought about by Canadian engineers. He believed that all over the world there would be seen many important developments, the result of war experiences.

High-Pressure and High-Temperature Steam

The Following Paper Read Before the Institution of Electrical Engineers Gives Some Interesting Engineering Data Regarding One Trend of Power Plant Development and Design

By J. H. SHAW

ALL engineers responsible for the generation of power by steam are seeking more economical methods by which the energy contained in the coal can be converted into energy of a more convenient nature. The power required may be in the form of electrical, hydraulic, or mechanical energy; the most important to the majority of the members of this institution is the first named, and this paper is written principally from the point of view of the engineer interested in the generation of electricity.

With the use of steam as a medium for carrying the heat contained in the coal from the boiler to the prime mover, it is unfortunate that, with the present knowledge of thermodynamics, the greater part of the heat in the coal is lost—a comparatively small portion up the chimney and the greater portion in the circulating water, via the condenser.

It may be possible in the future to eliminate some of this loss by the use of a substance, other than water, which will require less heat to convert it into gas. As an alternative, the gas turbine may offer the solution. As these alternatives have not yet approached the commercial stage, engineers are, for the time being, compelled to focus their attention on increasing the economy to be effected by means of plant using water as a heat conveyor.

It is apparent that in order to increase the heat efficiency of a steam plant, whose characteristics are that a constant loss is inevitable whatever the temperature and pressure, it is necessary to increase the working range of temperature and pressure.

The upper limit is perhaps the temperature at which metals rapidly lose their strength, and the erosive effect which the very hot steam will have on the blading of the turbine. The lower limit is generally decided by the locality of the power station. A works equipped with cooling towers cannot expect to obtain a lower bottom temperature than 75° F., and this only when the towers are amply proportioned and the ground space is not limited. A bottom temperature of 80° F. is more to be expected, which will give 28 inch vacuum or 2 inch absolute pressure. A power station located near a cold river or the sea, where the temperature of the water during the greater part of the year is approximately 55° F., can efficiently be equipped with condensing plant designed for 29.1 inches of vacuum, i.e. 0.9 inch absolute pressure.

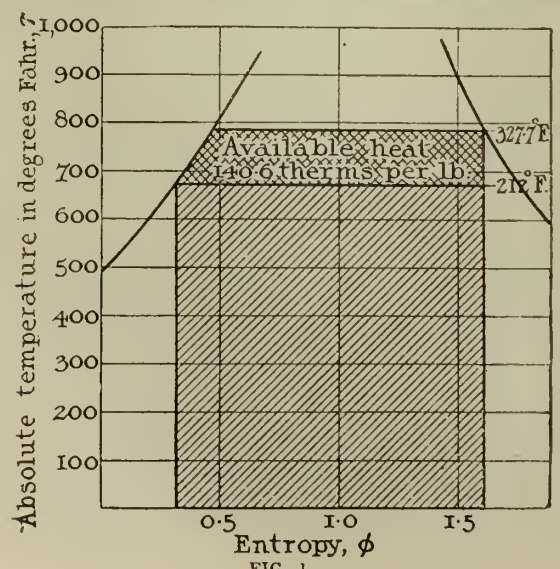


FIG. 1.

With cooling water at a temperature of 60° F. condensing plant for vacua between 28.5 and 28.8 inches can be installed.

There is little doubt that the majority of power station engineers have given attention to the efficient utilization of steam at the lower ranges of temperature and pressure, and have been during the past few years considering the

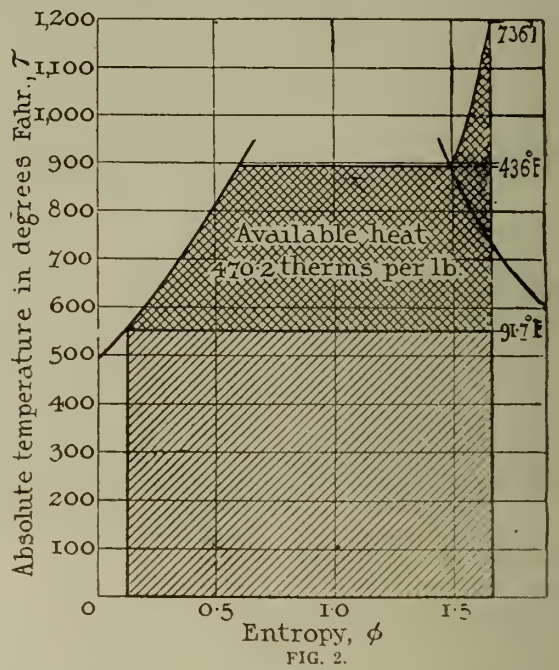


FIG. 2.

upper range. Here there is rather more scope for choice, but it appears that doubt exists as to whether it is the more economical to increase the temperature of the steam by superheating or to increase the range by the use of higher pressures and a moderate amount of superheat. This question has been shelved to a certain extent owing to engineers being engaged on war work, and thus unable to give the necessary time and attention to developing plant suitable for the higher ranges.

An interesting plant has been installed by the British Thomson-Houston Company at their Rugby power house, consisting of a B.T.H. turbine and a Babcock and Wilcox marine type boiler, capable of a normal evaporation of 18,000 lb. per hour with feed water at 80° F. (the working pressure being 350 lb. per square inch, the final temperature of the steam after passing the superheater 700° F., and the test pressure of the boiler 525 lb. per square inch). Good results have been obtained from the combination, and an inspection of the machine after about a year's operation showed no undue signs of wear.

At the Carville power station, Newcastle-on-Tyne, the latest section of the boiler house is designed for 275 lb. pressure, and at Glasgow the boiler pressure at the new works is to be 250 lb. per square inch.

A question that will appeal to all is "Will it pay?"

A good case can be made out for a jump to 600 lb. pressure with a total temperature of 700° to 800° F., but this will involve a considerable amount of development charges being borne by the undertaking or undertakings which are the first to adopt such a pressure. On the other hand, it appears that practically all designs of existing apparatus can be so modified as to admit of

pressures of 350 to 400 lb. per square inch. It would, therefore, seem that to increase the working range of steam without the development of new designs a pressure of 350 lb. can safely be adopted, and that if it is decided to increase the range the adoption of a pressure below this is akin to "hedging" the question.

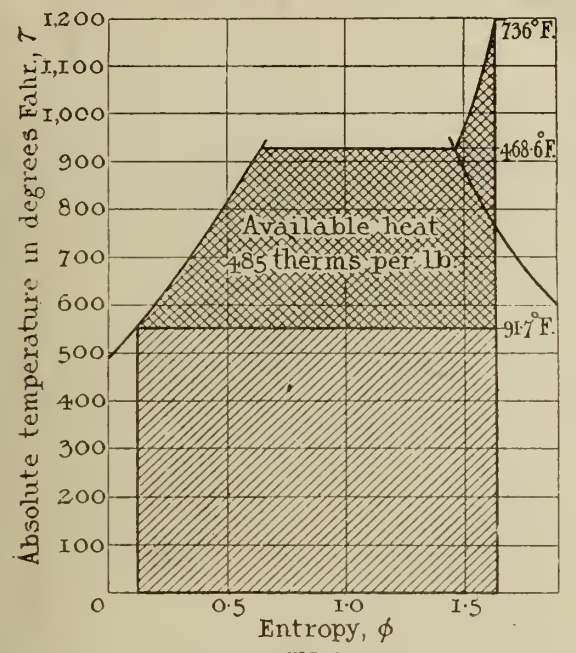


FIG. 3.

When considering any results of tests on high-pressure or high-temperature steam generating plant, it is essential that the tests on the boiler side and the tests on the turbine side be studied separately; further, it must be remembered that any results obtained on an extra high pressure boiler can be obtained and, considering the boiler pressure from the economizer, surpassed on a similar and similarly equipped low-pressure boiler.

By the aid of the temperature entropy diagram the gain due to increasing the working pressure and temperature ranges of the substance can be shown with advantage. Assuming frictionless adiabatic expansion, Fig. 1 shows the amount of heat available in 1 lb. of dry saturated steam at a pressure of 100 lb. per square inch absolute (327.7° F.) expanding to 14.7 lb. per square inch absolute (212° F.) and is equivalent to 140.6 therms per lb. Figs 2 and 3 represent the heats available per lb. of superheated steam expanding from 365 lb. per square inch absolute (736.4° F.) to 1.5 inches (mercury) absolute pressure (91.6° F.) and 500 lb. per square inch absolute (736.4° F.) to 1.5 inches (mercury) absolute pressure (91.7° F.). The amounts of heat available are 470.2 therms and 485 therms per lb. of steam respectively.

The "Mollier" diagram, by means of which problems in adiabatic expansion can be graphically solved, has total heat as ordinates and entropy as abscissæ. True isentropic or unresisted adiabatic expansion involves no change of entropy, and would be shown on the diagram by a straight vertical line. As an example, assuming that steam is to be expanded adiabatically from 200 lb. per square inch absolute saturated to 1 lb. per square inch absolute, the amount of heat in the steam before expansion can be read directly off the chart or obtained from tables in regard to steam, the value being 1,205.4 therms. Following vertically down the chart until the pressure line 1 lb. per square inch is reached, it will be seen that the amount of heat still remaining in the steam is 866.70 therms, and that the steam is 76.5 per cent. dry. Subtracting the latter value from the former, 1,205.4 — 866.7 = 338.7 therms, gives the heat drop or the number of therms available between the ranges above specified. As another example, with steam at 350 lb. absolute and superheated 250° F. and at a total temperature of 682.4° F., the initial heat is 1,361.2 therms, the final heat amounting to 922.5 therms at 1 lb. per square inch absolute; the heat drop in this case is 438.5 therms. Comparing the two examples, it will be seen that there is a gain of 99.8 therms per lb. of steam or water, or 29.5 per cent. increase in available heat in steam at the higher temperature and pressure over the lower pressure, while only 12.9 per cent. extra heat units were used in raising steam at the higher pressure over that required at the lower pressure.

The expansion that takes place in a steam turbine is not isentropic and is usually called adiabatic and resisted. Due to the friction, reheating takes place during the passage of the steam through the nozzles and blades, and the mixture gains in entropy. The amount of this gain can be calculated with considerable accuracy by turbine designers, and approximately by the user. Mr. Goudie, in his book on "Steam Turbines," has calculated a series of curves by which he arrives at the "reheat factor"; these curves are reproduced in Fig. 4, and can be used for multi-stage turbines and pressures between 150 and 200 lb. per square inch. The curves are likely to be low for higher steam pressures.

For a comparison between the cost of running a power station at 200 lb. pressure (gauge) and at 350 lb. pressure, Schedule 1 has been prepared. It is proposed to consider a riverside station, where the water is suitable for surface condensing. It is proposed to install 20,000 k.w. sets, and coal is assumed to be within a reasonable distance; the cost of the coal, with a net calorific value of 10,000 therms per lb., is for the purpose of the schedule assumed to be 10s. per ton at the works. The incombustible contents of the coal would amount to 20 per cent. The average water temperature is taken to be 60° F., and the vacuum 28.5 inches, with the barometer at 30 inches. The overall efficiency of the boiler house plant is assumed to be 77.5 per cent., which should be obtained with modern boiler control.

Turbine makers are not all in accord as to the efficiency to be expected from turbines of the size under consideration when working on high pressures. A well-known firm states that between 200 lb. pressure and 350 lb. pressure there will be a drop in ratio efficiency of 2½ per cent.;

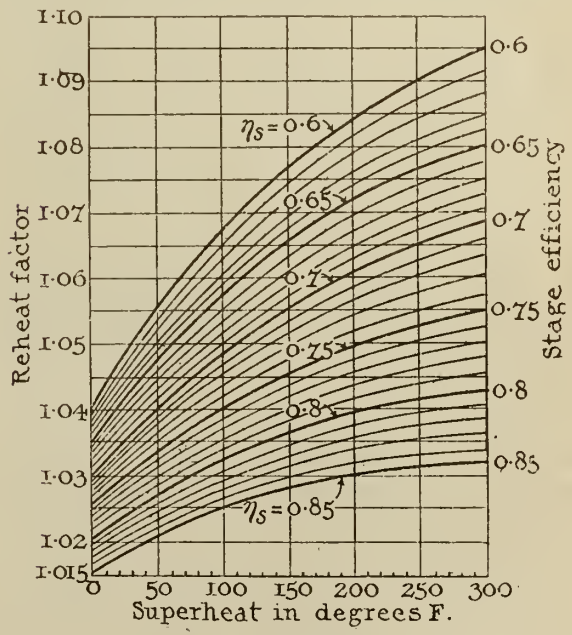


FIG. 4.

other manufacturers state that a turbine can be built with the same efficiency at 350 lb. pressure as at 200 lb. There is no doubt that the increased density of the steam at the higher pressure will increase the internal losses in the turbine.

Martin, in his book entitled, "Design and Construction

SCHEDULE 1.

ABSOLUTE PRESSURE AT TURBINE EXHAUST, 1·5 IN. (HG.) (91·7° F.). CONDENSATE TEMPERATURE, 85° F

Steam Pressure at Turbine	215 lb. per sq. in (abs.)					365 lb. per sq. in (abs.)						500 lb. per sq. in (abs.
Superheat of Steam at Turbine, ° F.	100°	150°	200°	250°	300°	50°	100°	150°	200°	250°	300°	268°
Total temperature of steam at turbine, ° F	487·9	537·9	587·9	637·9	687·9	486·4	536·4	586·4	636·4	686·4	736·4	736·4
Total heat in steam from 32° F., therms per lb.	1,265·0	1,293	1,319	1,345·5	1,371	1,249	1,278·5	1,307	1,335	1,363	1,389	1,382·7
Heat drop per lb. of steam, therms	379·1	391	403·4	416·1	429·2	402·4	415·4	428·7	442·2	456	470·2	485
Ratio efficiency of turbo-alternator	77·1%	77·6%	78·5%	79·0%	79·5%	75·5%	76·9%	77·6%	78·4%	78·9%	80%	80·2%
Internal efficiency of turbine	81·5%	82%	83%	83·4%	84·0%	79·8%	81·3%	82·0%	82·8%	83·4%	84·5%	84·6%
Steam consumption of turbine, lb. per kw.-hr.	11·7	11·25	10·8	10·4	10·0	11·3	10·7	10·28	9·86	9·5	9·15	8·89
Total steam consumption of turbine, lb. per hr.	234,000	225,000	216,000	208,000	200,000	226,000	214,000	205,600	197,200	190,000	183,000	177,800
Heat rejected to condenser from 32° F., therms per lb.	947	973	984	998	1,010	925	940	955	969	983	991	972·7
Ratio of circulating water to steam condensed	44	45	46	46·5	47·0	43	44	45	45·5	46	46	44
Circulating water, quantity, galls. per hr	1,029,600	1,012,500	993,600	967,200	940,000	971,800	941,600	925,200	897,200	874,000	840,000	785,000
Power for circulating pumps, b.h.p.	163	160	157	153	149	154	149	146	143	138	133	124
Power for air and condensate extraction pumps, b.h.p.	89	86	83	80	77	86	82	80	77	74	72	70
Power for boiler feed pumps, b.h.p.	104	100	96	92	89	166	157	151	145	140	135	177
Power for induced draught fans, b.h.p	222	220	220	216	212	218	212	207	203	200	195	186
Power for small auxiliary motors, b.h.p.	57	56	55	54	51	61	58	57	55	54	54	56
Total power for auxiliaries, b.h.p.	635	622	611	595	578	685	658	641	623	606	589	613
Total power for auxiliaries, kw	530	515	510	495	485	565	540	530	515	500	485	510
Net output to busbars, kw	19,470	19,485	19,490	19,505	19,515	19,435	19,460	19,470	19,485	19,500	19,515	19,490
Heat in steam from temperature of hotwell, therms per lb	1,212	1,240	1,266	1,293	1,318	1,196	1,226	1,254	1,282	1,310	1,336	1,329·7
Steam consumption per effective kw.-hr., lb	12·01	11·55	11·09	10·67	10·25	11·62	11·00	10·55	10·12	9·74	9·39	9·124
Pounds of steam evaporated and superheated per lb. of coal, lb	6·40	6·25	6·12	6·0	5·9	6·48	6·32	6·2	6·05	5·90	5·8	5·83
Coal consumption per effective kw.-hr., lb.	1·88	1·85	1·82	1·78	1·74	1·80	1·74	1·70	1·68	1·65	1·62	1·565
£ Cost of coal at 10s. per ton, generating $175·2 \times 10^6$ kw.-hr	73,200	72,000	70,800	69,200	67,600	70,000	68,000	66,400	65,200	64,400	63,750	61,250

of Steam Turbines," gives Dr. Lasche's formula for the power absorbed by rotating discs as—

$$\text{Power absorbed in kilowatts} = \frac{A}{5.5}\left\{\frac{\text{r.p.m.}}{1{,}000}\right\}^3 \frac{d\,l}{V}.$$

d = diameter of wheel in inches;
l = average length of blades in inches;
V = specific volume of the steam;
A = a constant.

The constant is unity for a wheel carrying one row of moving blades, and 1.2 for wheels with two rows. The formula is said to be valid for wheel diameters from 35 inches up to 47 inches, and for values of l ranging between ¾ inch and 2 inches.

The author above quoted further states that "the resistance offered by a turbine wheel when at work is, however, quite different from its resistance when motored round; with a wheel at work and with complete admission there is no true windage due to the blades, whilst with partial admission the blades on the active arc are also free from windage."

In view of the above and the difference between the views of experts, it will be advisable to look ahead and anticipate that the efficiencies of turbines of the size under consideration will be improved in the near future. For the purpose of the calculations a turbine ratio efficiency of 80 per cent. is assumed, at both 200 lb. pressure and 350 lb. pressure with the steam superheated 150 degrees F. and a constant vacuum of 28.5 inches. The corrections used for obtaining the consumptions at different steam temperatures are taken from Mr. Baumann's paper, Journal IEE, 1912, vol. 48, p. 768. An alternator of 20,000 k.w. capacity can no doubt be built to give an efficiency of 97 per cent. at unity power factor, thus making the turbo-generator ratio efficiency $0.80 \times 0.97 = 77.6$ per cent. Assuming bearing and other friction losses to absorb 2 per cent., the internal efficiency of the turbine will amount to 82 per cent.

Schedule 1 shows the comparisons of coal, steam, and heat consumptions for a 20,000 k.w. machine running under the conditions mentioned, at 200 lb. and 350 lb. pressure by gauge at varying superheats; also at 500 lb. pressure absolute and 268 degrees F. superheat, at which pressure and superheat the total temperature will be 736.5° F., which is about the maximum temperature at present recommended for the materials now being used in turbine construction. Schedule 1 shows that the cost for coal when generating 175.2 million k.w. hours with a load factor of 100 per cent. will be £64,400 at the higher pressure (superheat 250 degrees F.), and £69,200 at the lower pressure with corresponding superheat. This is a saving of £4,800 per 175.2 million k.w. hours, or 0.007 pence per kilowatt hour. Unfortunately, a load factor of 100 per cent. is impossible, and the conditions under which power stations are operated must be considered before even an approximate estimate of working costs can be arrived at.

An annual load factor of 50 per cent. may mean full load for half the number of hours in a year, or anything between this and half load for the full number of hours in the year.

In order to avoid having to assume a curve of load and the necessity of calculating the consumptions at partial loads, a method of computation generally adopted for calculations of this nature, and one which is sufficiently accurate for this purpose, is to assume that the

ratio of the station output to the total coal consumed is in accordance with Williams' law, that is, a straight line.

Fig 5 is plotted from results obtained at the Bradford Corporation's Valley road power station for a number of days during the year 1917. On this curve the weight of coal used is shown to be 60,000 lb. per day plus 2.32 lb. per unit generated. The quantity of coal per day, that is, 60,000 lb., is the no-load consumption of the work and will include the no-load consumption of one turbo-generator. In order to make the calculations as simple as possible, it is proposed to deduct the no-load consumption of one machine (5,500 lb. of steam per hour) from the works' no-load consumption, and to assume an evaporation of 6 lb. of water per lb. of coal, and to call the figure so obtained the works' standing loss.

$\frac{60{,}000 \times 6}{24}$ = No-load consumption of works in lb. of steam per hour = 15,000 lb. of steam per hour

Deduct the no-load consumption of one machine

$= 15{,}000 - 5{,}500 = 9{,}500$ lb. of steam

and $9{,}500 \div 6 = 1{,}583$ lb. of coal per hour.

To arrive at an estimated figure for the power stations under discussion, it is proposed to assume that the standing loss of the station designed for 200 lb. will be the

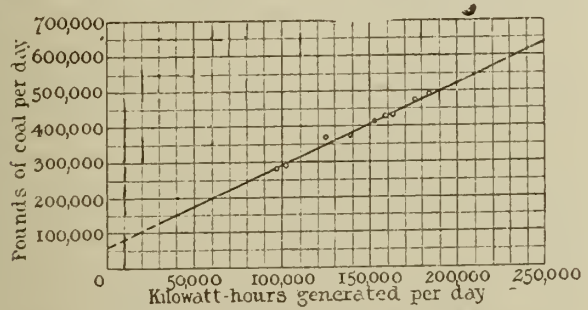


FIG. 5—STATION CONDITIONS—185 LB. PER SQ. IN. (GAUGE); 100 DEG F. SUPERHEAT; 28 IN. VACUUM; 30 IN. BAROMETER.

same as for the Valley road power station, that is, 1,583 lb. of coal per hour. It will be fair if the same basis is taken for the plant at 350 lb. pressure, with 8 per cent. added to the works' standing loss, representing roughly the higher temperature of the steam at the higher pressure. Standing losses must be approximately proportional to the top temperature, as this affects radiation, boiler exit losses, etc.

For a 20,000 k.w. set the no-load consumption will be approximately 22,000 lb. of steam, or 3,666 lb. of coal per hour. These figures plotted in conjunction with the steam consumptions shown in Schedule 1 give the total steam consumption at any load as

22,000 lb.+9.54 lb. of steam per kilowatt hour

for the plant operating at 200 lb. pressure, and

22,000 lb.+8.6 lb. of steam per kilowatt hour

and 3,729 lb.+1.45 lb. of coal per kilowatt hour for the plant operating at 350 lb. pressure and 250 degrees superheat.

In order to allow for changing over, for the period when two or more machines are temporarily running together at partial loads, for reduced efficiency in the boiler house due to adverse circumstances, and for the necessity of sometimes running the plant when it is not in the best condition, it will be advisable to add 5 per cent. to the figures obtained for the load consumption and 5 per cent. to the no-load loss of the turbine, thus making the consumptions and costs as below:—

	Maximum load of 20,000 k.w. and 50% load factor 87.6 x 106 units per annum.	
	200 lb. Pressure, 250 deg. Super-heat, 28.5 in. Vacuum	350 lb. Pressure, 250 deg. Super-heat, 28.5 in Vacuum
Works standing loss in tons of coal	6,200	6,700
No-load consumption of turbo-generators in tons of coal	15,100	15,314
Load consumption of turbo-generators in tons of coal	65,300	59,867
Total	86,600	81,881
Lb. of coal per unit on station busbars	2.211	2.094
Total cost at 10s. per ton	£43,300	£40,940
Cost of coal per unit	0.119d	0.1122d

A further Schedule (No. 2) has been prepared, showing comparative coal costs of riverside stations working at

200 lb. per sq. in. (gauge), 300 deg. F. superheat, and
350 lb. per sq. in. (gauge) 250 deg. F. superheat, and
485 lb. per sq. in. (gauge), 220 deg. F. superheat

All the efficiencies and calorific values used in preparing Schedule 1 are used in preparing the Schedule above mentioned, so that they are directly comparative.

Schedule 2

Steam pressure at turbine, lb. per sq. in. abs.	215	365	500
Superheat of steam at turbine, °F.	300	251.6	219.4
Total temperature of steam at turbine, °F.	688	688	688
Totalheat of steam(from 32 °F),therms per lb.	1371.2	1,363.2	1,356.0
Absolute pressure at turbine exhaust, in.(Hg.)	0.9	0.9	0.9
Heat drop per lb. of steam, therms	454.9	480.7	495.4
Ratio efficiency of turbine and alternator	79.5%	79%	78.6%
Internal efficiency of turbine	84.0%	83.4%	83.0%
Steam consumption of turbine, lb. per kw.-h.	9.46	9.00	8.77
Total steam consumption of turbine, lb. per hour	187,600	180,000	175,400
Heat rejected to condenser (from 32° F.), therms per lb.	985	962	945
Ratio of circulating water to steam condensed	81	80	77
Circulating water quantity, gals. per hr.	1,520,000	1,460,000	1,350,000
Power for circulating pumps, b.h.p.	240	230	215
Power for air and condensate extraction pumps, b.h.p	92	90	88
Power for boiler feed pumps, b.h.p.	84	133	180
Power for induced draught fans, b.h.p.	197	187	182
Power for small auxiliary motors, b.h.p.	62	64	66
Total power for auxiliaries, b.h.p.	675	704	731
Total power for auxiliaries, k.w.	560	580	605
Nett kilowatt output to busbars	19,440	19,420	19,395
Heat in steam from temperature of hotwell, therms per lb.	1,331.2	1,323.2	1,316
Steam consumption per effective kw.-hr., lb.	9.74	9.48	9.04
Lb. of steam evaporated and superheated per lb. of coal	5.83	5.86	5.89
Coal consumption per effective kw.-h., lb.	1.67	1.62	1.536
Coast of coal at 10s. per ton, generating 175.2 x 10.6 k.w.-h.	£65,200	£63,300	£60,100

Schedule 3

	215 lb. per sq in. abs., 250 deg. F. Superheat, 28 in. Vacuum	365 lb. per sq in. abs., 250 deg. F. Superheat, 28 in. Vacuum
Total heat of steam (from 32° F.), therms per lb.	1,345.0	1,363
Heat drop per lb. of steam, therms	401.3	441.6
Ratio efficiency of turbo-alternator	79%	78.9%
Steam consumption per kw.-h., lb.	10.75	9.85
Heat rejected to condenser, therms per lb.	1,011.5	996
Ratio of circulating water to steam	63.5	62
Power for circulating pump, b.h.p.	432	385
Total power required for auxiliaries, kw.	730	700
Lb. of steam per kw.-h. on busbars	11.1	10.2
Lb. of coal per kw.-hr. on busbars	1.79	1.675
Cost of coal at 10s. per ton per 175.2 x 10.6 kw.-h.	£70,000	£65,200

Circulating water at 80° F. discharged from condenser at 96° F. Efficiency of boiler house, 77.5 per cent. Coal with a net calorific value of 10,000 therms per lb.

The head against which the circulating pumps have to work is taken to be 50 feet.

Schedule 4

Steam pressure at turbine, lb. per sq. in. ab.	215	265	315
Total temperature of steam at turbine, °F.	688	688	688
Superheat at turbine, °F.	300	281.6	265.6
Total heat of steam (from 32° F.), therms per lb.	1,371.3	1,368.6	1,365.9
Absolute pressure at turbine exhaust, in.(Hg.)	1.5	1.5	1.5
Heat drop per lb. of steam, therms	429.2	440.3	449.1
Ratio efficiency of turbine and alternator	79.5%	79.1%	79.0%
Steam consumption of turbine, lb. per kw.-h.	10.023	9.82	9.65
Total steam consumption of turbine, lb. per hour	200,460	196,400	193,000
Steam consumption per effective kw.-h., lb.	10.3	10.10	9.94

Schedule 3 shows the coal required, and power for auxiliaries, for a cooling tower station working between 200 lb. per sq. in. gauge, 250 degrees F. superheat, and 350 lb. per sq. in. gauge, 250 degrees F. superheat exhausting against a back pressure of 1 lb. absolute pressure.

Schedule 4 gives the relative steam consumptions with steam at a temperature of 688° F., 215 lb. per sq. in. gauge, 265 lb. per sq. in. gauge, and 315 lb. per sq. in. gauge, exhausting against a back pressure of 1.5 inches of mercury or 28.5 inches vacuum.

The foregoing relates only to the cost of coal; the remaining items which make up the total works' costs are not likely to be affected by the use of higher pressures and temperatures. Oil, waste, and water are practically unaffected; repairs and maintenance may be increased, but not to appreciable extent. The capital cost of the plant is an item that may be affected to a considerable extent, but unfortunately the increased cost of turbines, boilers, pipes, etc., due to the use of higher pressures and temperatures cannot be given in a paper of

Steam Pressure ..	215 lb. per sq. in. abs.)					365 lb. per sq. in. (abs.)						500 lb. per sq. in. (abs.)
Superheat	100° F.	150° F.	200° F.	250° F.	300° F.	50° F.	100° F.	150° F.	200° F.	250° F.	300° F.	268° F.
1. Coal consumption (lb.) per effective kw.-hr. at 100 % load factor and no station losses	1·88	1·85	1·82	1·78	1·74	1·8	1·74	1·7	1·68	1·65	1·62	1·56
2. Coal consumption (lb.) per kw.-hr. delivered to busbars at 50 % load factor	2·32	2·28	2·24	2·211	2·18	2·22	2·18	2·15	2·11	2·102	2·06	2·0
3. Annual cost (£) of coal at 10s. per ton per 87·6 million kw.-hrs. at 50 % load factor	45,310	44,575	43,775	43,300	42,500	43,425	42,600	41,900	41,325	41,100	40,350	39,075
4. Estimated saving (£) per 87·6 million kw.-hrs., taking 215 lb. (abs.), 100 deg. F. superheat as datum.	—	735	1,535	2,010	2,810	1,885	2,710	3,410	3,985	4,210	4,960	6,235
5. £ capital that can be expended for annual payments to absorb amount shown in line 4. Life of plant 15 years, and compound interest at the rate of 5 %.	—	7,650	16,000	21,800	29,300	19,600	28,200	35,500	41,250	43,800	51,600	65,000

this description. At a time like the present, when all manufacturers are experiencing difficulties in maintaining deliveries of standard articles, it is not to be expected that they will go into costs of special apparatus. Further, with the continued increases in wages, the cost of transportation, and the cost of raw material, it is almost impossible accurately to estimate any costs that are to remain good for a length of time. Whereas before the commencement of the war a 5,000 k.w. turbine, alternator, and condenser could be purchased for £2.9 per kilowatt, a machine of 20,000 k.w. capacity now costs £4.1 per kilowatt.

With regard to the practical difficulties, it is but to be expected that before pressures of 500 lb. or 600 lb. per square inch are adopted, a radical departure will have to be made in present boiler construction. All square boxes and headers will be eliminated, the drums and tubes will be smaller in diameter, and the design of the boiler made more elastic. The type of boiler will no doubt assume the appearance of a flash boiler, with practically no steam or water reserve, and fired by gas on the surface combustion principle.

For more moderate pressures, up to 350 lb. per square inch, the existing type of boiler can be modified and successfully used. At Carville power station Babcock & Wilcox marine type boilers are being used, at 275 lb. per square inch gauge pressure, and at the British Thomson-Houston Company's works at Rugby a Babcock & Wilcox boiler is installed and successfully working at 350 lb. per square inch. Further, Messrs. Babcock & Wilcox state that they have at present two boilers on order for a working pressure of 475 lb. per square inch with steam superheated to a final temperature of 700° F., and that they are quite prepared to supply boilers in their ordinary business for such pressure and superheat.

With higher steam pressures the temperature of saturation is raised, and, due to this, greater care must be exercised in the quality of the water used for the boiler feed. A feed water that is perfectly satisfactory at 380° F. in a modern tubular boiler might be quite unsuitable for use in a flash boiler. The quantity of air, CO_2, and oxygen will have to be kept down to a minimum, and also the non-soluble salts which are generally in the water discharged from an ordinary lime-soda water softener. A natural development, and one which is already taking place, is to heat the feed water under atmospheric pressure by means of live or exhaust steam in order to drive off the entrapped and dissolved gases as much as possible. According to the table on page —, extracted from Lunge's "Technical Chemist's Handbook," it is necessary to raise the temperature of the water to 100° C. before the quantity of air in the water is appreciably reduced.

The source of water for use in high pressure plants will have to be carefully traced, and the treatment of the water should be such that a minimum of unsoluble salts remains in it after treatment. The purer the water the greater affinity it has for air, CO_2, and oxygen, and every care should be taken that it is not exposed to the air between the condenser and the boiler. In order to avoid such exposure to the air it is suggested that the feed pump should be an extension of the condensate pump and the condensed water pumped direct into the feed line.

The natural development of the turbine for higher pressures appears to be in a line with a Parsons two-cylinder machine, with a flexible claw-type coupling between the cylinders and a thrust bearing for each cylinder. For very large sets, above 50,000 k.w., the cross-compound turbo-generator will no doubt be used, the high pressure turbine being attached to a generator and the low pressure turbine to another generator. Each set can then be run at its most suitable speed, with resulting high efficiency. This arrangement will no doubt lead to reheating the steam after it leaves the high pressure turbine and before entering the low pressure machine. Dr. Ferranti has already done valuable work on this subject, the results of which have unfortunately not been published.

The design of the condensing plant is not likely to be modified because of the use of high pressure or high temperature steam, but it must not be lost sight of, that with steam initially at the same temperature but at different pressures the plant using the high pressure steam will reject less heat units to the condenser per lb. of steam used in the turbine.

The steam pipes to be used in a station where both high pressures and high temperatures are employed will have to be very carefully designed.

A well-known tube firm on being asked their opinion as to the difficulties to be experienced with steam piping have replied that:—

"The thickness of both the tube and flange would vary slightly in accordance with the pressure. We should certainly recommend the tubes to be of our lap welded process with flanges welded on, and in both cases the gauge of the piping and the thickness of the flange would naturally be increased according to the pressure to contend with.

"With regard to jointing material, we would suggest that corrugated rings and fibrine jointing compound would

Solubility of Gases in Water

Volume of gas 0° C. and 760 mm. (mercury) dissolved by one volume of water at the temperature indicated if the partial pressure of the gas is 760 mm. (mercury).

Water Temperature. C.	O*	H*	CO2†	N†	Air*
30°	0.02608	0.01699	0.665	0.01380	0.01606
35°	0.02440	0.01666	0.592	0.01271	.....
40°	0.02306	0.01644	0.530	0.01182	0.01503
45°	0.02187	0.01624	0.479	0.01111	.....
50°	0.02090	0.01608	0.436	0.01061	0.01418
60°	0.01946	0.01600	0.339	0.01000	0.01297
70°	0.01833	0.01600	0	0	0.01216
80°	0.01761	0.01600	.....	.....	0.01156
90°	0.01723	0.01600	.....	.....	0.01126
100°	0.01700	0.01600	.....	.....	0.01105

*Winkler. †Bohr and Bock.

be most suitable and, for preference, for high temperature a nickel ring. Steel bolts to be used and not wrought iron.

"Regarding the temperature of 800°, we have had practically little experience of such a high temperature, but quite frequently we supply tubes for a temperature of 700° and, as far as our knowledge is concerned, we have not found that this high temperature has been the cause of any undue shortening of the life of the pipes; in fixing the thickness of mains, however, the reduction in tensile strength through the increase in temperature would, of course, be kept in view.

"As far as we can see, one of the principal difficulties with this high temperature will be with expansion, as the pipes will be thicker and naturally more rigid, so that it will be necessary to lengthen the expansion bends or any natural bends which are taking up expansion in order to meet the additional expansion in the mains, and therefore this point will have to be carefully considered in designing installations.

"The points of anchorage will have to be very carefully watched, as invariably in boiler houses there is nothing very substantial to anchor off at the essential points."

The question of expansion at higher temperatures will be of the utmost importance. For example, take the case of a steam pipe 100 ft. in length, and assume that the pipe had been erected at 60° F. It will be found that at a temperature of 388° F., equal to steam at 200 lb. gauge saturated, the expansion is 2.59 inches, while at 786.6° F., equal to steam at 600 lb. pressure and 300° F. superheat, the expansion is 5.75 inches.

The expansion given can be readily taken care of if the designer can ensure that the expansion would always take place lengthwise in the pipe range. Unfortunately, taking a boiler off a range will cause a considerable cross-strain to the main header, due to the connecting pipes cooling down and contracting.

It appears that the main steam connections of the boiler will have to be designed in a flexible manner, in order to relieve the main range of stress. Further, these connections should be of the manifold or header type, that is, made up of many small pipe connections.

The specific volume in cubic feet per lb. of steam at approximately 800° F. and at pressures of 200 lb., 350 lb., and 600 lb. by gauge, are 3.47, 2.10, and 1.25 cubic feet per lb. Unfortunately the relative areas of the steam pipes cannot be reduced proportionately to the specific volumes, as the friction of the denser steam would cause undue pressure drop. Proportioned according to the density of the steam, a pipe to supply a 20,000 k.w. set could have a diameter of 12 inches at 200 lb. gauge and 800° F. total temperature, and a diameter of 7.25 inches at 350 lb. pressure and 800° F. superheat, with a velocity of approximately 150 ft. per second. In actual practice the diameters would approximate to 14 inches and 10 inches for 200 lb. and 350 lb. respectively.

There is no doubt that a large portion, in fact the major part, of the pressure drop in steam pipes as at present erected is due to the method of arranging ring mains and duplicate paths for the steam when certain parts of the main are down for joint making, and the provision of a duplicate path often so spoils the design that joints cannot be kept tight.

If the piping is designed on the unit principle, that is, a number of boilers practically isolated on to one generating unit, a small equalizing main only need be provided at the end of the boiler house. Ample arrangements can be made for expansion with such an arrangement, and drainage is required at two points only in each section. at the turbine steam separator and in the equalizing main. It could be arranged that steam would never enter or leave a pipe at right angles, and each branch would enter the main pipe at an angle of approximately 45 degrees.

From inquiries it is apparent that the boiler mounting and valve makers are quite alive to the possibilities of high-pressure and high-temperature steam coming into commercial use. One well-known firm reports:

"The highest steam pressure for which we have made valves is 400 lb. per square inch, and we are prepared to make the same for pressures up to 600 lb. per square inch.

"The highest temperature for which we have supplied valves is 700° F.

"The highest velocity in steam practice that we have met is 230 ft. per second."

They further state that with the limits mentioned above they have not found that high superheat has a detrimental effect upon steel or their non-ferrous alloy, which is used for the internal working parts of valves of their manufacture.

It is well known that cast iron when subjected to high temperature undergoes changes which in time causes it to distort and grow; there is also a chemical action taking place which causes the material to disintegrate and finally break away.

A 10-in. valve with a cast steel body and cast iron disc and seat, which was in service at the Bradford Corporation Valley road power station for 8 years, had to be taken out of commission on account of the valve grooving and breaking. This valve had not at any time been subjected to a higher temperature than 480° F.

An American firm reports as follows:—

"The increase of steam pressures above 200 lb. for commercial purposes has received impetus only during the last few years, and for that reason there is not a wealth of data to offer.

"It has been apparent to us for some time back that the trend of the engineering world was towards increased pressures and temperatures, and we have provided the market with material to meet the new requirements.

"We have designed a line of cast steel gate valves and special fittings for 400 lb. steam working pressure and total temperature of 800° F., and can furnish material for any steam pressure containing no greater temperature than above mentioned.

"It is not so much a question of pressure in the designing of a good valve or fitting as it is the temperature to which it can be subjected. It is a recognized fact that metals such as cast steel, cold rolled steel, nickel steel, and monel metal which are used in the manufacture of this class of material, show a decrease in elastic limit when temperatures higher than 750° F. are reached. The reduction of strength of the metal above 750° F. can, in a measure, be compensated for by proper design and liberal distribution of material, but other elements such as weight of piping, expansion and contraction, settling and water hammer must also receive serious consideration. The packing and gasket problems are also worthy of thought."

The question of the use of higher pressures is quite appreciated by the makers of economizers, who are prepared to manufacture economizers for 350-lb. boiler pressure or higher, either of their standard design, with the details modified, or of a design suitable for use as an integral part of the boiler, if necessary with horizontal and mild steel tubes.

General

It must be admitted that in order to attain a higher overall efficiency it is necessary to increase both the pressure and the temperature of the steam. An increase of pressure with a constant temperature would mean that the dew point is carried further up the turbine towards the high pressure end, thus tending to accelerate blade erosion in the lower stages and a reduced stage efficiency of the turbine. Also the high pressure blading of a turbine is considerably less efficient than the low pressure stages, and although the losses in the high pressure end are partly recovered in the low pressure blades, it is apparent that to assume that a turbine for extra high pressures can be built with the same efficiency as one for a lower pressure (within limits) is taking a hopeful view, and that there is justification for hesitation before adopting extra high pressures on the part of managers responsible for the financial results of large undertakings.

Firing Steam Boilers With Powdered Coal

The Following Article Gives an Account of Actual Test on Boilers Using Pulverized Fuel

IN the accompanying illustration may be seen a twin unit of the carburization process installed on 150 horsepower horizontal return tubular boiler. The director of the United States Bureau of Mines has stated that fully half a billion dollars were wasted in one year through the inefficient use of coal. It has been estimated that sixty-one per cent. of the coal mined in this country is used for power production in steam boilers in industrial plants and railroad locomotives. Taking the annual coal consumption for the United States as 500,000,000 tons, we find that approximately 305,000,000 tons are used for various steam power purposes. The use of coal for domestic purposes and small steam trade amounts to 16 per cent., or 80,000,000 tons.

Coal for coke making takes 13 per to 16 per cent., or 80,000,000 tons.

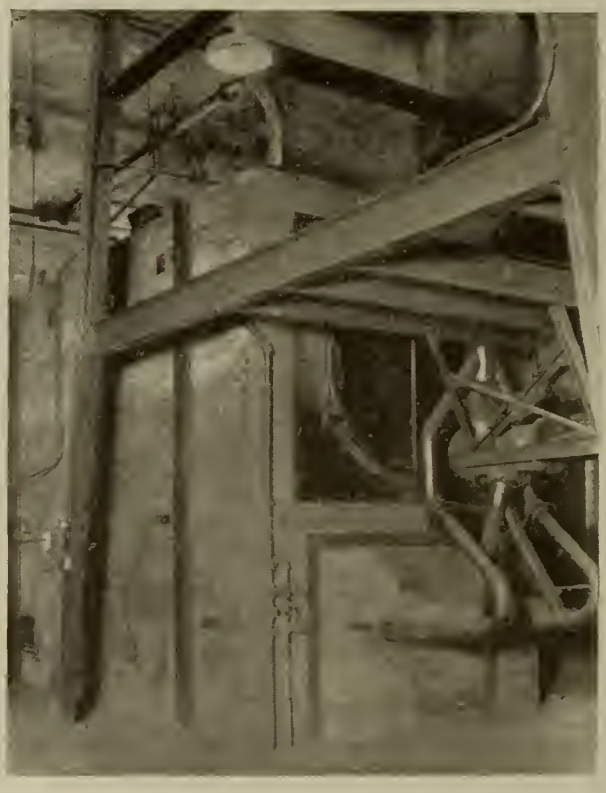
Coal for coke making takes 13 per cent.; exports, 4 per cent.; 2 per cent. is used at the mines: steamship bunker coal amounts to 2 per cent., and 1 per cent. is consumed in the manufacture of coal gas. It is indeed a matter of interest to know how much of this coal might be saved provided the boiler operators were made familiar with the conditions of most efficient firing and utilization of coal.

The preventable waste of fuel in the boiler furnaces of one steel mill amounted to 40,000 tons per year, which, at $5 a ton would cost $200,000. This was a comparatively modern plant. The efficiency of boiler and furnaces in a 14-day test was 55 per cent. The load factor was unusually favorable to high efficiency and could readily be raised to 70 per cent. or over.

Engineers advocating the use of powdered coal urge that, standing on the eve of what is to constitute the greatest revolution in the utilization of coal ever witnessed, there is given available means of achieving ideal operation. The burning of powdered coal under steam boilers with the positive assurance of obtaining complete combustion, a maximum boiler and furnace efficiency, under ordinary conditions of operation and with a smaller number of operators, is an accomplished fact. The inherent disadvantages of the older methods of firing the pulverized fuel have been overcome by the perfection of the carburization process and the Pruden carburetor.

It is claimed that the personal equation existing under conditions of grate-fired practice are eliminated if the installation has been made with due regard to the engineering requirements of the individual plants. The accurate control of air and powdered coal is obtained through suitable valve mechanisms which anyone can intelligently operate. The mixing of the coal dust and the proper amount of air is intimate and complete. Combustion, in the case of any grade or type of coal, even with 20 or 30 per cent. ash, occurs under the most favorable conditions. Every available B.t.u. in the fuel, whether Illinois screenings or North Dakota lignite, is liberated at the earliest possible moment, with the least amount of air necessary for complete combustion, causing a high furnace temperature and a minimum loss of sensible heat in the waste-flue gases.

The old bugbear of slag formation with powdered fuel has beat a hasty retreat under the pressure of actual results obtained under operating conditions where the carburization process is used.



PULVERIZED FUEL INSTALLATION.

The ash, which collects in the flues or on the water-tubes is light, porous and unfused, showing no tendency to form a hard cake, and should give no more trouble in a properly-installed equipment than does soot in ordinary grate-fired practice. The removal of the molten slag and ash from the bottom of the fire-box becomes with practice a simple operation, and, compared with the usual difficulties with clinkers on mechanical stokers, is indeed an item which should cause no real concern.

In case it is necessary to "bank" the fires it can be accomplished by turning a valve. When it is necessary to meet a "peak" load condition the desired boiler capacity is obtained in as simple a manner. When it is necessary to shut down the boiler—to clean out the flues or for other purposes—this can be done instantly, and when desired the fire can be turned on again like gas.

The photograph shows a 150 horsepower horizontal return tubular boiler, fired by two 12-inch Pruden carburetors. The results of an evaporation and efficiency test on the 150 horsepower horizontal tubular boiler fired by two 12-inch Pruden carburetors are of interest. The duration of this test was 23¼ hours. It was witnessed by a number of local engineers and technical men. The coal burned was a high ash (22.09 per cent.), LaSalle County, Illinois, screenings, with a heating value of 10,158 B.t.u. on a dry basis. The coal was dried and pulverized, the coal preparation unit having a capacity of 30 tons of pulverized fuel per day. As burned under the boiler, the coal dust had a moisture content of 2.94 per cent. A screening test showed that 98.8 per cent. passed through a 100-mesh screen and 90.5 per cent. through a 200-mesh screen.

The proximate and ultimate analysis of the coal is given in Table 1.

Table 1

Proximate Analysis

	Dry per cent.	As burned per cent.
Moisture		2.94
Volatile matter	37.61	36.49
Fixed carbon	36.51	35.42
Sulphur	3.79	3.71
Ash	22.09	21.44
	100.0	100.00

Ultimate Analysis

	Dry per cent.
Carbon	60.86
Hydrogen	4.32
Nitrogen	0.99
Oxygen	7.95
Sulphur	3.79
Ash	22.09
	100.00

The results and data of the test are of interest.

Table Data and Results of Evaporation Test

Test of Brownell tubular boiler located at plant at Chicago to determine evaporation.

Kind of furnace: special construction.

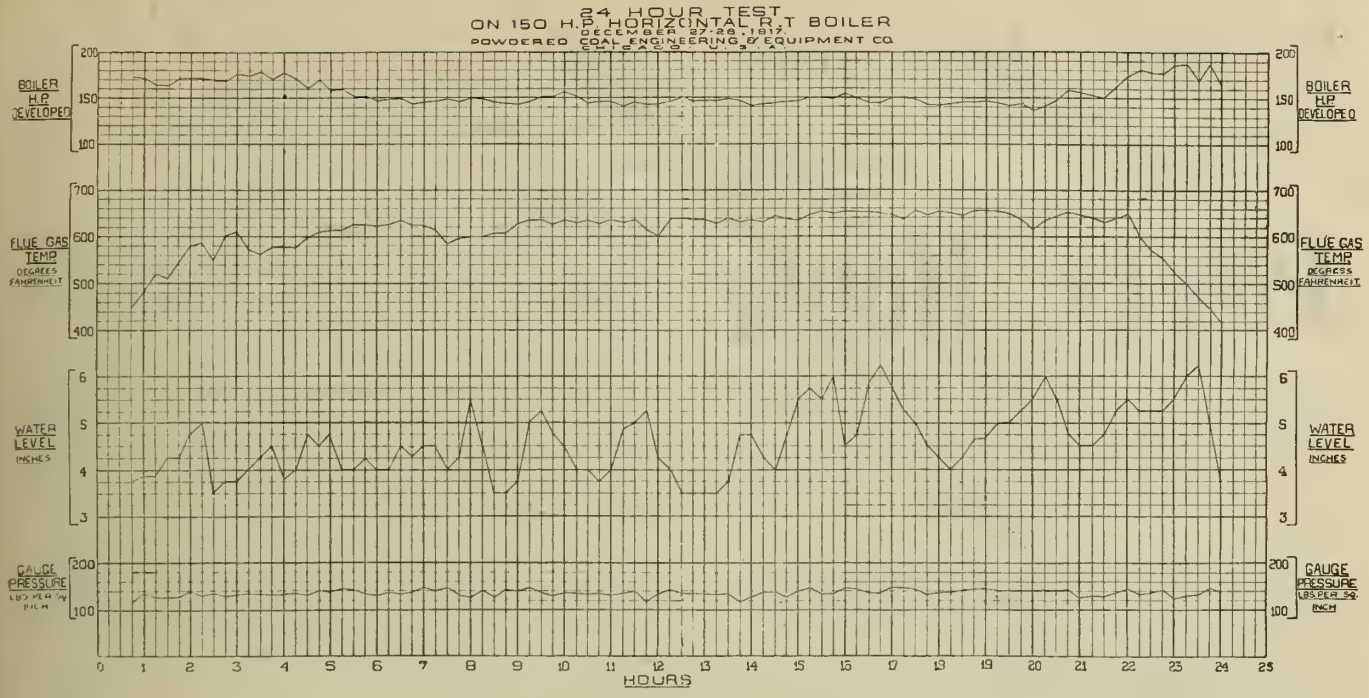
Grate surface: Grate absent; fired by two Pruden carburetors, 12 inch.

Water heating surface—1,504 sq. ft.

Superheating surface—None.

Date—December 27-28, 1917.

Duration—23¼ hours.


24 HOUR TEST
ON 150 H.P. HORIZONTAL R.T. BOILER
DECEMBER 27-28, 1917
POWDERED COAL ENGINEERING & EQUIPMENT CO.
BOILER H.P. DEVELOPED
FLUE GAS TEMP DEGREES FAHRENHEIT
WATER LEVEL INCHES
GAUGE PRESSURE LBS PER SQ. INCH
HOURS

RESULTS OF TEST RUN.

Kind and size of coal—LaSalle County, Illinois, screenings, pulverized 90.5 per cent. through 200-mesh; 98.8 per cent. through 100-mesh.

Average Pressures, Temperatures, etc.

Steam pressure by gauge—One boiler, 145 deg. Fahr.

Temperature of feed water entering—35.1 pounds.

Temperature of escaping gases leaving boiler—609.8 deg. Fahr.

Force of draft in firebox—0.15 in.

Percentage of moisture in steam—0.95 per cent.

Total Quantities

Weight of coal as fired—17.625 pounds.

Percentage of moisture in coal—2.94 per cent.

Total weight of dry coal consumed—17,107 pounds.

Total ash and refuse—3,679 pounds.

Percentage of ash and refuse in dry coal—22.099 per cent.

Total weight of water fed to the boiler—117,835 pounds.

Total water evaporated, corrected for moisture in steam—116,715 pounds.

Total equivalent evaporation from and at 121 deg.—129,554 pounds.

Hourly Quantities and Rates

Dry coal consumed per hour—735.7 pounds.

Water evaporated per hour corrected for quality of steam—5,020 pounds per hour.

Equivalent evaporation per hour from and at 212 deg. Fahr.—5,572 pounds per hour.

Equivalent evaporation per hour from and at 212 deg. Fahr. per sq. ft. of water-heating surface.

Capacity

Evaporation per hour from and at 212 deg. Fahr.—5,572 pounds.

Boiler horsepower developed—162 h.p.

Rated capacity in evaporation from and at 212 deg. Fahr. per hour—5,175 pounds.

Percentage of rated capacity—150 h.p.

Rated boiler horsepower, developed—108 per cent.

Economy Results

Water fed per pound of coal fired—6.69 pounds.

Water evaporated per pound of dry coal—6.84 pounds.

Equivalent evaporation from and at 212 deg. Fahr. per pound of dry coal—7.59 pounds.

Equivalent evaporation from and at 212 deg. Fahr. per pound of combustible—9.73 pounds.

Efficiency

Calorific value of one pound of dry coal—10,158.

Calorific value of one pound of combustible—13,039.

Efficiency of boiler, furnace and grate—72.5 per cent.

Efficiency of boiler and furnace—72.5 per cent.

Cost of Evaporation

Cost of coal per ton of 2,240 pounds delivered in boiler room (including drying and pulverizing)—$4.28.

Cost of coal required for evaporating 1,000 pounds of water from and at 212 degrees Fahr., $0.2793.

The CO_2 content is much higher than average or usual standard practice. It is certain that such a chart has never before been obtained in any type of steam boiler practice over such a long period of time, under operating conditions which are normal and which can be duplicated by ordinary labor any day of the year. The conditions under which the test was made were unfavorable from the standpoint of thermal efficiency, making it appear probable that under continuous service in ordinary weather the high boiler and furnace efficiency, 72.5 per cent. might easily be exceeded. The powdered coal was lighted under a cold boiler three hours before the test was started, the average temperature of the air fed with the powdered coal being approximately 4 deg. Fahr.

Bituminous coal of 18 per cent. ash, under ordinary conditions of grate firing will usually be found to produce an ash which contains from 16 to 18 per cent. combustible. The ash and slag produced in the test given above contained only a trace of combustible, less than 0.1 per cent. It is evident, then, simply from a consideration of the unavoidable losses in grate-fired practice, due to unburned material, that the burning of powdered coal by the carburization process represents a saving in this instance of $0.17 \times 0.22 \times 10{,}158 = 380$ B.t.u. per pound of coal, or a saving of 3.74 per cent. of the heating value of the coal, due only to the fact that the coal is completely burned.

The average modern plant using the same grade of coal would not, under ordinary operating conditions, realize a boiler and furnace efficiency of more than from fifty-five to sixty per cent., as against the efficiency of 72.5 per cent., which was obtained with powdered coal. Take a large central power plant that consumes 6,000 tons of coal per day. Assigning to such a plant an average monthly efficiency of 60 per cent., it is evident that by the installation of the properly-designed powdered coal equipment this company could realize a saving of 12.5 per cent. or 6,000 tons, or 750 tons of coal per day, which, at $5 per ton, would mean a daily saving of $3,750.

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Graded Certificates For Ontario Engineers

BEGINNING with the New Year the stationary engineer will be on the same footing as are his brothers in other provinces, so far as certificates of competency are concerned. An act making provision for the grading of certificates was passed by the legislature last spring and regulations have recently been issued by the Lieutenant-Governor-in-Council which make provision for its carrying out.

Four grades of certificates are provided for, and both engineers and firemen must hold certificates of some grade. Engineers in charge of a plant will have to hold certificates corresponding to the grade of the plant under their care, while firemen are required to have at least fourth-class certificates. Exceptions are made in the case of a fireman working for less than six months, and in the case of engineers operating plants under their care when the act goes into effect.

Present holders of certificates will be graded into two classes, second and third, the standing to be determined by the board. The first-class certificates will be granted only upon examination. It will not be necessary for engineers at present operating a plant to obtain the certificate necessary for its operation under the regulations, so long as he remains in his present position, but if he changes to a plant having a higher rating, it will be necessary for him to have the proper certificate for its operation, time being given for his preparation for examination.

The four grades of certificates which will be issued permit of the operation of plants having certain boiler horsepower ratings by the holders of corresponding certificates. This necessitates the grading of plants, and provision is made in the regulations for this being done. Certificates of rating will be issued to power plant owners and these will be placed adjacent to the certificates of the operating engineers.

In general, both the act and its accompanying regulations show evidence of careful working out, and make provision for wise regulation of stationary engineering in Ontario.

Requirements for admission into the various grades are quite severe, and are, in general, higher than those required by other provinces.

The fees are also higher than those for similar grades in other provinces, the fee for examination in the lowest grade being five dollars.

German Uses For Aluminum

THE shortage of copper in Germany during the war drove the Boche engineers to many expedients for the eking out of their supply and for the substituting of other metals to make up the shortage. Aluminum was largely used and of this metal, Germany, thanks to the bauxite deposits of Austria-Hungary, had an abundant supply. Electrical apparatus, generators and transformers were constructed with aluminum to replace the copper and excellent results were secured. Soldered joints were avoided and connections made by screwing and welding. With threaded joints of aluminum the contact surface was made 30 to 50 per cent. larger than with copper to avoid loss of efficiency. Copper plating was successfully practised and the increase in contact resistance due to heating thus avoided.

Generators and motors were constructed with aluminum and at the present time A. C. motors are being built which contain neither copper nor tin. The windings are of aluminum, the connections are sweated, slip rings, cables and brushes are of iron and the bearings are of lead magnesium alloy. Switch-gear, such as knife switches, oil switch contacts, etc., must be made of copper, however, as bad contacts and high contact resistance is apt to occur when the aluminum becomes oxidized with time.

On Regulatin' Prices

IT is a joyful thing, for sure, to read in these here times of how they're treatin' profiteers to jail terms and to fines, and makin' them loose up a spell and drop their ponderous wad, and get right out to earn their bread by gougin' up the sod.

With pure delight I scan them things, I read 'em line on line, while chills of pleasure and of joy they camp upon my spine.

Ah, well, it's time some move was made to shove us folks ahead, and push away the clouds that hang and bump upon our head; it's time they made our dollar sprout like some sweet-smelling vine, for it has shrunk to most like two nickels and a dime.

I wish them men would give to me a seat upon the board that's goin' to boot the prices down and scatter out the horde. I'd like to hear 'em call me out: "Old top, come have a seat, and use your brain to regulate the price of hay and meat."

I'd wiggle my big ears, I would, and hear the widder's cry about the price of liver a-campin' far too high, and then I'd set at once to work upon my new board seat to see that folks like me and you could get enough to eat.

I'd say to them what carve the cows, the rooster and the swine, that pounds of pork chops hence shall sell for just one single dime. A luscious T-bone steak I'd mark with paint and letters bold, and tell 'em that for fifteen cents that there thing should be sold.

I'd go unto the grocery store and say: "You grocery man, just yank the prices you've stuck upon each prune and fig and can, and take 'em quick from out of here; forget your glorious days, and I shall teach you, yes, by gum, to walk in humble ways."

I'd take the hands of time quite rough and wind 'em back a spell before I'd give them grocery men the high sign for to sell. The good old days, the grand old days I'd bring back with a bound, when butter dished up in a boat at 20 cents a pound.

I'd travel up and down the street, I'd visit every place, and buyers would be cheerin' me, a smile hung on their face.

And for my friends what like to smoke I'd surely do a turn, rememberin' cabbage leaves and truck and all things that would burn. The cheers would rise up like a cloud, they'd come from near and far, as I led back to life once more a good five-cent cigar.—ARK.

A Source of Waste

AN unusual case of water waste, described in "Canadian Engineering," was brought to light some years ago in a large office building, where an apparently excessive consumption caused the water officials to attach a meter to the service taps for the purpose of arriving at a suitable charge. It was hardly to be believed, but the registration by the meter showed that more water was being consumed at night, when the building was empty save for the janitor and family, than during the day, with all the offices occupied and water being freely used by all. A careful investigation was made, and it was found that all the toilets were fitted with a very poorly constructed ball cock fixture, which became disarranged every night by the increased pressure in the mains. This allowed a steady flow from the tanks down the waste pipes that lasted throughout the entire night all over the building until the day usage again reduced the pressure. Naturally, the owners of the building had a heavy water bill, but, needless to say, the wasteful fixtures were speedily replaced by others of a better kind, and this unusual and costly source of waste was closed.

The Engineer's Pants

By JAMES E. NOBLE, Again

SEPTEMBER 20 POWER HOUSE, has been received by me, and I have read the skit by ARK on page 423. He seems to love the engineer who waves a pants' worn seat; in fact, he states that such a man is pretty hard to beat.

The man who oozes oil from his boots and other parts is just a pure invention of that clever Mister Ark's. Perhaps the writer of the skit has got that basement sheen. Just let him take his last POWER HOUSE and look at 413. I feel quite sure that Writer Ark will feel so small and queer when he digests that poem by another engineer. There's nothing queer that engineers should sometimes takes a seat when they desire to think a thunk, or swallow up an eat. Most engineers, while standing up, can think as well as eat; their brains are in the upper part, not 'way down in their feet. The skilful touch's a goodly thing, I willingly declare, but such a touch is not much use when bunched up in a chair. It would be hard to move the engines into such a touch. In fact, I feel that such a move would get the chief in "dutch."

Now, I am up to "snuff, by gosh," and pretty hard to beat. I wear no patches at my knees and no gloss at the seat.

The reason that there is no gloss upon my breeches fair is just because I always keep a cushion on my chair.

A HELPING HAND

Engineers, firemen and other power plant operators are earnestly requested to take up any matters upon which they desire information with the Editors of POWER HOUSE. This applies particularly, at the present time, to the grading of certificates in Ontario. Any new development of this kind naturally gives rise to a period of uncertainty and information is often desired by those who are most intimately concerned. We are in a very advantageous position for extending a helping hand to those in doubt as to what to do under the new regulations. Questions regarding the Act, its regulations and their interpretation, requirements for the different grades, studies to be undertaken, etc., will be cheerfully answered.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

Readers are invited to send in answers to these problems, as they have been chosen for their interest and application to the practical side of power plant operation.

Perhaps you, too, have some pet problems, or hard nuts which you would like to ask your fellow engineers; if so, send them along for the benefit of others.

Answers, together with the original question, will be published in the issues following the appearance of the question.

Questions Answered

Question—80. At what pressure will a safety valve blow off, having a diameter of 4 inches, the weight of the valve and stem is 10 lbs., the lever is 20 lbs., and the ball 120 lbs.? The total length of the lever which is straight, is 44 inches. The weight is 40 inches from the fulcrum, and the distance from the centre line of the valve to the fulcrum is 4 inches.

Answer.—To find the pressure a lever safety valve is set for.

Formula: $(W\ L + w\ l + V\ B) \div A\ D$

Where—

W = Weight of load or weight of lever in pounds,

L = Distance of weight from fulcrum in inches,

w = Weight of lever in pounds,

l = Distance from fulcrum to centre of gravity, of lever in inches,

V = Weight of valve and stem in pounds,

D = Distance from centre line of valve to fulcrum in inches,

A = Area of valve in square inches.

Solution:

$$\frac{120 \times 40 + 20 \times 44/2 + 10 \times 4}{4 \text{ squared} \times .7854 \times 4} =$$

105 pounds.

* * *

Question.—81. With a safety valve having the dimensions given in question one, what weight is necessary to have the valve about to blow off at a steam pressure of 100 lbs. per sq. inch?

Answer.—Use the formula:

$W = [APD - (w\,l + V\,D)] \div L$

Solution—

$[4^2 \times .7854 \times 100 \times 4 - (20 \times 22 + 19 \times 4)] \div 40 = 113.66$ pounds.

The letters in this formula are the same as in No. 80, except P = steam pressure in pounds per square inch.

Question.—82. What is the absolute pressure if the vacuum gauge indicates 19 inches, while the barometer stands at 26 inches?

Answer.—Rule: To find the absolute pressure shown by a vacuum gauge, substract the vacuum gauge reading of the barometer and multiply the difference by .49.

Solution—

$(26 - 19) \times .49 = 3.43$ pounds.

* * *

Question.—83. Find the quantity of air required to completely burn one pound of fuel of the following composition: Carbon, 84 parts; hydrogen, 5 parts; oxygen, 7 parts; ash, 4 parts.

Answer.—Rule: To find the air required to burn a given fuel: To the carbon contained in the fuel add three times the hydrogen, multiply the sum by 1.52, and the result will be the air in cubic feet required, at a temperature of 62 degrees Fahr.

Solution—

$1.52 \times (84 + 3 \times 5) = 150.48$ cu. ft.

* * *

Question.—84. How many B.t.u. will be produced by the combustion of one pound of coal of the following composition: Carbon, 76.5 parts; hydrogen, 4.4 parts; oxygen, 3.0 parts; nitdogen, 1.1 parts; ash, 15.0 parts.

Answer—Rule: To find the heat of combustion of one pound of fuel, multiply the percentage of carbon by 146 and the percentage of hydrogen by 620; add the products and the sum will be the required heat of combustion in B.T.U.

Solution—$.146 \times 76.5 + 620 \times 4.4 =$ 13,897 B.T.U.

* * *

Question.—85. How many pounds of water at 212 degrees Fah. can be evaporated by 1 pound of the coal mentioned in question 5?

Answer.—Rule.—The find the number of lbs. of water at 212 degrees Fah. evaporated by one lb. of fuel. Divide the heat of combustion by 966.

Solution.—The heat of combustion was found to be 13,897 B.T.U. Therefore, 13897 divided by 966 = 14.38 lbs.

* * *

Question.—86. A boiler shell 72 inches in diameter is constructed of material 5 inches thick, which has a tensile strength of 60,000 lbs. per sq. in. What is the bursting pressure, taking no account of the weakening effect of the seam?

Answer.—Formula: $P = ts \times t \div d$.

Where ts = tensile strength in pounds per sq. inch.

T = two thicknesses of plates in inches.

D = diameter of boiler in inches.

P = bursting pressure in pounds per sq. inch.

Solution.—$60{,}000 \times .5 \times 2 \div 22 = 833.33$ lbs. per sq. in.

* * *

Question.—87. If the boiler shell whose dimensions are given in question 86 is constructed with a triple-riveted, double-strapped belt joint having an efficiency of 86 per cent., what is the bursting pressure?

Answer.—Multiply the bursting pressure in the former example by the efficiency of the joint in this question, the result will be the answer.

Solution.—$833.33 \times .86 = 716.66$ pounds per sq. in.

* * *

Question.—88. Find the load on a stay when the pitch is 8 inches either way and the steam pressure 83 lbs. per sq. inch.

Answer.—To find the load on a stay, multiply the area supported by it, by the working steam pressure in lbs. per sq. in.

Solution.—$82 \times 83 = 5{,}312$ lbs.

* * *

Question.—89. Staybolts 1¼ inches in diameter are placed 3½ inches from centre to centre. If the steam pressure is 100 lbs. per sq. inch, what is the stress per sq. inch in the stays?

Answer.—Rule.—The stress per sq. in. on a stay is found by multiplying the area in sq. in. supported by the stay by the working steam pressure in pounds per sq. in., and divide the product by the least cross sectional area of the stay in sq. ins. There, the area of the staybolt is $1¼ \times .7854 = 1.2272$.

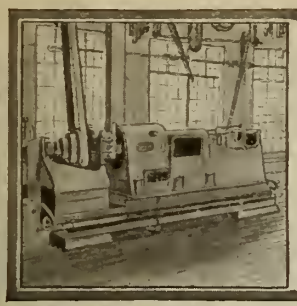
The stress is, therefore, $8½^2 \times 100 \div 1.2272 = 5{,}867.39$ lbs.

* * *

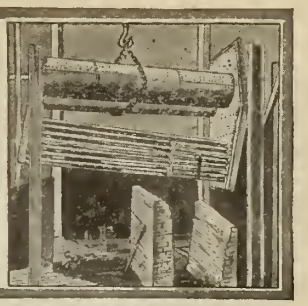
Question.—90. A stayrod 2 inches in diameter is cut with a U. S. standard thread and has 4½ threads per inch. What is the diameter at the root of the thread?

Answer.—Rule.—To find the diameter at the root of the thread, divide 1 by number of threads to the inch = 1 divided by 4½ = .2222 inches. This gives you the pitch of the thread. Then to find the depth of the thread multiply the pitch by .6495. Now we have $.2222 \times .6495 = .1443$ inches (depth). Then to find the diameter at the root of the thread. $D = 2 - 2 \times .1443 = 1.7114$ inches.

Continued on page 452



NEW POWER PLANT EQUIPMENT



SAFETY ENCLOSING COVER FOR MOTOR CONTROLING RHEOSTATS

As a result of almost continual widespread "Safety-First" campaigns, the necessity for safeguarding all machinery and those who operate it, is now generally recognized throughout the realm of industry as a matter of vast importance. In the electrical field rapid progress has been made in the past few years in designing new lines of apparatus redesigning old ones to make the safety feature more prominent, and particular attention has been paid to motor control device because, as a rule, this class of apparatus is handled either by unskilled labor or by those not familiar with electrical machinery, and the necessity for a fool-proof installation is the more obvious.

It is interesting to note how the face-plate rheostats manufactured by the Westinghouse Electric and Manufacturing Company, shown in Fig. 1, are protected, and how the enclosing covers are so designed that they can readily be applied to old rheostats to make old installations strictly modern.

As shown in the accompanying illustrations the enclosing cover is a solid sheet steel box which fits tightly against the rheostat base and is secured by four corner bolts. Pivoted to the cover are two cast iron arms, one with the operating handle on the outside, and one within made with a fork to engage the rheostat handle. To apply a safety cover to an old rheostat, it is only necessary to remove the four nuts on the corner studs of the face-plate and place them with adapter nuts and studs, furnished with the cover. The rheostat handle is

RHEOSTAT READY TO ATTACH COVER SHOWING ADAPTERS REPLACING NUTS AND FIBRE TUBE REPLACING HANDLE.

also removed and a fiber tube substituted. The cover is then put on so that the fork on the inner arm engages the insulating tube and the four nuts that were on the original rheostat are used to fasten the cover in place. The lead wires from the rheostat are brought through insulating bushings that are held in place by the edge of the cover. While no packing is used to make the cover water-tight, it fits so closely that it effectually prevents the entrance of metal chips, sawdust, or other material that would cause injury to the rheostat. The cover is grounded through the corner bolts, and being insulated from live

RHEOSTAT WITH SAFETY ENCLOSING COVER IN PLACE.

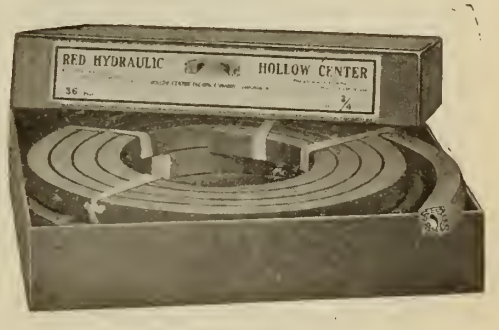
parts, renders it fool-proof and makes it impossible for an operator to accidentally receive a shock through coming in contact with the working parts of the face-plate.

The use of these covers or similar devices is one of the important requirements of the modern factory or machine shop, and in some localities it is demanded by law. These covers fulfill all requirements of a safety-first device and are easily and readily installed.

OVALHOLE PACKING

A new packing has been developed for the circumventing of the many piston packing troubles common to the engine room. It is often a difficult matter to keep steam from blowing past the packing in cases where rods are worn out of round. To obviate this difficulty, the Hollow Center Packing Co., Cleveland, developed the packing shown in the accompanying illustration.

The hole is oval shaped so that the packing is flexible and when put under strain by tightening the gland, it readily expands to compensate for irregularities. Another feature, it is pointed out, is the fact that the hollow construction gives the packing comparatively long life, due



OVAL HOLE HYDRAULIC PACKING.

to the fact that as the action of the rod wears the packing away, setting up the gland elongates the packing rings, making them fill the gland completely. It is said that the hollow design also eliminates undue friction which is apt to score the rod.

This material is made in three different grades; one for ordinary use, with steam at pressures up to 125 pounds, one for inside packed pumps and hydraulic service, and another high-pressure superheated steam. This latter is constructed of the highest grade heat-resisting material impregnated with a springy heat-resisting rubber compound

OVALHOLE REGULAR PACKING.

HIGH PRESSURE STEAM PACKING.

vulcanized to withstand high temperatures.

THE AUTOMATIC SUB-STATION FROM AN ECONOMIC STANDPOINT

The tendency in the development of modern electrical apparatus is to utilize more and more the automatic features which are proving to be important factors in extending its use.

No recent development has created more general interest of possesses more economic possibilities than that of the automatic sub-station.

The automatic sub-station in simple language consists of a synchronous converter, a bank of transformers and three mounted electrically operated switches, relays and instruments. It is really uncanny in what it will do when trolley voltage falls below a predetermined safe value, without human aid the converter starts up and reaches synchronism and assumes its share of the total load on the line. If the load increases to a point dangerous to the converter it immediately shuts itself down and the line switches all open. If a converter bearing should overheat, instantly a relay operates and the converter shuts itself down. If the load on the line drops to a point where the converter is not required, it automatically comes to rest. It will go through this cycle of starting and stopping just as often as the line conditions make it necessary, it being possible to start up, close all switches, open all switches and stop the converter twice per minute.

Naturally, since such power is at instant call without an attendant at the station certain limitations exist which react to counterbalance the good qualities of automatic switching, but they in no way destroy the great economical advantages of such switching.

A competent engineer must inspect the apparatus weekly, and the station must be cleaned up three or four times a month. One engineer could inspect a great many stations on a regular schedule so this item will add but a trifling labor charge. The cleaning up can be done by ordinary car barn labor.

The original investment, will, of course, be greater than a manually operated station of equal capacity.

There may be increased hazard to the equipment, although results thus far obtained, indicate that the equipment is better protected by automatic switching than by hand switching.

The automatic switching is more complicated than hand switching, but on close acquaintance it becomes quite simple.

Feeders must be applied with great care to save trolley wires which drop to the ground from annealing.

Since there are no operators to transfer high tension lines in case of trouble, these lines may in certain cases, have to be arranged for automatic installations. It may be possible to handle this high tension switching by remote control.

The economic features which offset the foregoing disadvantages are so great that they leave a heavy balance in favor of the automatic switching.

The fact that automatic sub-stations require no attendants should itself effect an economy of $2500 per station allowing two men per station for hand switching.

The absence of attendants leads directly to a second marked advantage, the elimination of labor difficulties. This is an important factor under the present disturbed condition of labor generally.

By re-locating or increasing the number of sub-stations enough feeder copper can be saved on many propositions to pay for a great proportion of the cost of automatic switching.

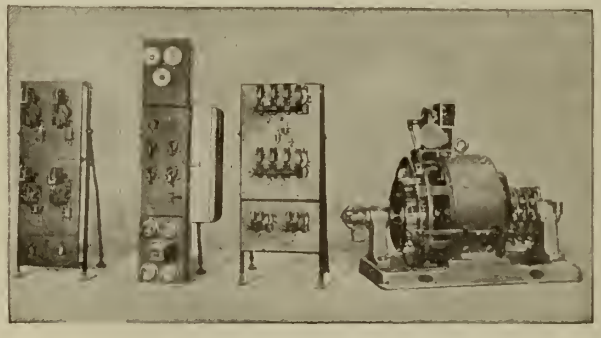
There is invariably a reduction of electrolysis due to absolutely correct location of automatic stations, thus reducing the return circuit in length and in losses due to drop.

Experience thus far indicates that reliability of operation will be increased. Considering the ability of the best operators than can be secured and the introduction of the ever varying "human element," the automatic switching should prove by far the more reliable method of operation.

Maintenance has been very low in those cases which have been under operation.

This charge will drop exactly in the proportion that inspection and cleaning of apparatus is kept up, and with experience, will doubtless drop to a very low value.

Summing up, there is no doubt but what the automatic substation is here to stay and its economic features demand consideration whenever the installation of a new sub-station is projected.



THE AUTOMATIC SUBSTATION

TYPICAL ECONOMIES

	1 Hr.	2 Hrs
Headway between		
Length of line, miles	25	24
No. of sub-stations	3	3
Capacity of Sub-stations, KW.	300	300
Distance between sub-stations, miles	10	10
Schedule speed, M.P.H.	25	25
Length of operating day, hrs.	20	20
Total Sub-station Hours (manual operation), hrs.	60	60
Total Sub-station Hours (automatic operation), hrs.	32	20
Running Light, loss per station, KW.	15	15
Energy saved per day (auto operation), KW. hr.	240	600
Energy saved per year (auto operation), KW. hr.	153300	219000
Value of energy saving at 1 cent per KW hr.	$1533	$2190
Labor saving per year, 6 operators at $70 per mo.	$5040	$5040
Total saving per year	$6673	$7230
Total investment automatic control, 3 stations	$1800	$1800
Interest, Insurance, Maintenance, Depreciation, Taxes, 15%	$2700	$2700
Cost of inspection per year.	$500	$500
Total annual charges	$3200	$3200
Net annual saving	$3373	$4030
Return on investment, per cent.	19.7	22.4

OUR QUESTION BOX

Continued from page 450

Question.—91. What working pressure will be allowed on a solid rectangular steel girder 2.5 ft. long, 7 inches deep and 2 inches thick, fitted with three staybolts? The girders are spaced 7 inches centre to centre. The pitch of the stay-bolts is 7.5 inches and the combustion chamber is 30 inches wide.

Answer.—The formula for this problem is as follows:

$B = Cd^2 T \div (W-P) DL.$

Where:

B = pressure in pounds per sq. inch

D = depth of girder in sq. inches.

T = thickness of girder inches.

W = width of combustion box, in inches, measured in the direction in which the girder is applied.

P = pitch of stay-bolts, in inches.

D = distance from centre to centre of gorders in inches.

L = length of girder in feet.

C = girder fitted with two or three stay-bolts, 825 is the constant for this

Applying the formula: $825 \times 7^2 \div (30-7.5) \times 7 \times 2.5 = 205.3$ lbs. p sq. in.

Question.—92. A boiler shell 60 inches in diameter and ½ inch thick, with a tensile strength of 60,000 lbs. per sq. in., has a double riveted longitudinal lap joint, having a rivet efficiency of 68.3%. Under Canadian Marine Rules, what working pressure will be allowed? All rivet holes are punched before bending.

Answer.—The factor of safety for the rivets in Canada is 4.25. For the shell this factor is increased by .5 and by .2, because all rivet holes are punched before bending, and also by .2 because double-riveted longitudinal lap joints were used, thus making the shell factor of safety $4.25 + .2 + .2 + .5 = 5.15$. Then the working pressure on the rivets is: $60{,}000 \times .683 \times ½ \times 2 \div 60 \times 4.25 = 160.71$ lbs. per sq. inch. Working pressure on plate is: $60{,}000 \times .743 \times ½ \times 2 = 144.27$ lbs. per sq. inch. The lowest pressure found by this calculation is taken as the allowable working pressure.

Therefore, 144.27 lbs. per sq. inch will be right.

The Operators' Point of View

METHOD OF KEEPING THE BELT IN THE SHIFTER FORKS

By L. G. Singer

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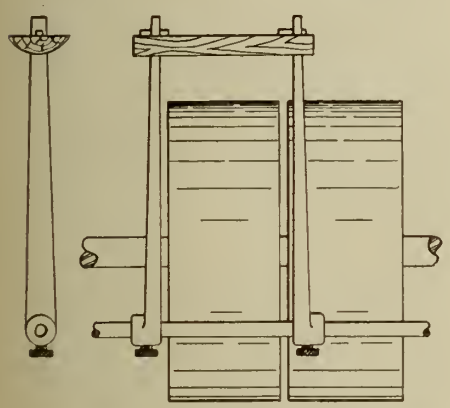
Frequently when a belt is shifted suddenly it flops out of its proper position between the shifter forks. This also may happen when the belt is loose



KEEPING THE BELT IN SHIFTER FORKS

or the shifter forks are too short. Such occurrences can be prevented by fixing (after the belt is in position) a wood strip across the lower ends of the forks, as shown in the accompanying picture. The strip can be held in place with spring cotters, set in drilled holes as suggested, or with pieces of wire suitably bent.

WATER GAUGES AND GAUGE GLASSES

On page 292, July 5, POWER HOUSE, R. Manly Orr describes a method for improving the water gauge. We all know how easily a gauge glass will break if it receives the slightest of scratches. Pulling the light spring off and forcing it on, and allowing the steel rod to lie against the glass makes three chances for such a scratch. It is good engineering to keep all metal contacts away from water glasses in use on high pressure boilers. The snaps could be arranged so that they would go over the gauge, fitting with the rod slightly away from the glass. A small or narrow strip of cardboard, bright red, green or other clear color, placed behind the glass and fastened at the top and bottom with a bit of string will answer the same purpose. The water acts as a magnifier and the height of the water is shown by the color all across, or filling the glass, above the water level only the narrow strip of color shows.

Gauge glasses with colors run into the glass, usually bright red, are made and have been on sale for many years.

Jack McAndrew.

COLORING LAMPS

On page 291, July 5, POWER HOUSE, there is an article by J. C. Supton on coloring incandescent lamps. Part of which follows, was published some years ago. Take a little white shellac, thin it down with alcohol, and by dipping the bulb in this is produced a splendid imitation of frosted glass when a clear white light is required. Care must be taken to have the shellac fairly thin, so that it will run smooth. If you use green, purple, red, blue or any other colored lamps, buy a package of egg dye of the color required, dissolve it in wood alcohol and pour it into the shellac. By using this or any transparent coloring, a vast number of beautiful tints can be made that will blend with any color scheme.

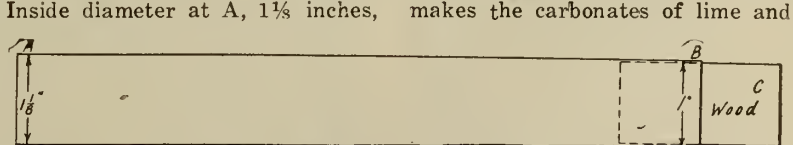
To go about it properly and to get the best results, after preparing your shellac, pour it into a vessel deep enough to immerse the lamp. Take a piece of wire and fasten it around the socket of the lamp, and bring over one end of the wire back over the end of the lamp to opposite side of the lamp to form a loop, then dip it in the solution and hang it up to drip and dry. (I have found by experiment that as good or better a coating can be given a cold lamp than a warm one, the coating being absolutely uniform with no streaks.)

While mixing in your color, bear in mind that the more dye and the less shellac the deeper the tint will be, and vice versa. Any of these colors can be removed with wood alcohol. Water has no effect on them.—J. E. M.

COMMUTATOR DRESSING

From a piece of galvanized sheet iron, tin or copper, make a tube 12 inches long. Inside diameter at A, 1⅛ inches, at end B, 1 inch only. This is the mould.

Have a piece of round wood 3 or 4 inches long, which will be a snug fit into end B.



COMMUTATOR DRESSING

Melt one pound of paraffine wax and add half a pound of bi-carbonate (baking) soda, and half pound fine powdered graphite, stir all well together and fill the mould. The wax must be very hot when the soda and graphite is added.

When the mixture is cold, hit the wood block at C a sharp blow with a hammer and this will drive the compound stick forward so that it can be drawn from the mould.

Save the tinfoil removed from friction tape and wrap is around the sticks to keep them clean, etc. The sticks should be cut into 5 or 6 inch lengths as they are about right for handling in this length. A little of this compound used on commutators once in a while is much better than dosing them with vaseline or dynamo oil as is frequently done.

FEED WATER HEATERS

By R. MacLaren

In a plant with which I am acquainted there is a closed feed water that is too small for the job as the feed water temperature is around 150 deg. Fahr. Later in the season when the lake temperature is higher it will rise to over 160 deg.

The heater is of the water-tube type, that is, the water circulates through tubes with the steam on the outside, and as the water enters at the upper end of the tubes and leaves at the lower end impurities get no chance to lodge in them.

While a closed heater of sufficient capacity will undoubtedly heat the water to over 200 deg., I believe that the open heater has merits which make its selection the only reasonable one in this particular case.

To raise the temperature to over 200 deg. a closed heater must have proportions more liberal than most builders are willing to give them, and certainly more liberal than most plant owners are willing to pay for.

When water containing bi-carbonates of lime and magnesia is heated to 180 to 212 deg., the carbonic acid gas which makes the carbonates of lime and magnesia soluble in water is driven out of combination with the carbonates and the latter are precipitated.

Given a chance, the CO_2, which is cor-

rosive, will leave the water, as will also the carbonates. In the closed heater there is no such chance, everything being swept on into the boiler. In the open heater, any good type of which has a filter incorporated in it, the gas has a chance to escape and the carbonates are caught in the filter.

In the open heater, the steam and water being in direct contact, if there is the quantity of exhaust steam present in the heater, theoretically required to heat the water, the water will be raised to a temperature of 212 deg. or higher, depending on the pressure.

The open heater is also a water saver. To heat the water from 50 to 212 deg equals 162 deg. rise, one pound of steam will heat $\frac{966}{162}$ equals 6 pounds almost of water; 6 pounds of water and 1 pound of steam equals 7 pounds feed water. That is, the open heater saves one-seventh of the feed water.

If there is a battery of four boilers of 130 h.p. each, and they are working up to their rating, they will use 15,600 pounds of water per hour. One-seventh of this equals 2,230 pounds, equals 223 gallons per hour.

The open heater also saves boiler compound. In the case of the closed heater in question, the compound has to deal with the carbonates as well as the sulphates. The open heater takes care of the carbonates and the compound has only the sulphates to deal with, and ought to be applied to the water after it has passed the heater.

MORE POWER PLANT AND OTHER KINKS

By J. E. McCormack

About 1½ years ago I clipped from a newspaper a recipe for making waterproof ink for use in labelling. I tried it and think it worth passing on as it is good and also inexpensive. Here it is: "In a small bottle place an ounce and a quarter of methylated alcohol, add a half ounce of shellac, and when this last is dissolved, immerse the bottle in hot water until the solution is warm. Then add slowly, while stirring rapidly, a solution composed of one hundred and fifty grains of borax dissolved in two ounces of water. Finally add coloring matter to suit, 4 or 5 grains of methyl violet being satisfactory, and dissolving well upon shaking. This makes a very fine waterproof ink for writing the labels on botles and for other purposes."

In making it I had some difficulty in getting the given amounts of alcohol and of water to dissolve the shellac and borax, in fact, I finally added just a little bit more to make the last few grains dissolve, but when finished I liked the ink. I tried to get it dense enough by adding black dye, to make a drawing ink, but did not get it to give good blue prints, so abandoned this phase of the subject. Later I tried some by adding a little water and as much yellow dye as the mixture would dissolve. This was more successful, but I prefer the purchased liquid waterproof India ink for drawing.

The tightener on a twelve-inch belt was so heavy that it was customary to use two men to lift it. Later, when running short-handed, it was not always convenient to procure a helper from another machine and I found that by standing on the lower part of the belt, about six inches from the floor, and putting my shoulder under the upper part of the belt, I could raise the tightener without help and set a prop under it, whereas I could not in other positions secure such an hold and footing as would enable me to raise the tightener alone. By forcing the belt apart, as above described, after having put my weight on the under half to tighten it, I could apparently use my strength to better advantage.

* * *

After fitting some machinery together in which we used such bolts as were at hand, we had quite a few bolt ends protruding ¼ to ¾ of an inch, and we wished to cut them off. The other fellow said wait until to-morrow. When to-morrow came he appeared on the scene carrying a big cold chisel, perhaps 1¾ inches wide or more and weighing probably eight pounds. His method was for him to hold his big cold chisel tight against one side of the bolt to be cut, while I with an ordinary sized cold chisel and a hammer attacked the bolt on the other side. I was surprised to find that his chisel cut into the bolt about as far as mine did, each chisel cutting to near the middle of the bolt. Apparently it was like a man putting a hundred lbs. on a small rope, it did not matter if the rope was tied to a post or was being held by another man pulling 100 lbs. on the other end. The strain on the rope is the same. Similarly, with the same blow on my chisel his chisel in bracing against mine did its share of the cutting. We soon had the bolts trimmed.

* * *

When doing repair work where old wooden parts or materials are involved and there is some danger of hitting a nail or nails when boring required new holes, the boring often may be done by means of twist drills. They must occasionally be removed and cleared of chips as the work proceeds. They will bore a little more slowly than the ordinary carpenters' bit will do, but will not be damaged by cutting against a nail. I also find that if one is using a brace which has no ratchet attachment, and he is boring in wood, and in a place where he can only make ½ to ¾ turn of the brace each time, then a twist drill used instead of a carpenters' bit will bore a hole under these circumstances. It would not do, though, to try this latter method when drilling iron, because the backward turning would put a wire edge on the drill, thus interfering with its cutting qualities when turning forward again.

When lacing belts by means of leather laces, the end of the lace may be hardened to facilitate pushing it through the holes by holding it in the flame of a match for a few seconds. A little experience will enable one to get it about right on most laces, but sometimes one gets some from which oil fries out and ignites, and the leather crumbles away when squeezed. With this class the flame is no use. Possibly with some of them hot water, if convenient, will serve as I have known scalding water to harden some grades of leather.

* * *

On small engines I have sometimes found an eccentric and crank pin oil cup having an upright tube or spout in its centre. Evidently the idea was to prevent oil flow except during the time the engine was in motion. It was once the custom to use a wick in the tube or spout of all such cups. This wick required attention every few days as it would clog or else would pack and would not let enough oil flow even though at first adjusted for plenty of flow. As an experiment the putting in of a piece of coarse wire or a small iron rod effectively and very satisfactorily replaced by the wick, and by a little experimenting the size and length use could be regulated to suit the oil flow. Shortening it (within limits) to allow it some up and down motion when the engine was in motion increased the amount of flow. By changing both size and length the flow can be widely varied.

METHOD OF REMOVING CAPS OF METAL CANS

By R. W. Stafford

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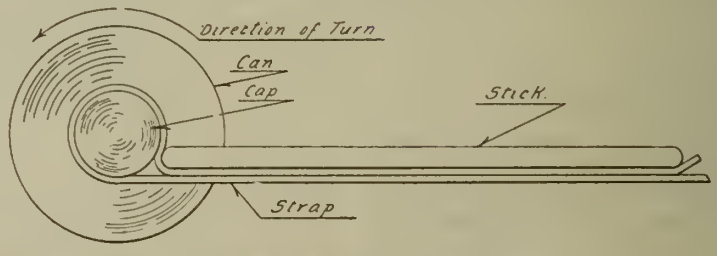
When the metal cap of a harness dressing or a metal polish can sticks, it can be readily loosened by gripping it with a loop of leather strap—shawl strap or rein, for example—the hitch being held on the cap with the fingers. If it proves particularly obstinate, a stick of wood can be applied as a lever, as shown in Fig. 1. This method has been found very effective in a number of instances.



REMOVING STUBBORN CAPS

DIRECT USE OF COAL AS FUEL WASTES MANY VALUABLE BY-PRODUCTS

In a monograph on the subject of the "Coal Resources of Canada—Their Relation to the Industrial Development of

the Country," by Mr. F. E. Lucas, published in The Final Report of the Fuel Controller, the advantages of utilizing coal in the production of coke, rather than using coal directly as a fuel, are pointed out. After showing the favorable qualities of coke as a fuel, the paper says:

"In the production of coke many valuable by-products are obtained: gas, tar, ammonia, benzol, toluol, xylol, and naphtha, or combining the latter four, a motor fuel much superior to the best gasoline obtained.

"We are not getting anything like the amount of light, heat, or power we should, or could get, and in getting this extra light, heat and power, we would not only be conserving the coal supply but getting cheaper power and at the same time recovering other products which would be of great economic value to the country and lead to the extension of existing industries and the establishment of new ones.

"Starting with the importation of anthracite, which is practically all used as domestic fuel. This can be almost entirely eliminated, and in so doing give as large returns on the invested capital as any industrial concern in the country.

"Referring back again to the by-products, a word now about their use and the markets available.

Gas

"If the plant is near a large city or thickly-populated district, it might all be sold for domestic lighting and heating. This is done in many districts by selling direct to existing gas companies, for no gas company can produce gas at the price at which a by-product coke plant can afford to sell it. Or if there are large industrial works within reach, it can be sold to them and at such a price as to be more economical than coal, or it can be used in gas engines and power developed. The figure generally accepted as being reasonably conservative for gas-engine practice is 11,500 B.t.u. per horsepower, and it will be readily seen how tremendous quantities of power can be made available from this source.

"Gas supplies for domestic use must have the sulphur extracted. This is done by iron oxide, from which the sulphur can be recovered for the manufacture of sulphuric acid, which is needed for the production of ammonium sulphate.

Tar

"This product can be used directly as a boiler or furnace fuel by being burned in the same manner as oil, or it can very cheaply be dehydrated and the more highly volatile matter extracted and then used for road binding. Even for firing it would be found advantageous to dehydrate. Some tars, depending on the temperature and conditions of the coking process, can be used as fuel for Diesel engines. The most economical way to handle the tar, however, is to distill it and recover the various volatile fractions, such as the benzol, toluol, naphtha, the carbolic oils, creosote, naphthalene, and pitch.

"The benzol, toluol, naphtha, etc., can be added to that recovered directly from the gas, for motor fuel. The crude carbolic finds a market with manufacturers of antiseptics, colors, explosives, and a great deal is used in recent years in the manufacture of phonographic records, imitation amber for pipes, etc.

"So far as the value to the country is concerned, the creosote recovered is one of the most valuable by-products of the coal. Railway ties have doubled in price in the past ten years, and there is every prospect of a pro rata increase in further years. The forestry branch reports 19,100,000 ties used on Canadian roads in one year. A fairly safe assumption would be a complete renewal of all ties every five years, while fifteen years might be taken as a reasonable average life for creosoted ties. The cost of creosoting is less than the cost of a new tie, so that the creosoting of the ties becomes not only a commercially attractive proposition, but will save many millions of feet of lumber annually.

"The same process of reasoning may be applied to mine ties and timbers, and also to bridge timbers.

"The general adoption of the creosoting process would materially reduce this number in a few years. If we assume a consumption of only 10,000,000 ties per annum there would be required about 25,000,000 gallons of creosote oil per year, or the distillation of 85,000,000 gallons of tar, which would in turn require the carbonizing of 8 000,000 tons of coal.

"The naphthalene finds a market as a color base, for the manufacture of deodorizers, disinfectants, moth balls, etc., and also in the manufacture of a chlorinated wax for use in electrical work.

Benzol

"Under this name is often included the toluol, xylol and naphtha, which are recovered at the same time. Each of these products, together with naphthalene, can be recovered separately and refined to their chemically pure state, and there will undoubtedly be a market for a small quantity of each for solvents, dry cleaning dyes, explosives, etc. During the war the toluol and a considerable portion of all benzol recovered was used in the manufacture of explosives.

"The great market now the war is over is undoubtedly to combine the four products, benzol, toluol, xylol and solvent naphtha, as a motor fuel, giving a product which distills between 78 and 165 degrees C. This fuel has been carefully tested and found to give from 20 to 30 per cent, greater mileage than the best gasoline, with about 15 per cent. greater power, easier starting, no knock with advanced spark and actually less tendency for the formation of carbon in engine cylinders. Benzol itself comprises approximately 70 per cent. of the fuel and this freezes at 44 degrees Fah. The addition of the toluol and other products named, in the proportion in which they are recovered, brings the total fuel mixture down to a freezing point of approximately zero F., so that to make an all-year fuel for our climate we have to mix with sufficient gasoline to lower the freezing point still further. The addition of 25 to 30 per cent. of gasoline gives a freezing point low enough for most places, except in the north, where it might be necessary to add as high as 50 per cent.

"According to Government statistics, Canada's consumption of gasolene in 1916 was 74,000,000 gallons, of which 18,000,000 gallons was imported as distilled product, and most of the remainder was made from imported crude oils. So that it is evident that with a total Canadian production of say 20,000,000 tons of coal, if it was all carbonized and the motor fuel recovered, the market would still be far short of being satisfied. This does not take into consideration the fact of the continued yearly increase in consumption which is bound to occur.

Ammonia

"While this has been shown in the balance sheet as sulphate of ammonia which is used almost entirely as a fertilizer, yet it can be recovered in the form of concentrated liquor containing from 16 to 25 per cent. ammonia for the manufacture of explosives, or in the form of dry ammonia gas for refrigerator purposes, or as the aqua ammonia of commerce and chemistry. However, these are only small markets when compared with the market as a fertilizer. Its only competitor, as a nitrogenous fertilizer, is nitrate of soda from Chili, and as the population of the country increases and virgin lands become exhausted, we must, if we are to be fed, keep up the productiveness of the land in a great measure by the use of artificial fertilizers.'

RELATIVE ADVANTAGES OF ROTARY CONVERTERS AND MOTOR-GENERATORS

By C. A. Booth

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It is frequently necessary to supply direct current when only alternating-current power is available on the public service company's mains. Either motor generators or rotary converters may be used for converting the direct to alternating-current power. But a rotary converter is probably the most desirable for such service. This statement might not have been true five years ago—before the rotary or synchronous converters were developed to their present state of perfection. The synchronous converter usually costs less and occupies less floor space than does an equivalent motor-generator. However, there is a fixed relation between the alternating-current voltage delivered to a synchronous converter and the direct-current voltage delivered by it. On the other hand, with the motor-generator, either the alternating or the direct-current voltage may, within reasonable limits, be varied independently of one another. The direct-current voltage furnished by a synchronous converter can, however, be, with suitable equipment, increased or decreased by adjusting the alternating-current voltage. One feature of a synchronous motor-generator set which sometimes makes its installation desirable is this: By over-exciting the synchronous motor, the power-factor of the alternating-current system which serves it may be improved.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black	Galvanized
	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard	**Lapweld**	
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 26% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ i.n	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	60
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	65½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon....	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Brnziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper $22 00		$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12 00		$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

Trade Gossip

Jenkins Bros., Montreal, have recently obtained a large order for valves from Cuba. It has been learned that considerable business in this connection is developing from South America and the West Indies. Plenty of shipping space is available for export in this direction.

From a statement recently made by an official of the Canadian Pacific Ocean Service, there is every reason to believe that there is plenty of space available for the export of Canadian products. As a matter of fact, many shipping firms are looking for cargoes, and it would appear that the cry of exporters of lack of shipping space, due to the requirements of the Ministry of Shipping, is not warranted.

The Montreal General Tool Company are now manufacturing the "Victory" water heating system, and they have constructed a system at the factory for demonstration purposes. They will carry on this new development in conjunction with their line of Talbot boilers, which are oil-fired. They have already obtained a large contract for installation in a new church to be erected in Notre Dame de Grace. This will be the first installation of its kind in Canada the fuel being crude oil.

The Canadian S K F Company, Ltd., Toronto, have issued Bulletin No. 3 of their series on ball bearing applications. This is the first of several on their application to electric motors.

The Bureau of Mines, in connection with the opening of their new laboratories at Pittsburgh, have issued a very attractive and interesting booklet, descriptive of the various portions of the new development.

The Heine Safety Boiler Co., St. Louis. Mo., have issued an interesting book on "Marine Boiler Logic." This publication is descriptive of the new type of Heine marine water tube boiler and its application to present day shipbuilding requirements.

Mr. L. G. Chase, formerly efficiency engineer, Rosemary Manufacturing Company, Rosemary, N.C., has been appointed mechanical engineer of the Yarnall-Waring Co.

Franklin W. Gilman, combustion engineer with the Sanford Riley Stoker Company of Worcester and the Murphy Iron Works of Detroit, is sailing from Vancouver on October 2 for Japan. He will remain in that country for about a year in connection with the installation and operation of stokers (manufactured by the two companies).

CORRECTION

In one of our last issues we had occasion to review a circular illustrating and describing "Bowser" lubricating oil storage systems. Credit should have been given to the S. F. Bowser Company, Ltd., Toronto, Ont., as manufacturers of the system in question.

A Continent Wide Service

MACGOVERN & COMPANY POWER MACHINERY

In Stock for Immediat Shipment

MOTOR GENERATOR SETS

2 and 3 Phase—25 Cycles

D.C. Generator. K.W.	Volts.	Make.	R.P.M.	H.P.	Volts.	A.C. Motor. Make.	R.P.M.
56¼	125			75			480
100	123		720	150	220	WESTINGHOUSE	720
2—125		ALLIS CHALMERS	720	350KW	2300	ALLIS CHALMERS synchronous	750
300	275/300	GEN. ELEC.	750	435	2300	GEN. ELEC.	750
1—200	125	NATIONAL BRAKE and					
1—300	500	NATIONAL BRAKE		550KW	6600	synchronous	
2—300	500	NATIONAL BRAKE	500	550KW	6600	synchronous	500
		2 and 3 Phase—50 and 60 Cycles					
15	125	CROCKER WHEELER	1120	25	440	CROCKER WHEELER	1120
25	125	GEN. ELEC.	1200	35	2300	GENERAL ELEC.	1200
30	125	CAN. WEST.	850	50	550	FAIRBANKS MORSE	860
35	120	BULLOCK	850	50		WESTINGHOUSE	850
40	125	GEN. ELEC.	1200	75	550	WESTINGHOUSE	1200
40	550	GEN. ELEC.	845	50	550	GEN. ELEC.	900
75	125	WESTINGHOUSE	1140	112	2200	WESTINGHOUSE	1140
75	2200	ALLIS CHALMERS BULLOCK			220	ALLIS-CHALMERS BULLOCK	
75	110	GEN. ELEC.		100	550	ALLIS CHALMERS	
80	220	BRITISH WEST.	720	120	440	BRITISH WEST.	720
96	550	GEN. ELEC.		145	600	synchronous	800
100	125/250	TRIUMPH	870	150	2300	TRIUMPH	870
100	550	WESTINGHOUSE	580	150	2200	WESTINGHOUSE	580
100	250	RIDGEWAY	1200	150	2300	RIDGEWAY	
100	250	GEN. ELEC.			2200	GEN. ELEC.	
102/510	60/300	VICKER			550	VICKER	700/720
150	500/550	GEN. ELEC.	600	200	440	GEN. ELEC.	
150	125/250	WESTINGHOUSE		200	220	WESTINGHOUSE	580
150	230 275	GEN. ELEC.	571	200	2080	GEN. ELEC.	
250		CAN. GEN. ELEC.	756	275KVA	2200	CAN. GEN. ELEC. syn.	
500	560	GEN. ELEC.	400	710	2300	GEN. ELEC.	400
500	275	GEN. ELEC.	400	530KW	2300	GEN. ELEC.	710
750	250	GEN. ELEC.	720	1100KVA	2300	GEN. ELEC. syn.	
		Direct Current					
5	110		1800	7½			1800
7	300		720	10			720
2— 75	125	GEN. ELEC.	900	150KW	2300	GEN. ELEC. syn.	900
2—250	125		720	700KVA	6600		720

ROTARY CONVERTORS

25 Cycles

K.W.	Make.	A.C. Volts	D.C. Volts.	Phase.	R.P.M.
100	CHAPMAN & WALKER	400	550	6	750
200		178	250	2	750
250	GENERAL ELECTRIC	350	550	3	750
300	NATIONAL	330	550	3	500
1500	GENERAL ELECTRIC		263	6	214
		60 Cycles			
100	WESTINGHOUSE	372	550	3	900
150	WESTINGHOUSE	177	250	6	1200
300	WESTINGHOUSE		600	3	600
400	GENERAL ELECTRIC	430	600	6	900
500	WESTINGHOUSE	177	250	6	
600	WESTINGHOUSE	177	250	6	1200

MACGOVERN & COMPANY, INC.

Buyers and Distributors of New and Used Machinery

Offices : New York, Pittsburgh, St. Louis
Plants : Brooklyn, N.Y., Lincoln, N.J., and Linden, N.J.

285 Beaver Hall Hill
MONTREAL, QUE.

VULCAN SOOT CLEANERS FOR RETURN TUBULAR BOILERS

is the title of a new bulletin just published by the Vulcan Soot Cleaner Company, Du Bois, Pa. This bulletin describes their Model "M," front end type, and their Model "R," rear end type. The bulletin states that since 1906 approximately two million h.p. of return tubular and Scotch marine boilers of many different types were equipped with these two cleaners.

The bulletin shows how the cleaner is installed in settings of typical construction. It gives the results of tests conducted by the Engineering Department of the University of Illinois, and by the Iowa Soldiers' Home, at Marshalltown, Iowa.

All engineers who are anxious to save coal, who operate tubular boilers, and who are troubled with soot, should have a copy of this bulletin.

INDUSTRIAL LIBERTY

Industrial liberty, like civil liberty, must rest upon the solid foundation of law. Disregard the law in either, however good your motives, and you have anarchy. The plea of trades unions for immunity, be it from injunction or from liability for damages, is as fallacious as the plea of the lynchers. If lawless methods are pursued by trades unions,

whether it be by violence, or by intimidation, or by the more peaceful infringement of legal rights, that lawlessness must be put down at once and at any cost."

—Louis D. Brandies.

Montreal.—Further developments of the water powers of the St. Maurice River is being considered by the St. Maurice Paper Company. It is understood that the company has leased two sites on the river known as Les Forges and La Gabelle, and it is intended to combine these two, which will give a head of 33 feet, and increase the power now available about 40,000 horsepower.

Extensive preparations are now under way for the Jacques Cartier centennial to be held next month in Montreal. This celebration will last for eight days, from August 9th to the 17th inclusive. An industrial fair will be held in connection with the event and to this end exhibition stalls are now being erected on Fletcher's Field, where the main festivities will take place. It is anticipated that the Prince of Wales will unveil the monument during his visit to the city.

New Quarters.—The International Machinery and Supply Company have acquired a four storey building at 421 St. James Street, Montreal, and in a short time will remove from their present office. The new building will have a floor space of about 7,000 square feet, and in addition to their present activities the firm will start an electrical department. R. J. Hiller will be the manager of the new department.

The J. C. Wilson Mfg. Co., Limited
BELLEVILLE, ONTARIO
Mechanical Engineers, Pattern Makers, Founders and Machinists. We build complete Hydraulic Turbine Equipment, Flumes, Head Gates, Racks, Waste Gates and Winches. Water Wheel Governors, Gearing, Pulleys and Shafting.
Makers of the "Little Giant" Turbine.
Put your water wheel proposition up to us

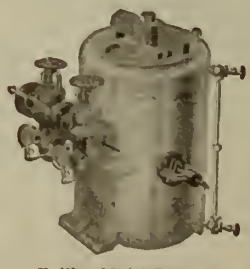
ENGINEERS WANTED
To sell locally for firm of mechanical and electrical engineers, and secure inquiries for firm handling pumps and general power apparatus, on commission basis. Address
RODERICK J. McLEAN
128 Bleury St. Montreal

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
Nos. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS
An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.
E. H. KELLOGG & CO.,
New York, U.S.A.

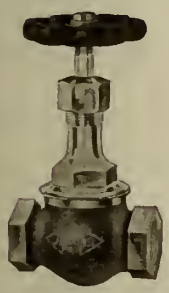
"TAGLIABUE" TEMPERATURE and PRESSURE CONTROLLERS
There is a "Tag." controller for every industrial operation where **Regulation** of **Time, Temperature** or **Pressure** is required.
Send for a Bulletin applicable to YOUR particular business.
RECORDING AND INDICATING INSTRUMENTS
THERMOMETERS
PYROMETERS
HYDROMETERS
HYGROMETERS
CONDENSATE AND LIQUID LEVEL CONTROLLERS
STEAM, WATER, AIR AND GAS METERS
E. J. PHILIP & SONS
103 Hamilton Trust Bldg. 57 Queen St. West
TORONTO, ONT.

MASON SPECIALTIES

Mason No. 55 Pump Pressure Regulator.

Reilly Multi-Screen Feed Water Filter.
We'll Solve Your Problems!
When you link up with MASON you are not only assured of getting power house specialties famous for their quality of manufacture and reliability in service. You are also offered the advice of competent engineers. Men who are trained to treat power house problems. Men who are concerned with result. Their advice means economy and efficiency in your plant. And their services cost you nothing.
The Mason Line Includes:
Mason Reducing Valves (Genuine).
Mason Pump Governors.
Mason Pressure Controllers.
Bundy Steam Traps for every service.
Cuppus Turbine-driven Blowers.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Burly Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Stratton Steam Separators.
Reilly Multi-coil Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Multi-screen Feed Water Filters.
Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.
The Mason Regulator & Engineering Co., Limited
Successors to H. L. Peiler & Co.
Montreal Office and Factory
135-153 Dagenais St.
Toronto Representative:
The Arthur S. Leitch Co., 1002 Kent Building

VALVES

TRADE JENKINS MARK



Jenkins Bros

Favoured—and Why!

DEPENDABLE Valve Service at MINIMUM upkeep cost. This is the reason why JENKINS BROS.' VALVES have won the confidence of power house Engineers and Superintendents for over half a century. Extra good quality of metal, careful construction and scientific design (that is they are made extra heavy and strong at points where pressure and strain is greatest) accounts for their superiority.

There's a Jenkins Bros.' Valve for every purpose. You will know the genuine article by the **Diamond Trade Mark** with the signature **Jenkins Bros.** cast on the body. Never fail to look for it. It means service and **economy** to you.

Catalogue No. 8 Free on Request

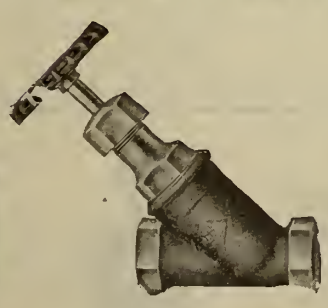
JENKINS BROS., LIMITED

103 St. Remi Street - Montreal, Canada

European Branch

6 Great Queen St., Kingsway, London, W.C. 2, England

Agencies in All the Principal Countries of the World.



Planing Mill Fan

No. 2 Vacuum Cleaner

Sturtevant (TRADE MARK)

SYSTEMS

Autoforce Ventilator

Steam Turbine

Electric Propeller Fan

STURTEVANT SUPREMACY

For upwards of 60 years the name Sturtevant has been pre-eminent among makers of air-moving apparatus. More Sturtevant apparatus is now in use than all other makes—combined. Isn't that fact significant? All Sturtevant products are built to an ideal—based on—

Quality—Efficiency—Economy

Medium Pressure Blower

Sturtevant (TRADE MARK)

Steam Engines

Standardized Types VS7 and VS8

Low Pressure Blower

—reflect the supreme refinement attained from 50 years of successful engine building. Designed to U.S. Navy specifications. They are compact, quiet, as well as efficient of operation and—thoroughly dependable. Entirely enclosed and automatically lubricated, therefore, admirably suited to isolated installations—and—

VS7 — Showing eight oil feeders of gravity oiling system

High Pressure Blower

Volume Blower and Exhauster

Gasolene Generating Set

Require Very Little Attention

Types VS7 and VS8 differ only in method of lubrication. The former is one of gravity sight feed with automatic return oil pump, while the latter is of automatic forced feed lubrication. Both systems have their friends.

Ask for Catalogue 239

Turbo-Blower

Direct Current Motor

B. F. Sturtevant Co., of Canada Limited

GALT, ONTARIO

TORONTO MONTREAL WINNIPEG

Type H Air Washer

Fuel Economizers

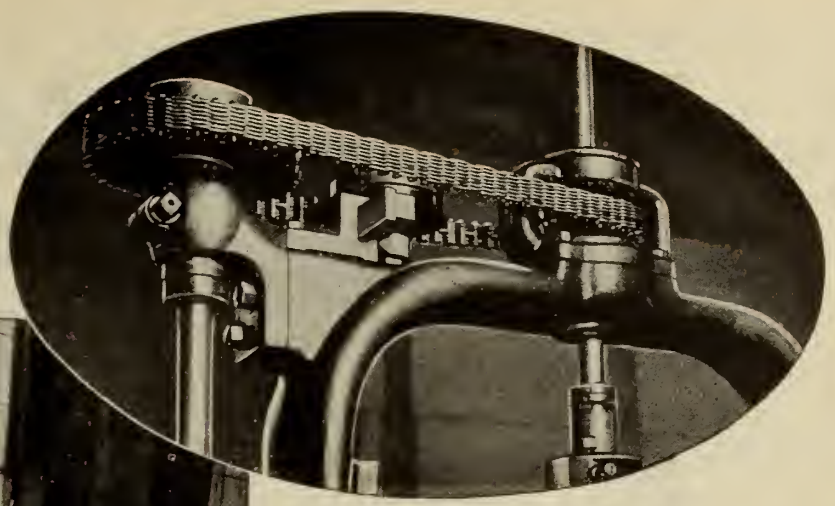
Sturtevant (TRADE MARK)

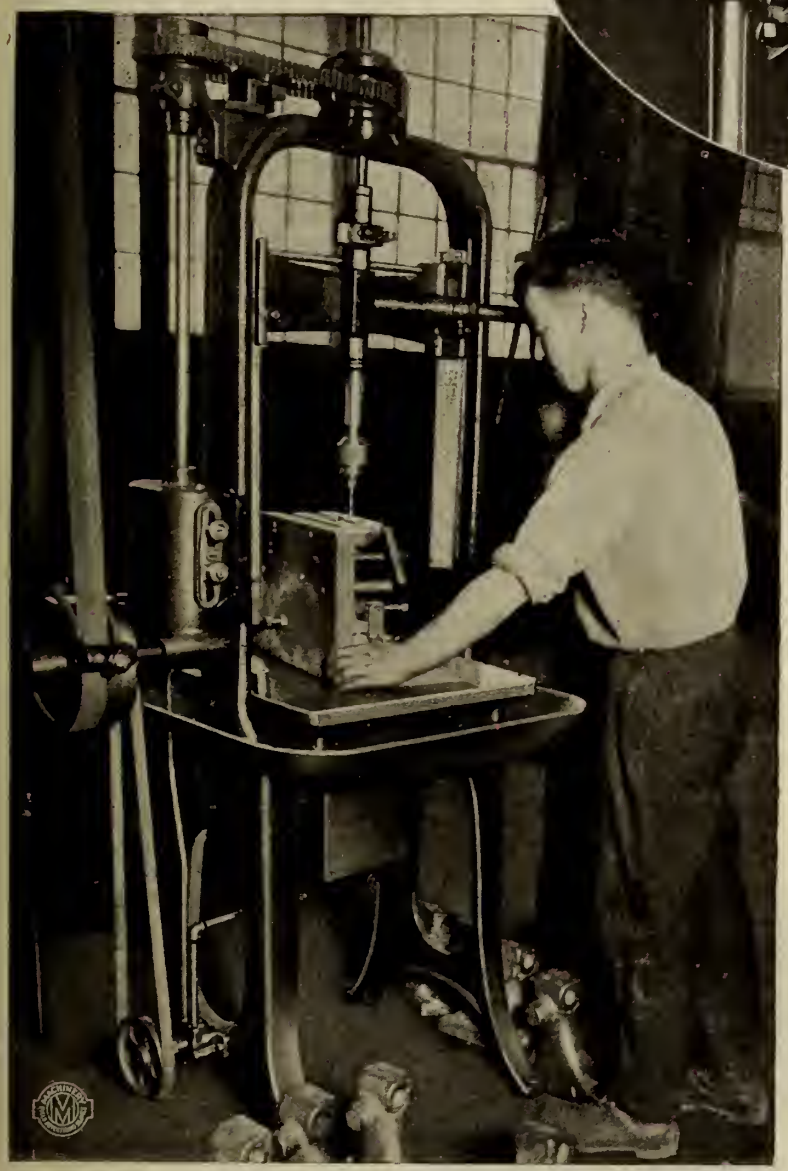
PRODUCTS

VS-7 Steam Engine

Heater

The Drive for High Speed or Heavy Service





Gearing in this capacity would be noisy and would depreciate rapidly. Belting would necessitate a large idler and the power loss would be prohibitive. Chain is the answer to a problem of this kind—Morse Chain.

There are Reasons Why This New Drilling Machine is Driven by Morse Silent Chain

This new drill is a product of the Edlund Machinery Co., of Cortland, N.Y., and is designed for heavy duty drilling at high speeds.

As may be seen, a vertical drive shaft parallel to the drill spindle extends upward from the feed change box to the top of the machine.

From this point a 1" Morse Silent Chain transmits power to the vertical shaft which drives the drill spindle. The sprocket on the drive shaft has 37 teeth, that on the drill spindle 25.

With the drive pulley running at 500 R.P.M., four spindle speeds are obtained —380, 660, 950 and 1215 R.P.M.

MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD **ITHACA, N. Y.**

Morse Engineering Service *Write for Booklets* *Assistance Without Obligation*

Address Nearest Office

BOSTON, MASS. .....141 Milk Street
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CLEVELAND, OHIO .....Engineers Bldg.
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"Morse is the Guarantee Always Behind the Efficiency, Durability and Service"

ECONOMIC Carling BLOWERS SUPERIOR

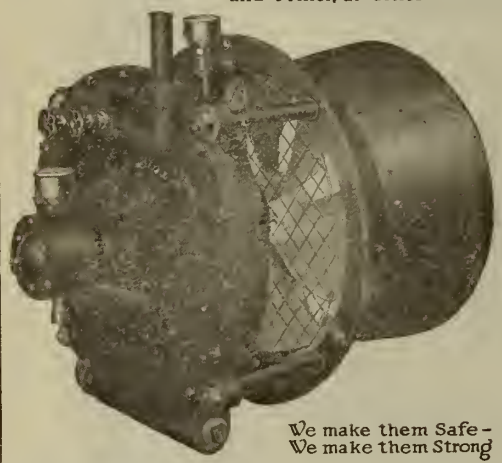
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
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MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

60% Air Space and 90% Underdraught

Insure combustion that is perfect. For this reason soft coal, the highest grade hard coal or cheap screenings can be burned on Cyclone Grates with absolutely no clinker formation and positively no loss of fuel energy.

Your engineer can install Cyclone Grates without delay or trouble, and the 30-day trial offer period is long enough to prove their worth to you.

The Canadian Steam Boiler Equipment Co. Limited
Sole Makers for Canada
20 McGee St., Toronto, Ont.
AGENTS: St. John, N.B.; F. W. Blizzard, 329 Charlotte St.; Montreal, Mason Regulator Co., Ltd., St. James St.; Hamilton, Robt. Fitzsimmons, 8 Grove St.; Winnipeg, Vulcan Iron Works; Ottawa, J. W. Anderson, Room 7, Bank St. Chambers.

Cyclone Grates

TRADE KIELEY MARK

KIELEY

Traps
Separators
Regulating Valves
Back Pressure Valves
Pump Governors
For Every Servic e

Reliable STEAM, WATER and AIR

SPECIALTIES

Simple and sturdy in design, low cost of operation and accuracy in regulation—these are the advantages that accrue when you equip your plant with KIELEY Specialties. We can supply all your requirements promptly. Write for catalogue of the full KIELEY line.

THE ARTHUR S. LEITCH CO., Kent Building TORONTO

"SAFETY FIRST"

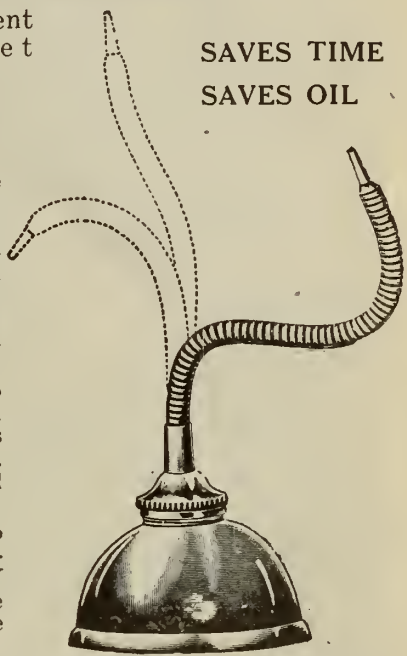
Bend the Spout

to suit the position

Every requirement satisfactorily m e t with

ALL-WAY OILERS

SAVES TIME
SAVES OIL



Note the flexible spout. It enables you to oil all places —many places that previously c o u l d only be reached with force pump cans with specially bent spouts.

Indispensable t o those who know. Will last as long as six ordinary oil cans. Saves 50% of oil bills.

Ask your dealer to show you the complete ALL-WAY line of oilers. If he cannot do so, please write to us.

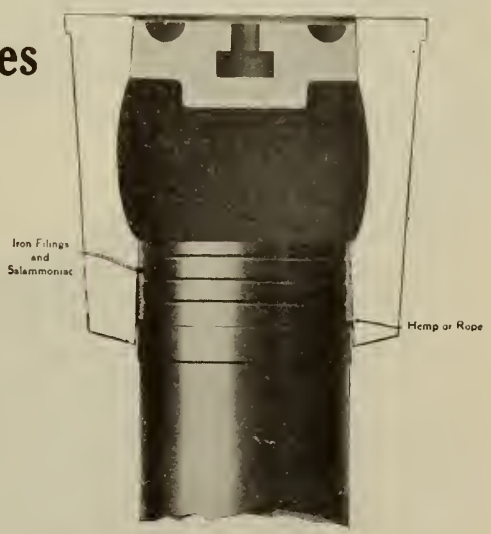
THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO

Article No. 2

Economiser Tubes

Cr oss Section of Patented Top Header Showing Internal Lid Construction.

are carefully cast in vertical d r y s a n d moulds from a mixture giving a tough, close-grained casting which has proved to be most effective in resisting corrosive action of the gases. After removing from moulds the tubes are carefully cleaned, inspected and hydraulically t e s t e d f o r strength and defects.

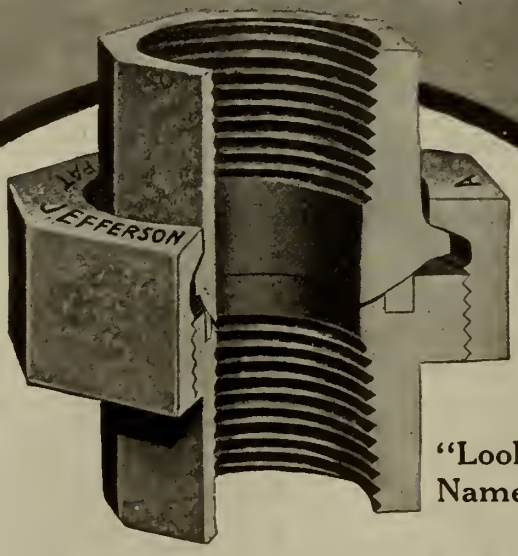


Repair Tube and Cross Section of Header Showing Iron filings and Salammoniac Rust Joint.

The right hand cut shows the method of joining tubes and headers. The tapers at either end of the tube are in opposite directions with the smaller diameter at the ends of the tube. The left ha nd cut shows the method of making the joints for repair tubes.

GREEN'S ECONOMISER, LIMITED, TORONTO

JEFFERSON



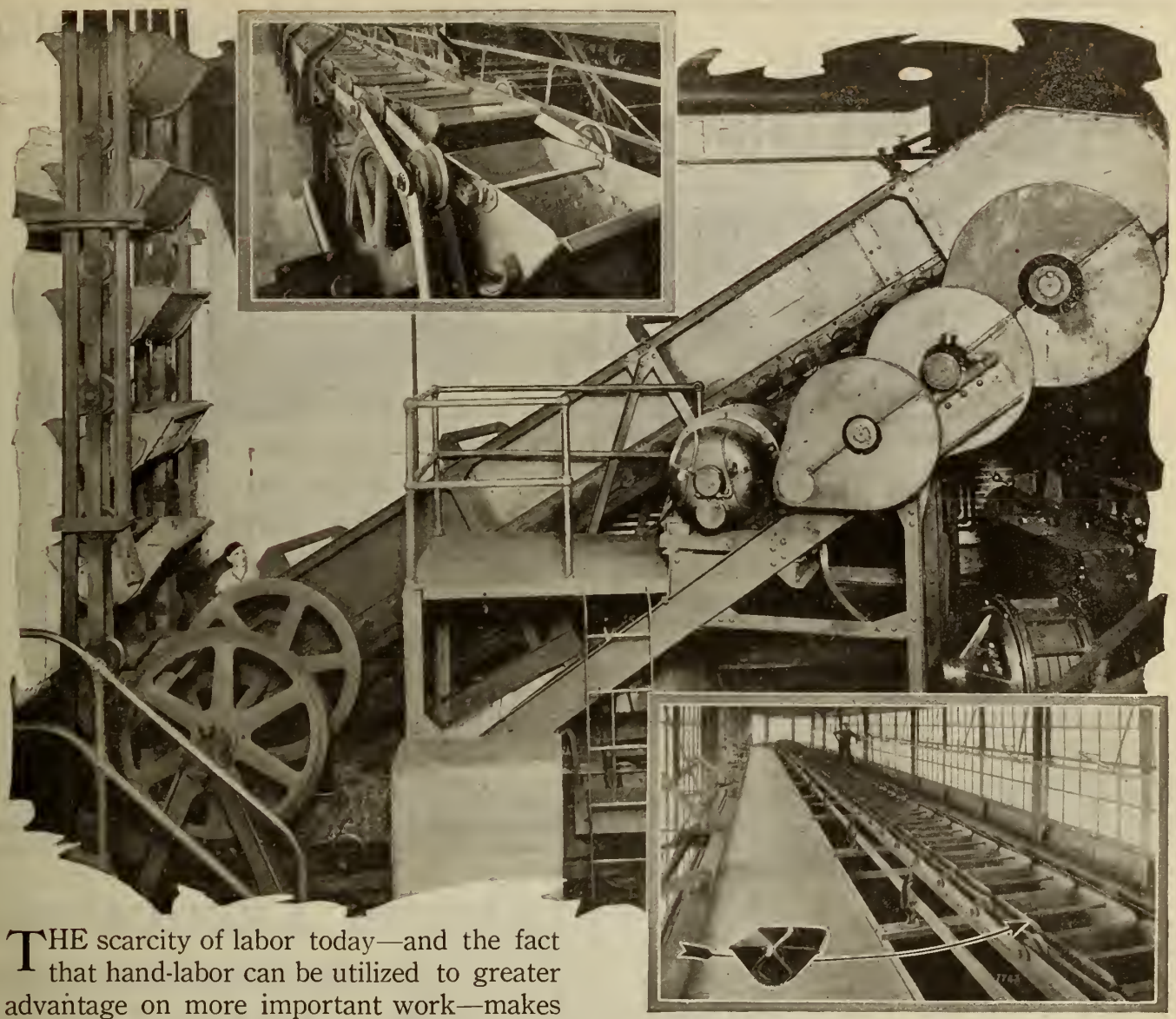
"Look for the Name on the Nut"

JEFFERSON UNIONS are particularly adapted to the requirements of underground pump service. The Brass Seat Ring makes a tight brass-to-iron joint which cannot corrode, and is easily disconnected. The Spherical Ground Joint takes care of alignment difficulties and makes possible a tight joint even if the line is not exactly straight.

And there are other important reasons why JEFFERSONS are better. "The Name on the Nut" protects you against substitute "just-as-good" unions. You would have a mighty hard time trying to make tight a leaky union with a "just-as-good" promise.

Ask your Jobber and JEFFERSONS. He knows every union that's made and can tell you just why JEFFERSONS are better. Write TODAY for our Catalog "UNIONS"

The Jefferson Union Co.
Lexington, Mass.



THE scarcity of labor today—and the fact that hand-labor can be utilized to greater advantage on more important work—makes the purchase of Link-Belt Elevating and Conveying Machinery for handling coal and ashes in the boiler plant, a most profitable investment.

You can save more money by the efficient and economical handling of coal and ashes in your boiler house than in many other parts of your business. Being out of the way—usually in a hot, dusty place—this all-important work is apt to be neglected.

We specialize in designing and building coal and ashes handling machinery. Like all Link-Belt Equipment it is ruggedly constructed; built for hard service, and fully guaranteed.

Let us suggest a Link-Belt Coal Handling installation for your Boiler House. Write for catalog No. 220.

CANADIAN
LINK-BELT CO., LIMITED
WELLINGTON AND PETER STS. - TORONTO

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
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Write for Catalogs
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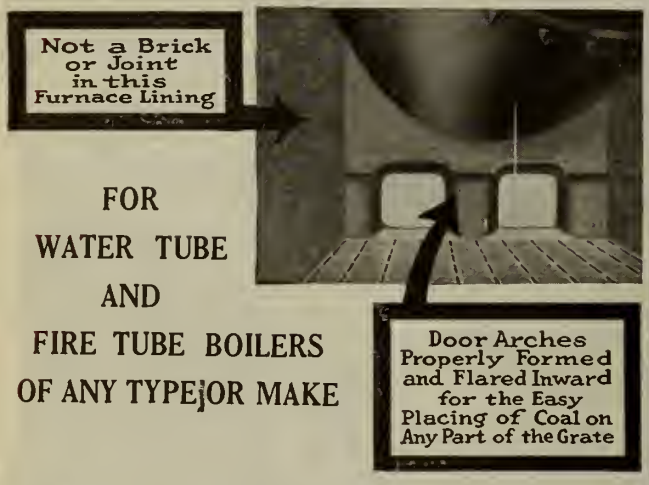
LINK-BELT
Elevators and Conveyors

DURABLE FURNACE LININGS


Not a Brick or Joint in this Furnace Lining
Door Arches Properly Formed and Flared Inward for the Easy Placing of Coal on Any Part of the Grate

FOR WATER TUBE AND FIRE TUBE BOILERS OF ANY TYPE OR MAKE

A FURNACE lining that is gastight and remains gastight in service is easy to build with

BETSON'S

REG. U.S. TRADE MARK PAT. OFF.

PLASTIC FIRE BRICK

It comes in yellow-top barrels ready for use. Anyone can do the job. Experts not necessary. A mallet and trowel are the only tools required.

There is no mystery about Betson's. It is the pioneer and proven Plastic Fire Brick that has made practical the one-piece furnace lining without joints, and is not affected by expansion and contraction. It has a record of 20 years' experience and satisfactory service under all sorts of trying conditions.

Write for booklet that tells of its uses in the boiler room.

Canadian Distributors

International Chemical Co.

44-46 Lombard Street

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9-42

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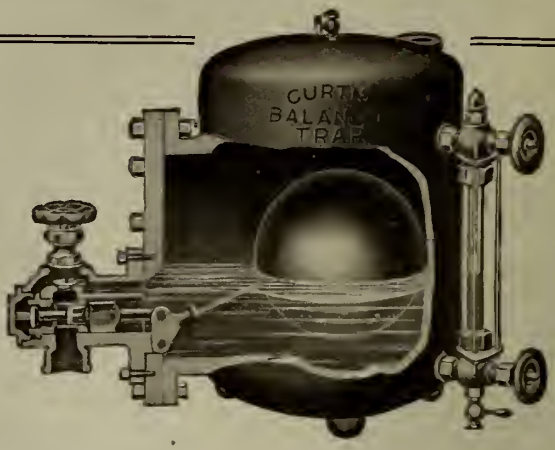


Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1919 Catalog of Curtis Engineering Specialties.

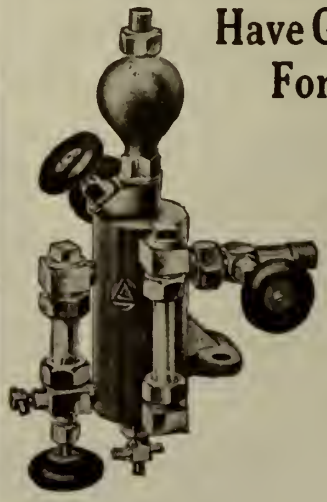
JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.

WALKERVILLE, ONT.

The 2-Part Trap

TWO major parts make up this distinctively simple trap: the body, with inlet and outlet connections; the cover, in which the Dunham Thermostatic Disc is securely fastened.

This disc of special phosphor bronze contains a fluid which is extremely sensitive to temperature changes over a wide range—10 pounds of pressure to 15 inches of vacuum.

Temperatures above normal close the trap; temperatures below normal open it for the escape of the troublesome air and water.

Should it ever become necessary to renew a trap, the cost is confined to the top part only. Just screw a new one into place. Judging from some of the original traps (installed 15 years ago) we do not anticipate much demand for new tops.

The complete story of Dunham Heating Service is quite interesting. Write for it.

C. A. DUNHAM COMPANY LTD., TORONTO, ONTARIO

HALIFAX
OTTAWA
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The DUNHAM HEATING SERVICE

MONTREAL
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Any Capacity

NORWALK AIR & GAS COMPRESSORS

Any Pressure

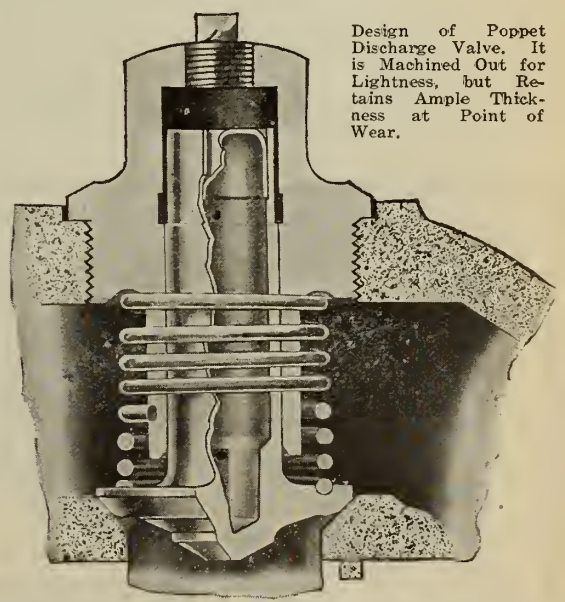
Distinctive Features that Add to Norwalk Efficiency

6—DISCHARGE VALVE

By painstaking design both light weight and double thickness at wearing surfaces have been obtained in Norwalk compressor discharge valves. Abundant area is allowed for the passage of air or gas around and through the valves. All cushioning consistent with rapid, efficient action is provided.

One feature is worth careful note. The valves are placed in the *cylinder heads*. Thus the shortest possible post and least dead space is obtained. This also allows the water jacket on the gas cylinder to keep maximum length.

New bulletins on Air, Oxygen, Hydrogen, Acetylene and Carbonic Acid Gas are ready. *Tell us where to address your copies.*



Design of Poppet Discharge Valve. It is Machined Out for Lightness, but Retains Ample Thickness at Point of Wear.

The Norwalk Iron Works Co., South Norwalk, Conn.
Pioneer Builders of Compressors

Showing ease with which Plibrico is laid in place

IT'S PLASTIC

and particularly adapted for Jointless, one-piece front-door arches, bridge-walls, side-walls and combustion chamber.

BETTER THAN FIRE BRICK

Can you see the advantage and economy?

Write for a free copy of our 36-page book of useful information on furnace building and maintenance

JOINTLESS FIRE BRICK CO.

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Drop-Forged

Chain Pipe Vise

MADE entirely of drop-forgings and wrought steel, these Vises are unbreakable, compact, rapid in action and positive in gripping pipe. They are attachable *anywhere*—any handy bench, post, or other support will answer. Remember, Williams' Chain Pipe Tools have been *Standard* for nearly half a century—they are all backed by our absolute and unconditional guarantee of service.

Vises in 3 sizes for ⅛ to 8-inch pipe.

Descriptive Booklet on Request.

J. H. WILLIAMS & CO.

"The Drop-Forging People"

78 Richards St., Brooklyn, N.Y.

The A. G. Low Co., Ltd., 78 Pacific Ave., Saskatoon, Sask.
Agents for Manitoba, Saskatchewan, British Columbia and Alberta.
Western Office and Warehouse: 78 So. Clinton St., Chicago, Ill.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

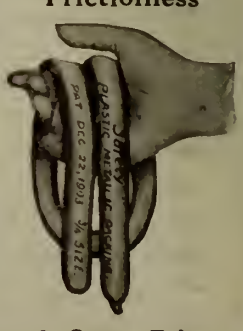
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

AGENTS WANTED

Practically Frictionless



In Cotton Tubes

VULCABESTON

Red Fibre Sheet Packing

It isn't just a marine packing, or a locomotive packing, or an acid plant packing, or a superheat, high pressure power-house packing. It is the *universal* packing — all these in *one.* Consequently Vulcabeston simplifies packing problems. No matter how many kinds of pipe lines you have to provide for, Vulcabeston is the *only* packing you need.

VULCABESTON is heat and moisture-proof and as nearly indestructible as packing can be. It is made from long fibre asbestos by a special process. Unlike rubber and many compressed asbestos sheet packings, it cannot be squeezed out, but has unusual resiliency and pliability.

If your regular dealer does not carry Vulcabeston, write us direct

The Johns-Pratt Company
Hartford, Conn., U. S. A.

19-11

VULCABESTON

Is the Alien a Menace?

IN the October issue of MACLEAN'S MAGAZINE a strong presentation is made of the reason why the people of the West are against further foreign immigration.

"The Menace of the Alien" depicts the foreign problem in the Canadian West as it exists to-day, and shows every one of us why we must Canadianize our Ruthenians, Austrians, Slovaks, and our fifty-seven other varieties before we allow any further "unrestricted" immigration.

This article is written by a member of MACLEAN'S MAGAZINE staff who has just returned from a careful, personal investigation of the situation. Shall we have a "White West?" Many Westerners are demanding it. Are the aliens to swing labor into the bosom of the O.B.U.? It is being done—and what must we do to stop it?

The "inside" story of the routing of the Drumheller miner aliens by returned Canadian war veterans is here told by MACLEAN'S for the first time. What leadership must be substituted for the O.B.U. leadership of these foreigners?

The October issue of MACLEAN'S is a Western number in the sense that it contains many articles and stories of distinctly Western interest. For instance:

X "Those Pesky Farmers Out West"

By Hopkins Moorhouse, Author of "Deep Furrows"

They have completely upset the old order of things. No longer will politics consist of the comfortable fight between the Ins and Outs with the old party lines maintained. The grain growers on the Prairies have upset the calculations of the professional politicians and completely changed the face of Dominion politics.

X "Fifty Years in the West"

By Professor W. T. Allison

A breezy and readable sketch of the business career of Winnipeg's veteran business man, James H. Ashdown.

"Further Discoveries of New Land"

By Vilhjalmur Stefansson

The final and most interesting instalment of Mr. Stefansson's story of his wonderful trip of five years' duration in the Canadian north in which he tells for the first time of finding new continents in the Arctic and hoisting there the Canadian flag.

X "The Banshee Bell"

By Edith G. Bayne

A bright love story laid in the mountains of British Columbia.

Other Splendid Features of October MacLean's

X "The Turmoil at Ottawa"

By J. K. Munro

A comprehensive survey of Dominion politics, written with complete impartiality and absolute candor. It is bright and breezy, with a knock in every line for the politicial opportunists. It plucks many tail feathers from our party leaders.

"Spanish Doubloons"

By Camilla Kenyon

The start of a bright and fascinating serial story by a brilliant young writer. It is the Spanish Main brought up-to-date, treasure hunting with a background of fun and romance.

"The Airy Prince"

By Arthur Beverley Baxter

A complete novelette in which is presented a bird's-eye view of England in time of war. It is one of the most brilliant stories that has been written of recent years.

"His Majesty's Well-Beloved"

By Baroness Orczy

The latest novel by this popular authoress appearing exclusively in MACLEAN'S.

"Ebb and Flow"

By C. W. Stephens

A strong business story laid in the province of Quebec.

Over 70,000 Canadian Families Buy

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

OCTOBER ISSUE *Now On Sale At All News Dealers* *20c*

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UNITED STATES FOOD ADMINISTRATION

Columbia River Packers' Association, Astoria, Oregon

Magnolia Metal Co. 10/16/18

Gentlemen:—Engines, Line Shaft Bearings, Thrust Collars, Thrust Shaft Bearings, Stern Bearings and general equipment of our Alaska Fleet of Fishing Vessels are regularly inspected and repaired at this port. We have been using your MAGNOLIA METAL for this work with entirely satisfactory results.

Yours respectfully,

COLUMBIA RIVER PACKERS' ASSOCIATION.

J. A. BERG, Foreman, Machine Shop.

SOLD BY LEADING DEALERS EYERYWHERE OR

MAGNOLIA METAL CO.

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("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

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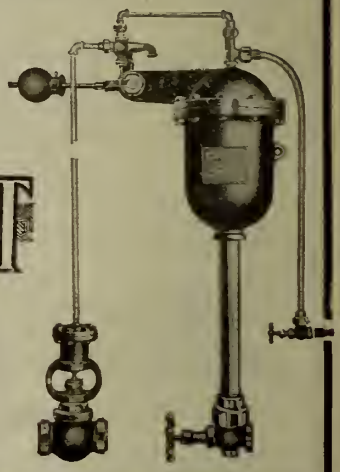
Keeps Boiler Water Within 1/4" of Middle Gauge---

Regardless of load or firing.



VIGILANT

Automatic Feed Water *REGULATOR*

Has many points of interest economically. Learn all about it.

Send for Catalogue.

The CHAPLIN-FULTON MFG., CO.
28 Penn Ave., Pittsburgh, Pa.

The Simplest and Best Cleaner on the market is

PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
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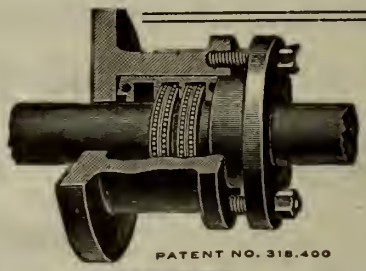

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" "	774,490	" "	898,066
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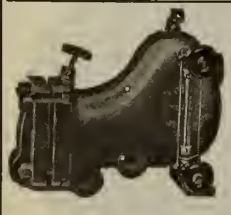
HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO.,
Wilkes-Barre, Pa.
Incorporated 1897



McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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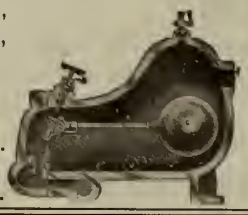

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26 Craig Street MONTREAL, CAN.
WATSON & McDANIEL CO.
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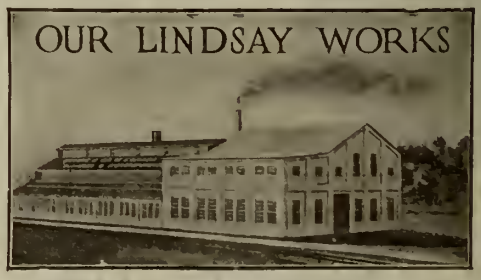
Water Turbines, Hydraulic Governors, Centrifugal Pumps



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Lindsay, Ontario

DARLING BROTHERS, LIMITED
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120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

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Engineers, Machine and Foundry Contractors
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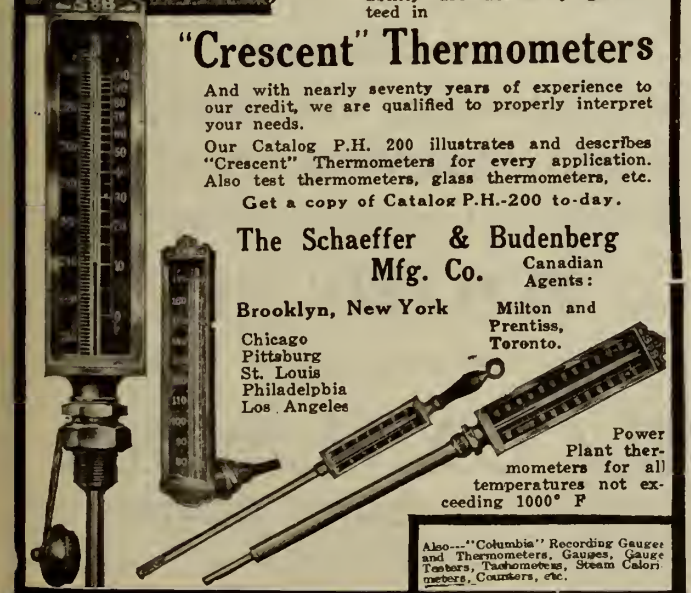

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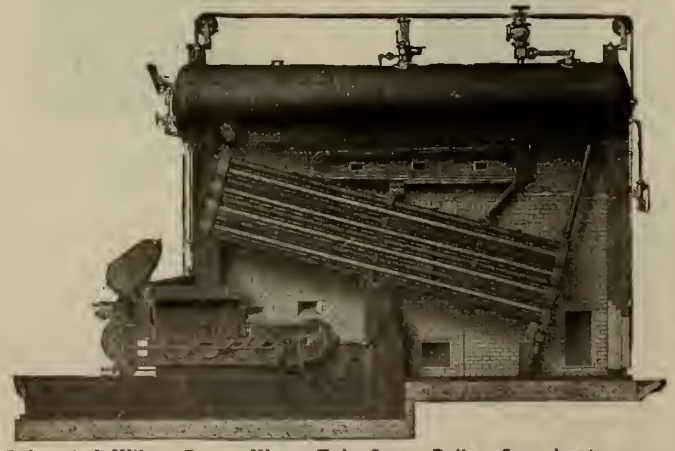

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DRAFT APPARATUS SYSTEMS, MECHANICAL
The Mason Regulator & Eng. Co., Ltd., Montreal
Green's Economiser, Ltd., Toronto.

DRAFT RECORDERS
Jas W. Hays Corp., Michigan City, Ind.
Defender Automatic Regulator Co., St. Louis, Mo.

DRAFT GAUGES
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithica, N.Y.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

EJECTORS AND SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENAMELWARE FITTINGS, IRON PIPE
Empire Mfg. Co., Ltd., London, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

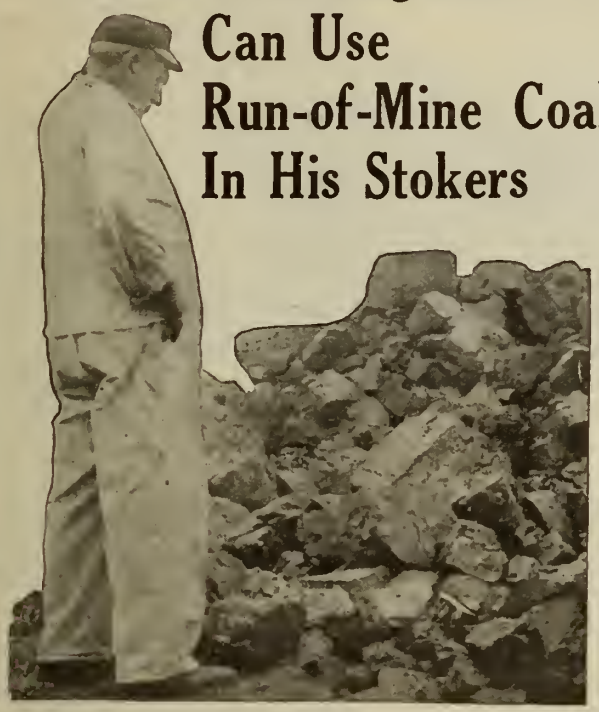
ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N.Y.

ENGINES; GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.

ENGINES, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Montreal General Tool Co., Montreal, Que.
Waterous Engine Works Co., Brantford.

How Your Engineer Can Use Run-of-Mine Coal In His Stokers



Every indication points to a coal shortage before Winter sets in. To increase production, the coal operator will ship the size most easily loaded, Run-of-Mine. As a result, screenings cannot always be secured when needed.

"But," says **your ENGINEER,** "our Boiler plant is equipped with automatic stokers—and to make steam we have got to have coal of the right size—we can't use Run-of-Mine."

You can insure him a constant supply of stoker coal by installing a JEFFREY SINGLE ROLL CRUSHER in your plant.

A single operation of this crusher will reduce Run-of-Mine to the proper size for your stokers.

Bulletin No. 141-4 gives complete information why the Jeffrey Crusher safeguards your coal supply, and eliminates the worries of buying properly sized coal. SEND FOR COPY.

THE JEFFREY MFG. CO.

Canadian Branch and Warerooms:
MONTREAL

The ULTIMATE in Blow-off Valves

The "Duro" has demonstrated its peculiar adaptability as a blow-off by many years of satisfactory service, with a minimum cost for upkeep.

The self-cleaning seat feature prevents an accumulation of sediment on the seating faces during the blow-off, thereby reducing wear to a minimum and preventing leakage while the boiler is in operation.

To further enhance the durability of the valve, the disc is reversible; the disc faces can easily be replaced with new material in case of wear, and all the parts including the seat ring and reversible disc are renewable.

The materials and workmanship are of characteristic Lunkenheimer "Quality."

Specify Lunkenheimer "Duro" and insist on their installation.

Write for descriptive booklet No. 515DC.

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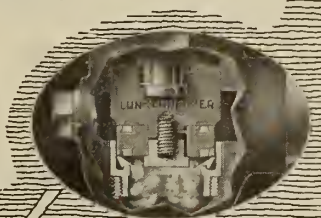

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ENGINES, MARINE
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Canadian Allis-Chalmers, Ltd., Toronto.
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Montreal General Tool Co., Montreal, Que.

ENGINES, SAW MILL
Goldie & McCulloch Co., Galt.
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Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd.,
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Franklin Williams Co., New York.
Watson & McDaniel Co., Philadelphia.

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Alberger Heater Co., Buffalo, N.Y.
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

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J. H. Williams & Co., Brooklyn, N.Y.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Engr. & Equip. Co., Worcester, Mass
Green's Economiser, Ltd., Toronto.

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Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Royles, Ltd., Irlam, Manchester, England.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Darling Brothers, Ltd., Montreal, Que.
Green's Economizer, Ltd., Toronto.
Laurie & Lamb, Montreal.
E. J. Philip & Sons, Toronto.

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Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
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E. J. Philip & Sons, Toronto.
Scaife & Sons, Wm. B., Pittsburgh , Pa.
York Mfg. Co., York, Pa.

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Beveridge Paper Co., Montreal, Que.

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Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK, PLASTIC
Gates Refractories, Limited, Montreal.

FIRE BRICK MORTAR
Jointless Fire Brick Co., Chicago, Ill.

FIRE BRICK CEMENT
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, MARINE
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

FLUE GAS COLLECTORS
The Jos. W. Hays Corp., Michigan City, Ind.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto,
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co., St. Louis, Mo.

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Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

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FUEL OIL SYSTEMS
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FURNACES, BOILER
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

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James Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

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Can. H. W. Johns-Manville Co., Toronto, Ont
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.

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Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Uehling Instrument Co., New York, N.Y.
E. J. Philip & Sons, Toronto, Ont.

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Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

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Graton & Knight Mfg. Co., Montreal, Que
Shell Bar Boico Supply Co., Toronto, Ont.
Sarco Co., Inc New York, N.Y.

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GAS PRODUCER PLANTS
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Canadian Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE METERS
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GASOLINE PUMPS, SELF MEASURING
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GASOLINE TANKS
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Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

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Defender Automatic Regulator Co., St. Louis, Mo.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont
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GAUGES, AMMONIA, OIL, GAS, AIR
The Mason Regulator & Eng. Co., Ltd., Montreal.
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Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

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Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
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Defender Automatic Regulator Co., St. Louis, Mo.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Taylor Instrument Co., Rochester, N.Y
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
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Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Beveridge Paper Co., Ltd., Montreal, Que.

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Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
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Babcock & Wilcox, Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto, Ont
Goldie & McCulloch Co., Galt.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar. Boico Supply, Ltd., Toronto, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
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Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

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J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

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Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.
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HOIST HOOKS
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Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont.
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Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
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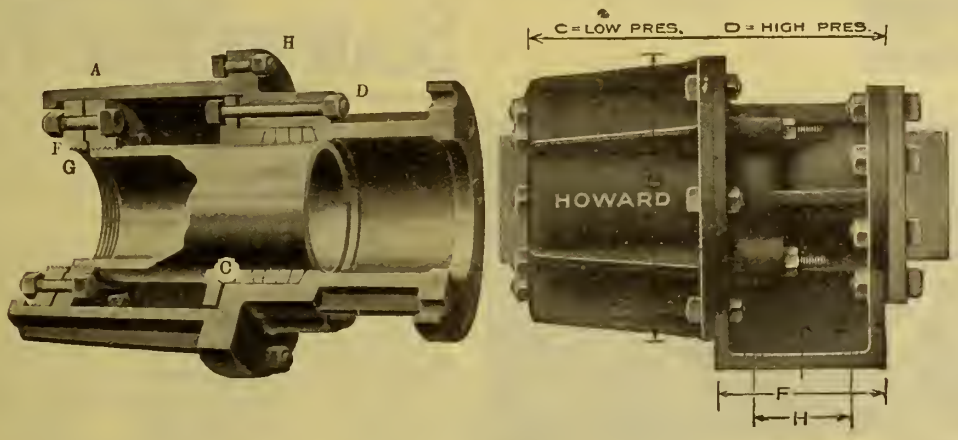
CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



Howard Guided Expansion Joints

Howard Guided Expansion Joints put the "How" in all expansion problems. The high pressure and superheat of modern engineering practice have added tremendously to pipe line dangers and the engineer's troubles.

"How" to take up the greatly increased expansions and contractions while at the same time keeping joints tight under the greater pressures?

That is the question to which HOWARD Guided Expansion Joints are the exclusive and satisfactory answer.

MAXIMUM OF TRAVERSE is the first essential of an expansion joint. Here the HOWARD excels with its full 4 inches of play between the "cold" position (see cut above), and the "hot" position. Assuming the outside temperature is 32 degrees, this 4 inch play amply takes care of the linear expansion in more than 100 feet of wrought iron pipe at any pressure from 30 to 300 pounds. Very often one HOWARD, by its greater capacity, takes the place of two or more other expansion joints.

Inquire about this to-day.

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Halifax St. John Quebec Montreal Ottawa Toronto Hamilton Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Scale in Your Boilers

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

METLSKIN CO., Inc.

Rochester, N. Y.

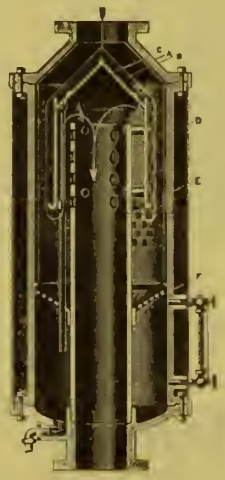
Canadian Representatives:

Canadian Fairbanks-Morse Co., Limited

St. John Montreal Quebec Ottawa Hamilton
Toronto Windsor Winnipeg Calgary
Vancouver Victoria Saskatoon

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

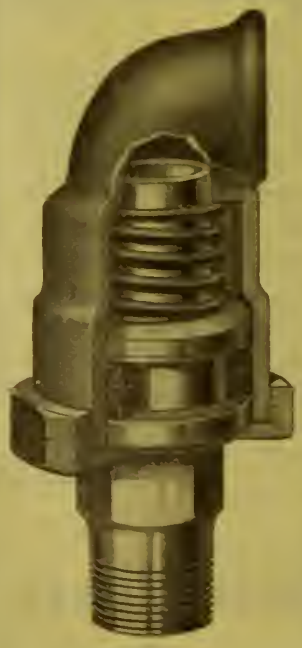
II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents
Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
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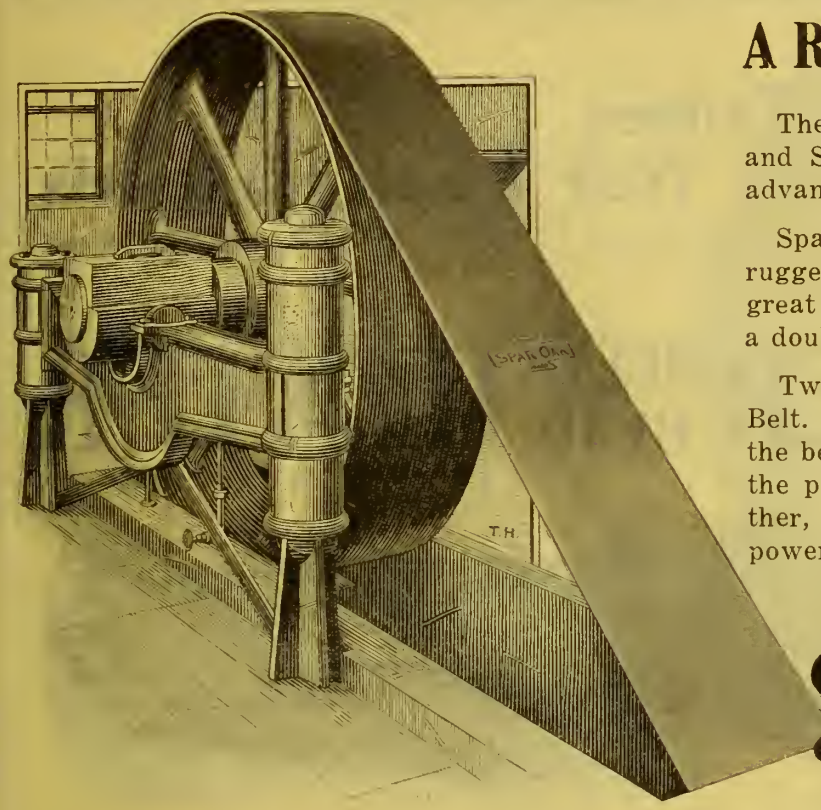
EVERYTHING MECHANICAL



A Rugged Pulley-Gripper

There is nothing like leather for belting, and SparOak Leather Belting has peculiar advantages all its own.

SparOak is a two-in-one belt combining rugged strength with unique pulley-grip. Its great endurance and minimized slip make it a double-service belt of unusual qualities.

Two kinds of leather enter into a SparOak Belt. The outer ply is oak tanned, cut from the best selected center stock. The ply next the pulley is Graton & Knight Spartan leather, tanned to give pliability and traction power unequalled by any other material.

SparOak Belting

Here is an 18" SparOak Belt on a hard drive in a warm, moist atmosphere where the extreme flexibility of Spartan and the firmness of Oak leather are necessary.

SparOak is the answer to a great many perplexing belt problems, saving power and standing up under the most severe conditions.

If you have a troublesome belt drive, consult us as to what belt is required. Maybe it is SparOak, but in any event one of the Graton & Knight Standardized Series of Belts will fit exactly. Write for our booklet on Standardized Belting.

SparOak Belts grip from the start. During the weeks most new belts take to "work in," a SparOak Belt is giving full power and keeping production up to normal. And SparOak Belts keep on gripping for years under adverse conditions. They withstand repeated shifting, and the wear against step cone or flange pulleys. They render efficient service on drives with high speeds, small pulleys, and heavy loads. In short, any of the factors that quickly wear out ordinary belts affect SparOak belting amazingly little.

CANADIAN GRATON & KNIGHT, LTD.
Montreal, Canada

Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria

Graton & Knight
Standardized Series
MADE IN CANADA
Leather Belting
MADE IN CANADA
Tanned by us for belting use

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

No Buckling
Split Tubes
Nor Leaky Heads

Because in this Alberger Heater expansion stresses are positively overcome by the use of a divided tube head which takes care of the unequal elongation of the tubes in the various passes.

With this
ALBERGER MULTI-HEAD HEATER

your hot water cost will be cut down. You will be saved steam repairs—fuel—space. You will need no extra storage tank because the water will be heated to the required temperature as fast as it is withdrawn.
You will need less fuel because the small diameter helically corrugated seamless pure copper tubes insure very rapid heating; they have been proven to transmit 50% more heat than any plain tube heater of similar size.

Send for Bulletin No. 201

Capacities range from 200 to 200,000 gallons per hour.

ALBERGER HEATER COMPANY
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DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY
STANDARDIZATION

During the past few weeks we have presented facts relating to the performance of DURABLA sheet in all main services where gaskets are essential—air, water, oil, steam, ammonia, gasoline and acids. That DURABLA successfully withstands extreme conditions in all of these particular services is proof that it is one material for every condition of every service, and that it is all that is implied by the term "standard."
In order to standardize on a gasket material it is necessary to determine by test to your own satisfaction the fact that a certain material meets all your specific requirements.
DURABLA Gasket Material in any quantity will be shipped to you under money back guarantee that it will make a tight joint wherever a permanent gasket is required.

One Standard material for all gasket work—Sold on a Service Basis.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada:
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DURABLA

CANADIAN
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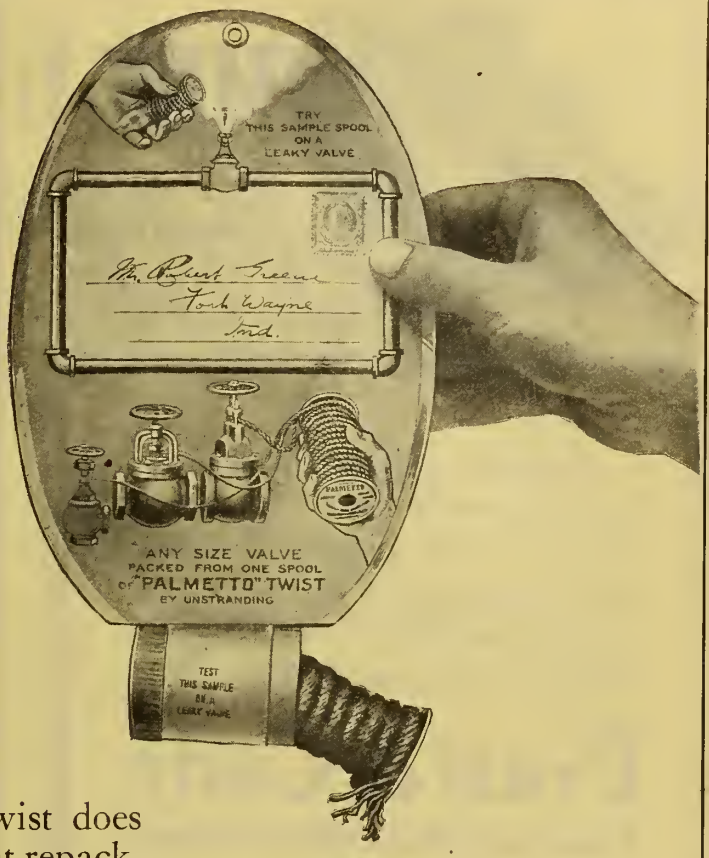
EVERYTHING MECHANICAL

May We Send You this SAMPLE Spool of

TRADE MARK
"PALMETTO" TWIST PACKING
REG U S PAT OFFICE

just to prove to you the long service-quality of the genuine "PALMETTO"?



"PALMETTO" Twist does away with the constant repacking of globe and other small valves because it has the quality that lasts—graphite grease lubricant in each single strand.

ANY SIZE VALVE PACKED FROM ONE SPOOL OF "PALMETTO" TWIST—by Unstranding.

"Palmetto" also comes in braided form for rods, in 5-lb. boxes.

Let us send you samples.

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EVERYTHING MECHANICAL

WHAT!
Throw away a good Pair of Shoes that could be Half Soled!

Absolute extravagance! And yet, thousands upon thousands of valves are discarded every year—only partly worn out. A needless waste that could be prevented by the installation of

Pratt & Cady
Renewable Disc Globe Valves

When the old asbestos disc of a P. & C. "Renewable" is worn out, it can be replaced in a few minutes without removing the valve from the pipe line—at a fraction of the cost of a new valve. Just like half-soling a pair of good shoes. And once more your valve is ready for a long term service—as good as new.

The *next time* you have a valve breakdown replace that valve with a Pratt & Cady "Renewable." A long-wear valve outside of its renewable feature.

Made in all sizes and for every kind of service. Remember, NEXT TIME!

Write today for our Valve Catalog and be ready for an emergency

PRATT & CADY CO., INC.
HARTFORD, CONN.

Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Power Pumps and Asbestos Packed Cocks

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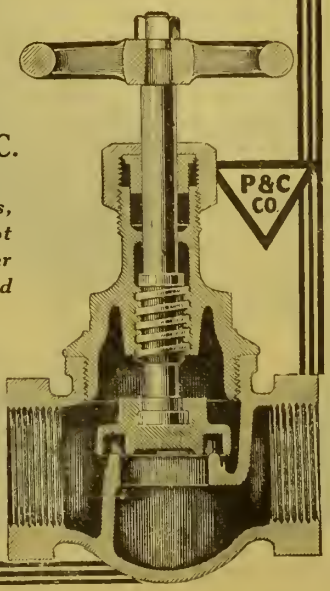

A VERY LITTLE STUDY
of our new booklet—
"A Steam Trap Catechism With Specification Data"

will help you to a better understanding of Steam Trap problems and why AMERICAN IDEAL STEAM TRAPS give such good service.

Ask our nearest office for your copy.

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American Steam Gauge & Valve Mfg. Co.
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THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

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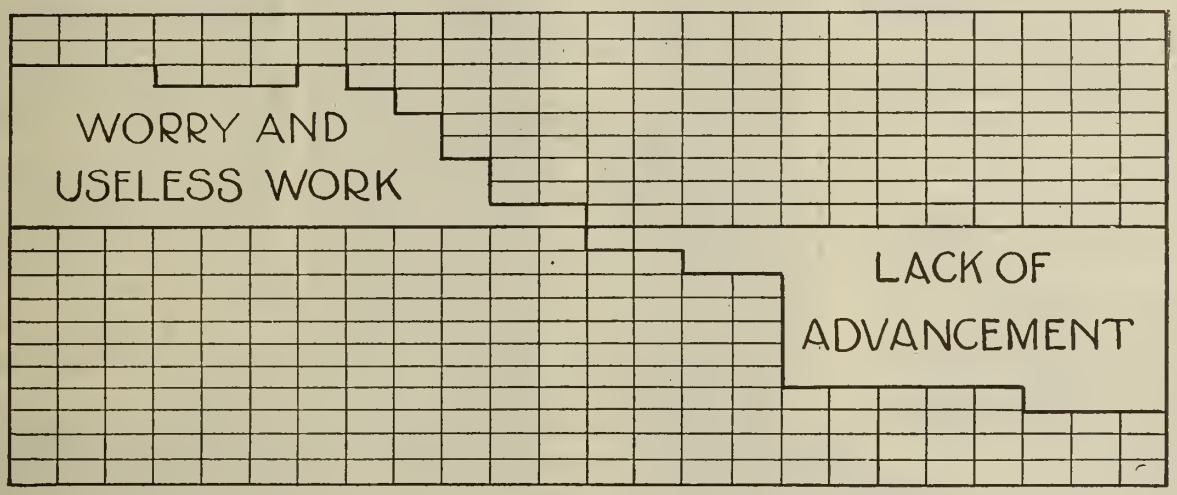
Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

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Help It Along

If you cannot change an out-of-reach valve, at least make it easy to operate. A

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

brings the valve within reach from the floor. Write for Catalog.

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New Bedford, Mass.

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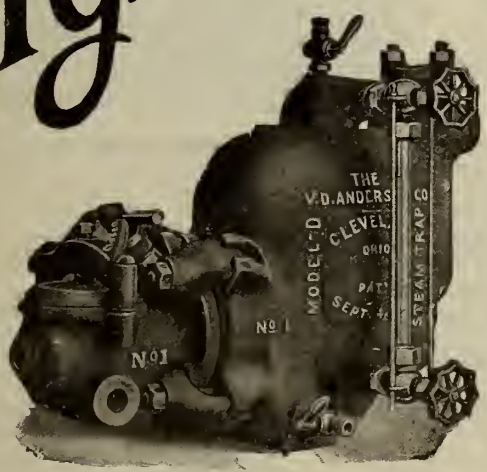
Make an instinctive appeal to the machinist. It isn't only their accuracy and utility—it's something in the finish and quality of the tool itself that seems to make it easier to do good work.

Catalog No. 21 "CD," illustrating and describing 2100 different kinds and sizes of tools, sent free on request.

The L. S. Starrett Company
The World's Greatest Toolmakers. Manufacturers of Hack Saws Unexcelled.
Athol, Mass.

42-961

Stays Tight



The ANDERSON Model "D" Steam Trap

Just think of the satisfaction you have once this perfected trap is in your steam-room!

Tight from the day you put it in! Of that you can be sure.

It is operated by a counterbalanced Lake Superior Copper Float. Its large air valve is ever under deep water seal, and never will it wire draw.

Furthermore, every part is machined to solid gauge. Self-contained strainer and self-contained by-pass are Anderson features. Note the outside gauge glass. And the simple design! It gives you complete accessibility to every part.

Write for full particulars.

The V. D. ANDERSON COMPANY

1935 West 96th Street, CLEVELAND, OHIO

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Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.
PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Works, South Norwalk, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GAS
Norwalk Iron Works, South Norwalk, Conn.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
S. F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
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Shell Bar Boico Supply, Ltd., Toronto.
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S. F. Bowser Company, Limited, Toronto, Ont.
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York Manufacturing Co., York, Pa.
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S. F. Bowser Company, Limited, Toronto, Ont.
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MacKinnon Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
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Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.
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Jamison Cold Storage Door Co., Hagerstown, Md
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal
Norwalk Iron Works, South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.
REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal
Defender Automatic Regulator Co., St. Louis, Mo.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
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MacKinnon Steel Co., Sherbrooke, Que.
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Jamison Cold Storage Door Co., Hagerstown, Md
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Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.
ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.
SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
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National Boiler Protector Co. of Canada, Montreal, Que.
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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.
SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.
SMELTER LININGS
Beveridge Paper Co., Montreal, Que.
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Babcock & Wilcox, Ltd., Montreal.
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Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
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J. H. Williams & Co., Brooklyn, N.Y.
SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.
SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.
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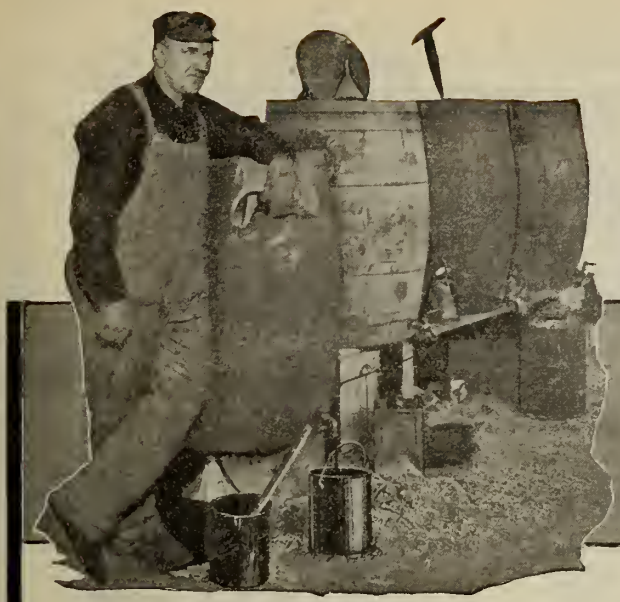
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., V. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal
Cole, Ltd., Geo. W., Toronto

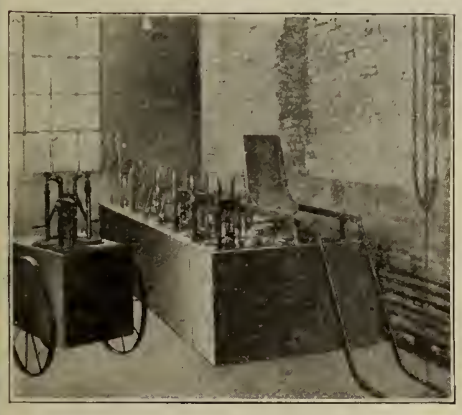


Stop Wasting That Oil !

You don't allow castings, finished parts or supplies to lie around without an accurate record of them. Such things go into the store room, carefully checked in and charged out as used—Why?—It is the only safe, systematic way to do.

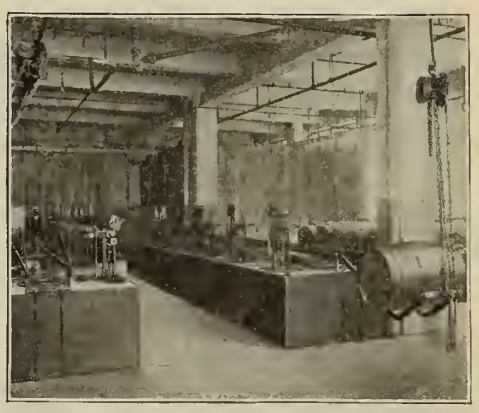
Are your oils handled as carefully? They can be, and can be accounted for as easily as other materials—receipts checked, accurate quantities given out, charges made to the departments using and records kept if desired.

BOWSER ESTABLISHED 1885 Storage Systems



BOWSER Lubricating and Paint Oil Battery Installation with Portable Outfit for Lubricating Oil

Save the Oil



Double Battery Installation for Paints and Other Oils, one unit or as many as needed can be installed.

Bowser Systems enable workmen to get full value from every drop of oil, save a great amount of time and labor in handling.

Put your Oil storage problems up to the Bowser engineers. Let them make a survey of your plant, show you just what you may expect to save by the use of Bowser oil handling equipment. It costs you nothing and it should mean a saving for you. *Write us today for further information.*

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6 Castlereagh Street

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The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Mason Regulator & Engineering Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL TANKS
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Goldie & McCulloch Co., Galt.
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Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
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Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

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Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Royles, Ltd., Irlam, Manchester, England.

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Babcock & Wilcox, Ltd., Montreal.
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Green's Economiser, Ltd., Toronto.

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SWITCHES AND SWITCH BOXES
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J. H. Williams & Co., Brooklyn, N.Y.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Mfg. Co., York, Pa.

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S. F. Bowser Company, Limited, Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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MacKinnon Steel Co., Sherbrooke, Que.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
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THERMOMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

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Canadian Fairbanks-Morse Co., Montreal.
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Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

TRAPS, STEAM AND WATER-LINE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.

TRUCKS, FACTORY
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Canadian Fairbanks-Morse Co., Montreal.
Victoria Foundry Co, Ltd., Ottawa.

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Babcock & Wilcox, Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (Vacunm and Gaa Filled Types)
Penberthy Injector Co., Windsor, Ont.

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TURBINE WATER WHEELS
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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg. Co., Belleville, Ont.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Engr. & Equip. Co., Worcester, Mass.
Escher Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

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Canadian Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNDERGROUND TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

UNLOADERS, CAR
Portable Machinery Co., Inc., Passaic, N.J.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VACUUM GOVERNORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Canadian Steam Boiler Equipment Co., Toronto
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

VACUUM REGULATING VALVES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VACUUM TRAPS
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

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Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

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Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Darling Brothers, Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Victoria Foundry Co. Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Mfg. Co., York, Pa.

AIR VALVES
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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Jenkins Bros., Ltd., Montreal.
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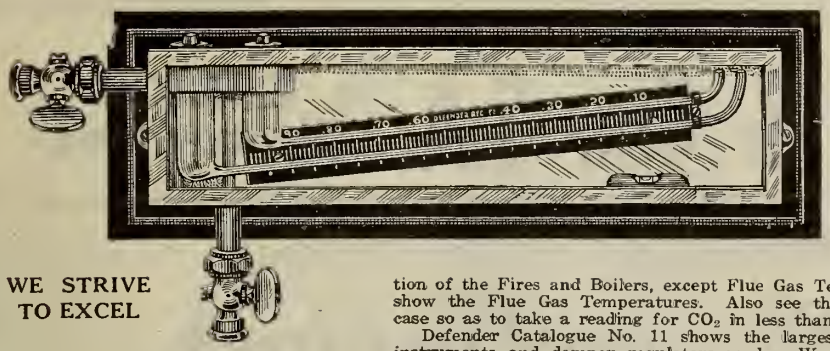

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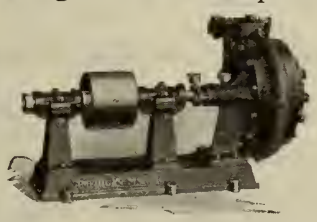

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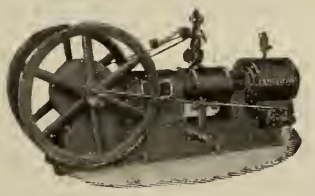

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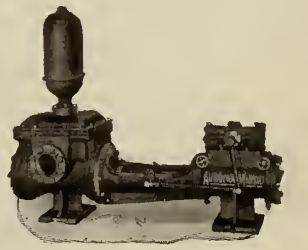

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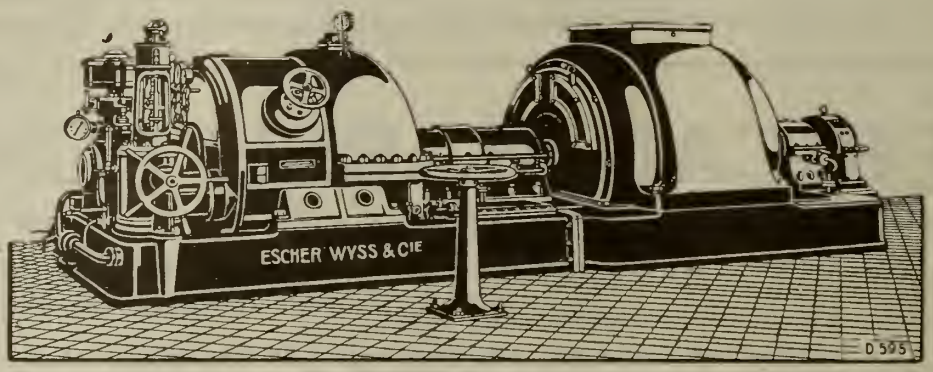

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But Goodyear has developed new and higher standards of hose efficiency.

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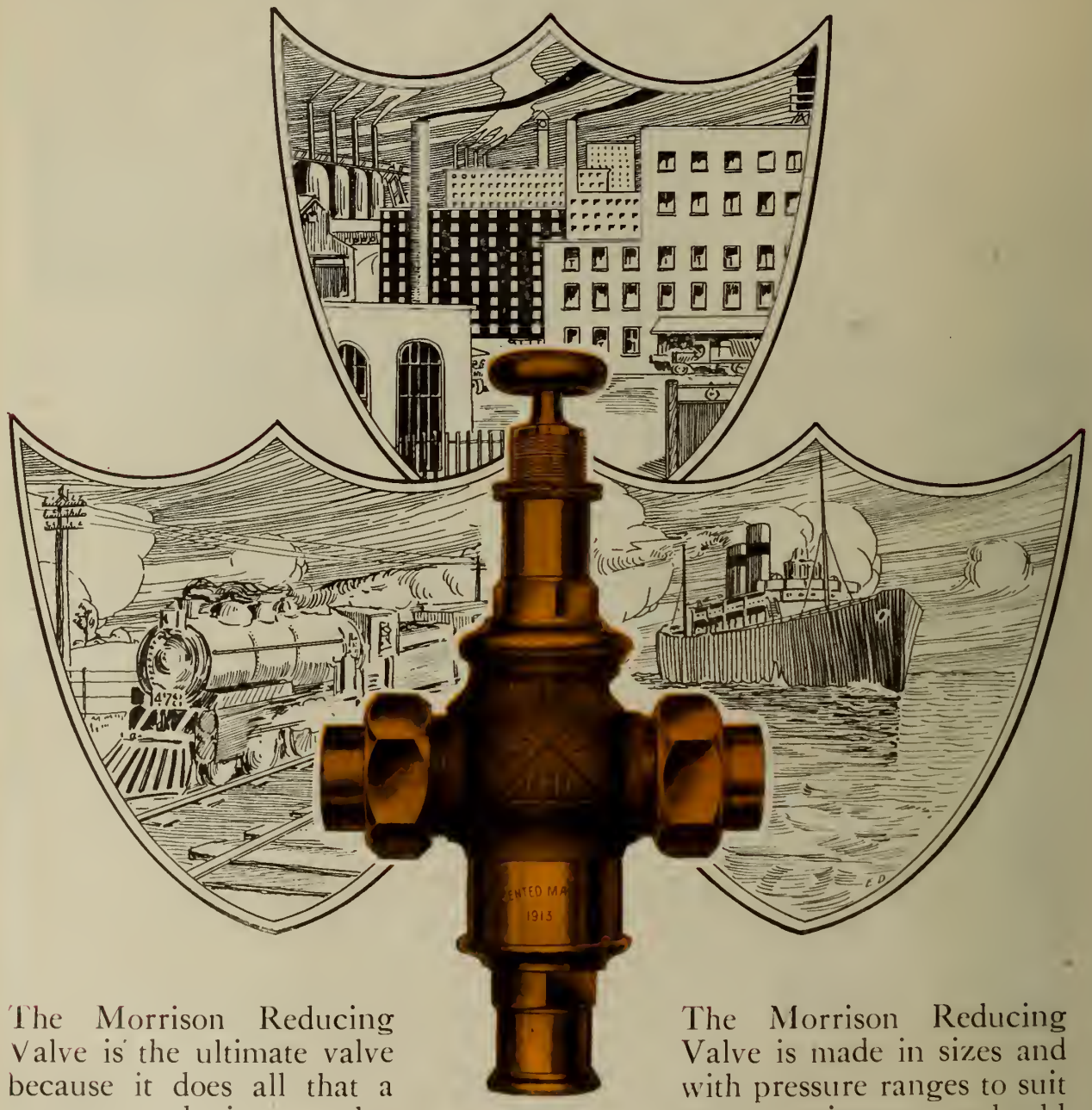

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ANNUAL DIRECTORY NUMBER

POWER HOUSE

A semi-monthly newspaper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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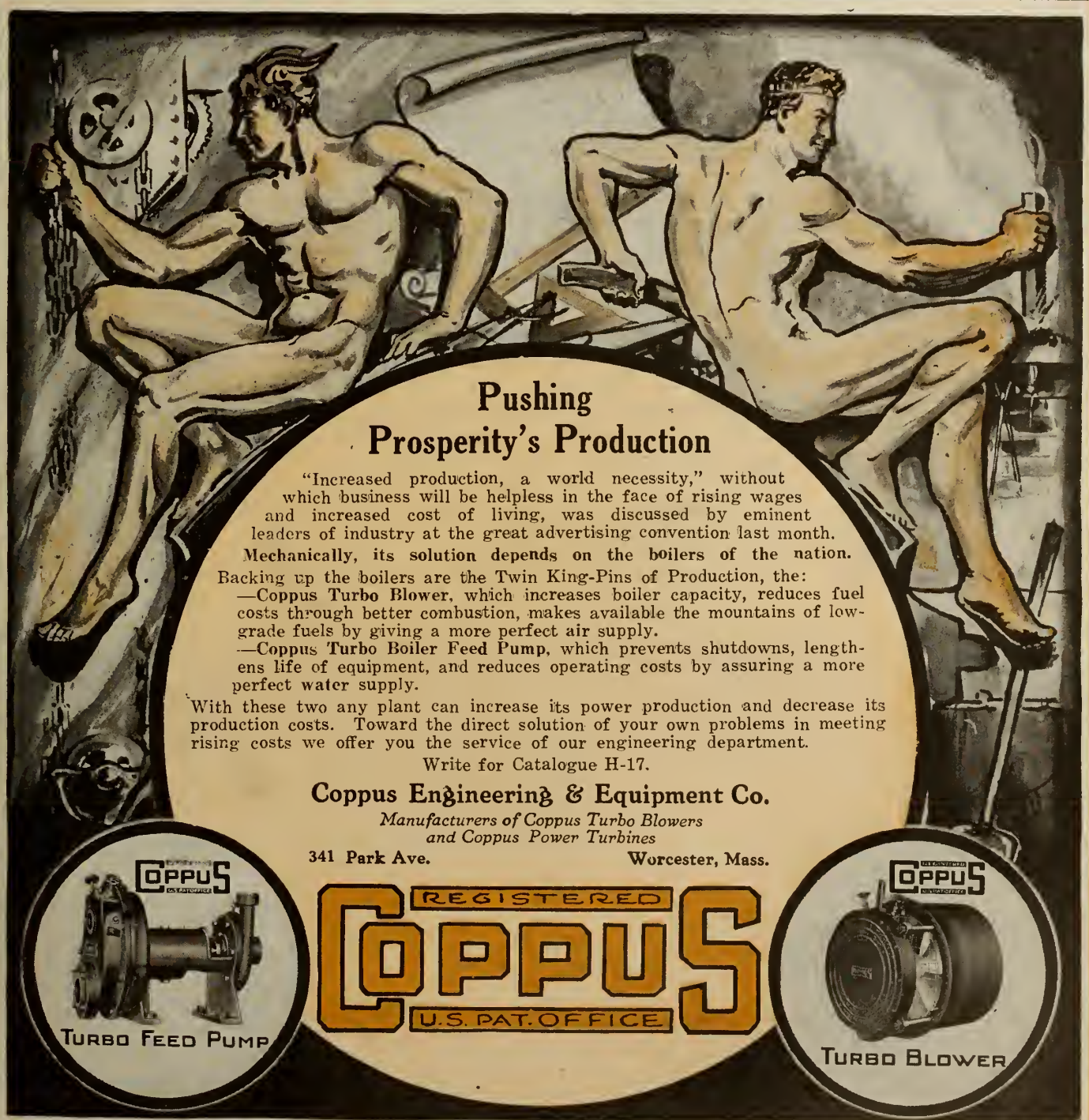

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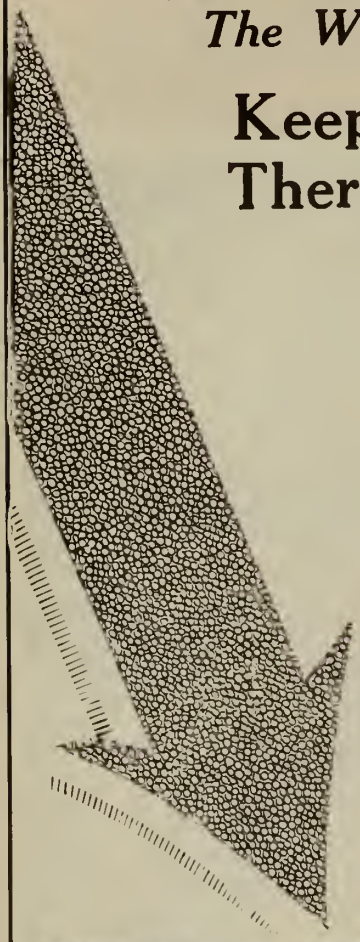

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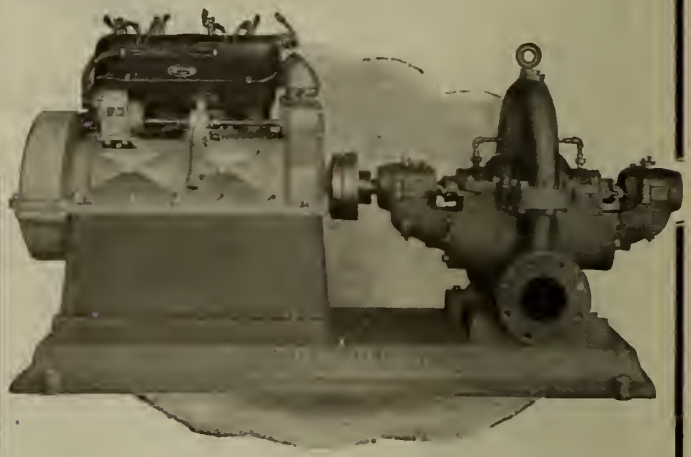

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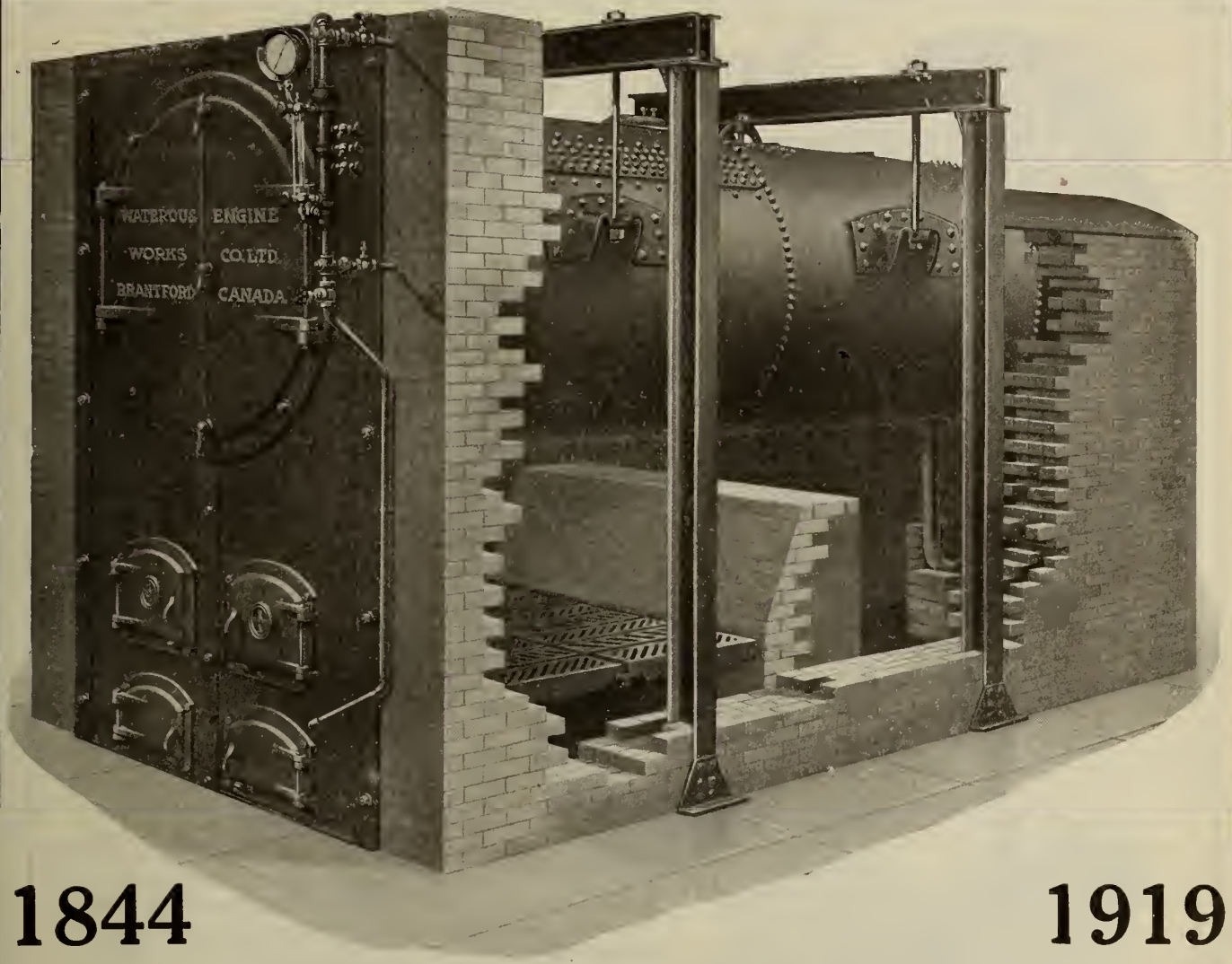

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GASWORKS:—Ammonia and benzol stills, condenser and scrubber temperatures, exhauster and oven offtake controls, tar extractor control, holder seal-water temperature control.

Our bulletins showing instruments as applied to your industry, will be mailed at your request.

Republic Flow Meters

TO MEASURE

Steam, Water, Air or Gas

Indicating, Graphic Recording and Integrating

Use a REPUBLIC Meter to Measure

Steam generated at the boilers.

Steam distributed to departments or sold to customers.

Apply a steam meter to your carbureted water gas sets. It will show the number of Runs, the time of Blow and time of Make Periods, amount of steam used per run and total steam used.

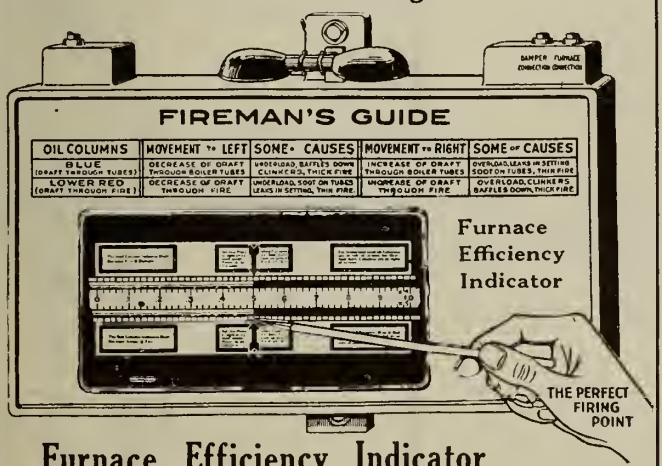
Feed-water, water supplied to departments, total water pumped.

The gas you make, also the gas used by your steel furnaces (coke oven or blast furnace gas).

Measure the air you compress and the amount you supply to your customers.

IT INDICATES

WHAT You Are Doing WHILE You Are Doing It


FIREMAN'S GUIDE
OIL COLUMNS
MOVEMENT TO LEFT
SOME CAUSES
MOVEMENT TO RIGHT
SOME OF CAUSES
BLUE (DRAFT THROUGH TUBES)
DECREASE OF DRAFT THROUGH BOILER TUBES
UNDERLOAD, BAFFLES DOWN, CLINKERED, THICK FIRE
INCREASE OF DRAFT THROUGH BOILER TUBES
OVERLOAD, LEAKS IN SETTING, SOOT ON TUBES, THIN FIRE
LOWER RED (DRAFT THROUGH FIRE)
DECREASE OF DRAFT THROUGH FIRE
UNDERLOAD, SOOT ON TUBES, LEAKS IN SETTING, THIN FIRE
INCREASE OF DRAFT THROUGH FIRE
OVERLOAD, CLINKERS, BAFFLES DOWN, THICK FIRE
Furnace Efficiency Indicator
THE PERFECT FIRING POINT

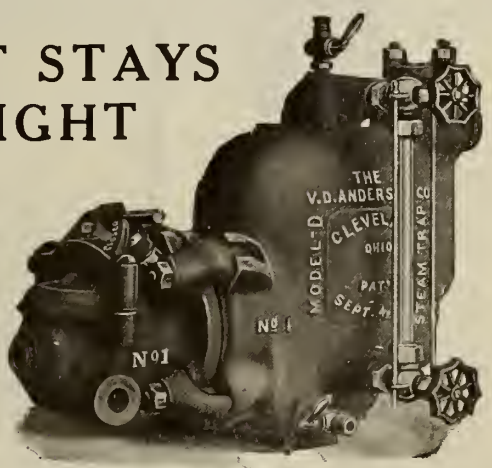
Furnace Efficiency Indicator

SUPPLIED ON APPROVAL

We will attach this instrument to your boiler and leave it to you, to say if it is worth its cost—if not, it will be removed at our expense.

The greatest aid to the fireman in the economical burning of coal.

IT STAYS TIGHT



ANDERSON MODEL "D" STEAM TRAP

gives you complete accessibility to every part.

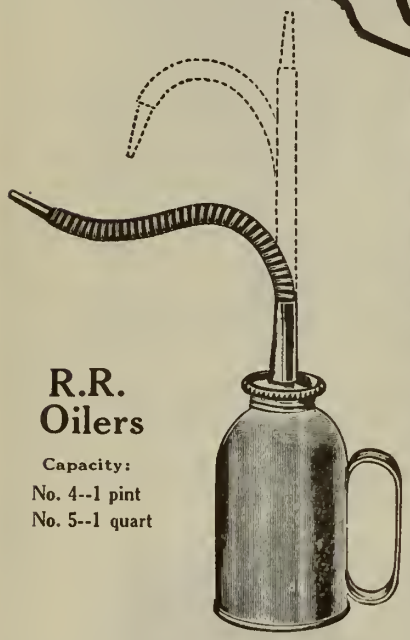
We sell the complete line of Anderson Specialties in Ontario.

Steam and Air Traps
Oil Separators and Filters
Literature on request.

E. J. PHILIP & SONS

Room 103 - 57 Queen Street West - Toronto, Ontario

ALL-WAY OILERS



R.R. Oilers

Capacity:
No. 4--1 pint
No. 5--1 quart

The "All-Way" is an oiler fitted with flexible steel spout, made to bend any angle or position without breaking or interfering with the flowing of the oil. A big saver of time and oil.

The All-Way Oiler

Steel Spring Bottom
Nos. 1, 2, 3

Capacity:
No. 1 -- ⅓ pint
No. 2 -- ½ pint
No. 3 -- 1 pint

Dealers Everywhere

HALIFAX, N.S.
Cottingham, E. S.
Stairs Son (Wm.) & Morrow Ltd.
ST. JOHN, N.B.
Thorne & Co., Ltd., W. H.
MONCTON, N.B.
Sumner Co.
FREDERICTON, N.B.
Chestnut & Sons, Ltd., R.
SHERBROOKE, QUE.
Codere & Fils Ltd.
Mitchell & Co., Ltd., J. S.
MONTREAL, QUE.
Caverhill, Learmont & Co.
Canadian Fairbanks-Morse Co.
Crown Cycle & Motor Co.
Davidson Mfg. Co., Ltd., Thos.
Foss Machinery & Supply Co., Ltd., Geo. F.
Frothingham & Workman, Ltd.
Goodwin's Ltd.
Lewis Bros. Limited.
Power Equipment & Supply Co., The.
Renaud Motor Supply Co., The
Richardson & Bureau
Williams & Wilson, Limited.
OTTAWA, ONT.
Keyes Supply Co., Ltd.
PEMBROKE, ONT.
Dunlop & Co., Ltd.
PETERBOROUGH, ONT.
Davidson, R. W.
KINGSTON, ONT.
Canadian Locomotive Co., Ltd.
TORONTO, ONT.
Aikenhead Hardware Ltd.
Canadian Fairbanks-Morse Co., Ltd.
Cutten & Foster Limited
Howland Sons & Co., Ltd., H. S.
Kloepfer Ltd., C.
Rice Lewis & Son, Ltd.
Tire Import Co., Ltd.
Wilkinson-Kompass Co.
HAMILTON, ONT.
Alexander Hardware Co., Ltd.
Wood, Alexander & James
Walker-Vallance Ltd.
Wilkinson-Kompass Co.
Mill: Hardware Co., Ltd.
Wilson Auto Specialties Co.
LONDON, ONT.
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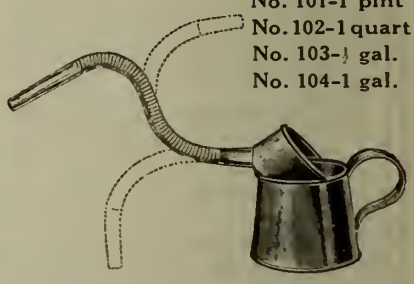
MacLaren Tire Co., The
KITCHENER, ONT.
Fennell & Son, John
COLLINGWOOD, ONT.
Whites Limited.
PORT ARTHUR, ONT.
Wells & Emmerson.
WINNIPEG, MAN.
Ashdown Hardware Co., Ltd.
Ackland & Son, Ltd., D.
Great West Electric Co., Ltd.
Miller-Morse Hardware Co.
Wood Vallance Ltd.
MOOSE JAW, SASK.
Canadian Specialty Co.
REGINA, SASK.
Motor Supplies Limited.
CALGARY, ALTA.
Chapin Co., The
Motor Car Supply Co., Limited.
LETHBRIDGE, ALTA.
Western Canada Hardware Co., Ltd.
VANCOUVER, B.C.
Kloepfer Hardware Co., Ltd., The.
VICTORIA, B.C.
Prior & Co., Ltd., E. G.

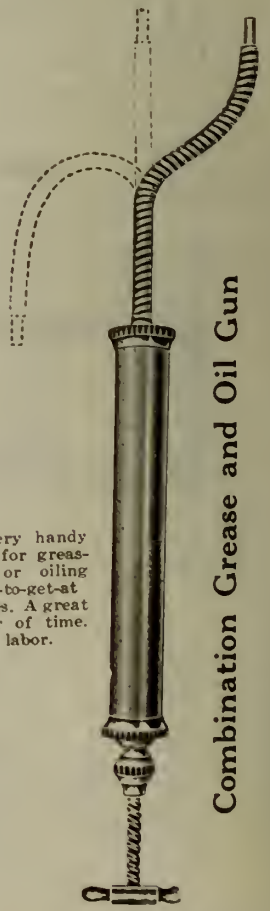
The All-Way Oilers will save you 50 per cent. of your oil bill. Try them.

Capacity:
No. 101-1 pint
No. 102-1 quart
No. 103-½ gal.
No. 104-1 gal.



Combination Filler and Funnel

This filler eliminates the necessity of the use of a separate funnel, as with the flexible spout any part can be readily reached.



Combination Grease and Oil Gun

A very handy tool for greasing or oiling hard-to-get-at places. A great saver of time. And labor.

Manufactured by

The All-Way Oiler Mfg. Co., 196 King Street W. TORONTO, CAN.

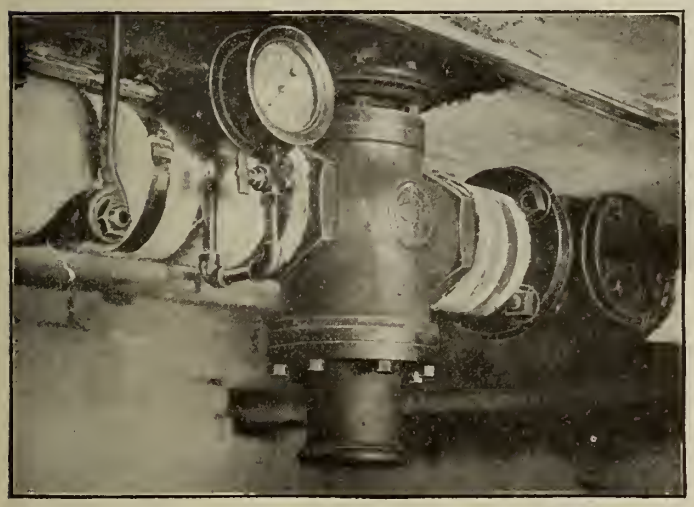
Three Veterans

Here is actual proof of Real Service and Real Value given by

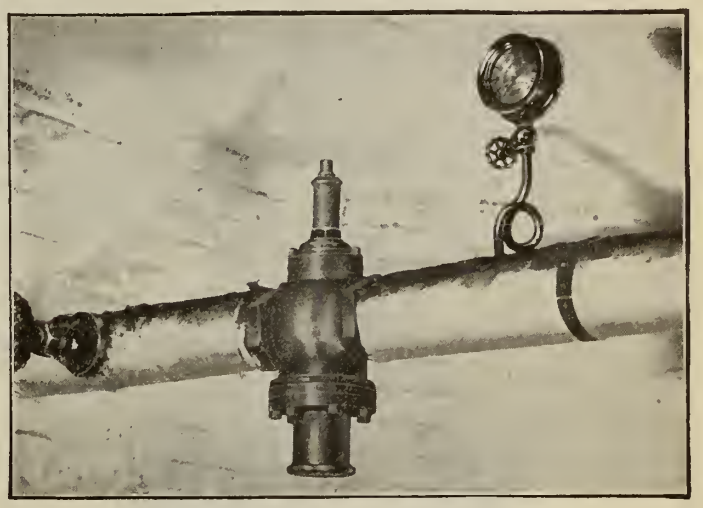
MASON REDUCING VALVES

23 YEARS

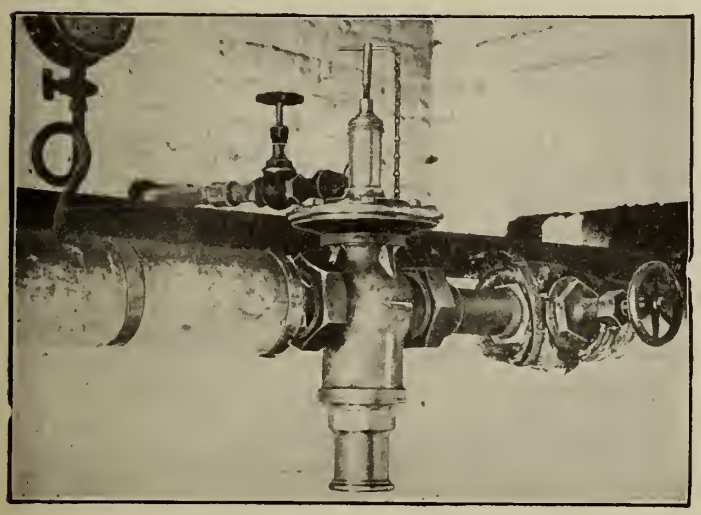
Born in 1896---and "still going strong"



No. 1—3" Mason Standard Reducing Valve.



No. 2—Mason 2½" Standard Reducing Valve.



No. 3—Mason 2" Standard Reducing Valve.

23 YEARS AGO

in November, 1896, two of these valves (Nos. 1 and 2) were installed on the heating system of the Protestant Hospital for Insane, at Verdun, Montreal. No. 3 was installed in 1899.

It was one of the present chief engineer's first jobs. Mr. Thompson found them in the store on his arrival to take charge.

No. 2 and No. 3 have never been taken out of the line. No. 1 was repaired for the first time in September, 1919, requiring new main valve and auxiliary valve.

Such examples are the reason why Mason Valves are **imitated** and **pirated.**

Every dealer and jobber in Canada can supply you with **genuine** Mason Valves.
All genuine Mason Valves are distinguished by the Mason trademark cast on the body.

The Mason Regulator & Engineering Co., Limited

Successor to H. L. PEILER & COMPANY

Toronto Representative:
The Arthur S. Leitch Co.
1002 Kent Building

Montreal Office and Factory
135-153 Dagenais Street

Jenkins Bros.

Type "K" Brass Gate Valves

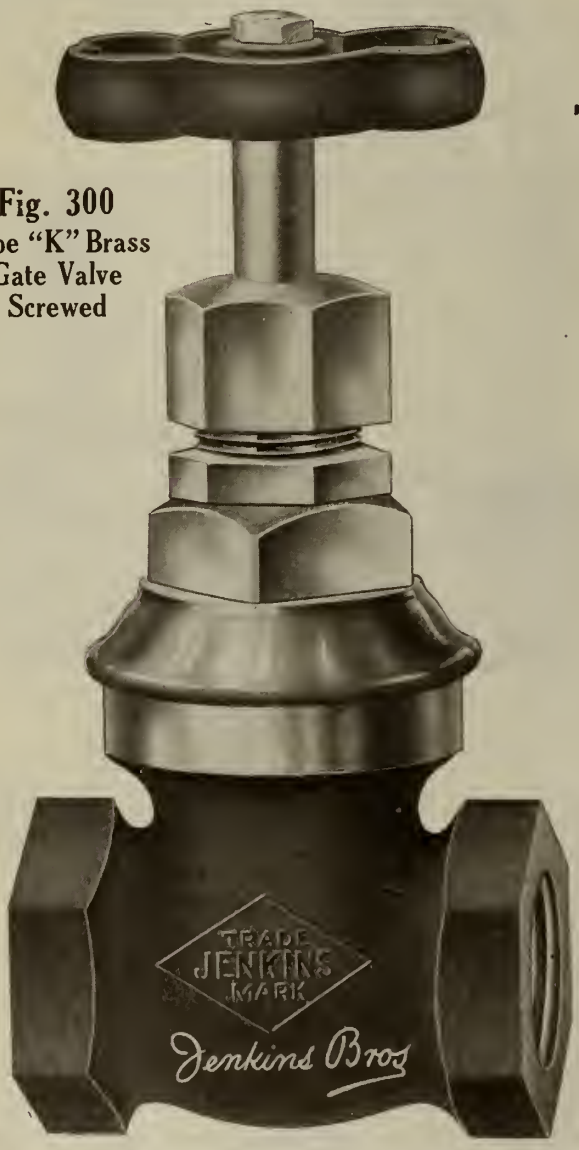


Fig. 300
Type "K" Brass Gate Valve Screwed

PARTICULAR attention is paid to every detail in the manufacture of Jenkins Bros.' Type "K" Brass Gate Valves.

Before they are delivered for shipment every valve is carefully inspected and thoroughly tested under working conditions by steam and hydraulic pressure.

Type "K" Brass Gate Valves carry the well-known JENKINS BROS.' guarantee of *Service* and *Satisfaction*. You can tell genuine Type "K" Gate Valves by the Diamond Trade Mark—always look for it.

Your dealer will supply you. Catalogue No. 8 sent free on request.

TRADE JENKINS MARK Jenkins Bros

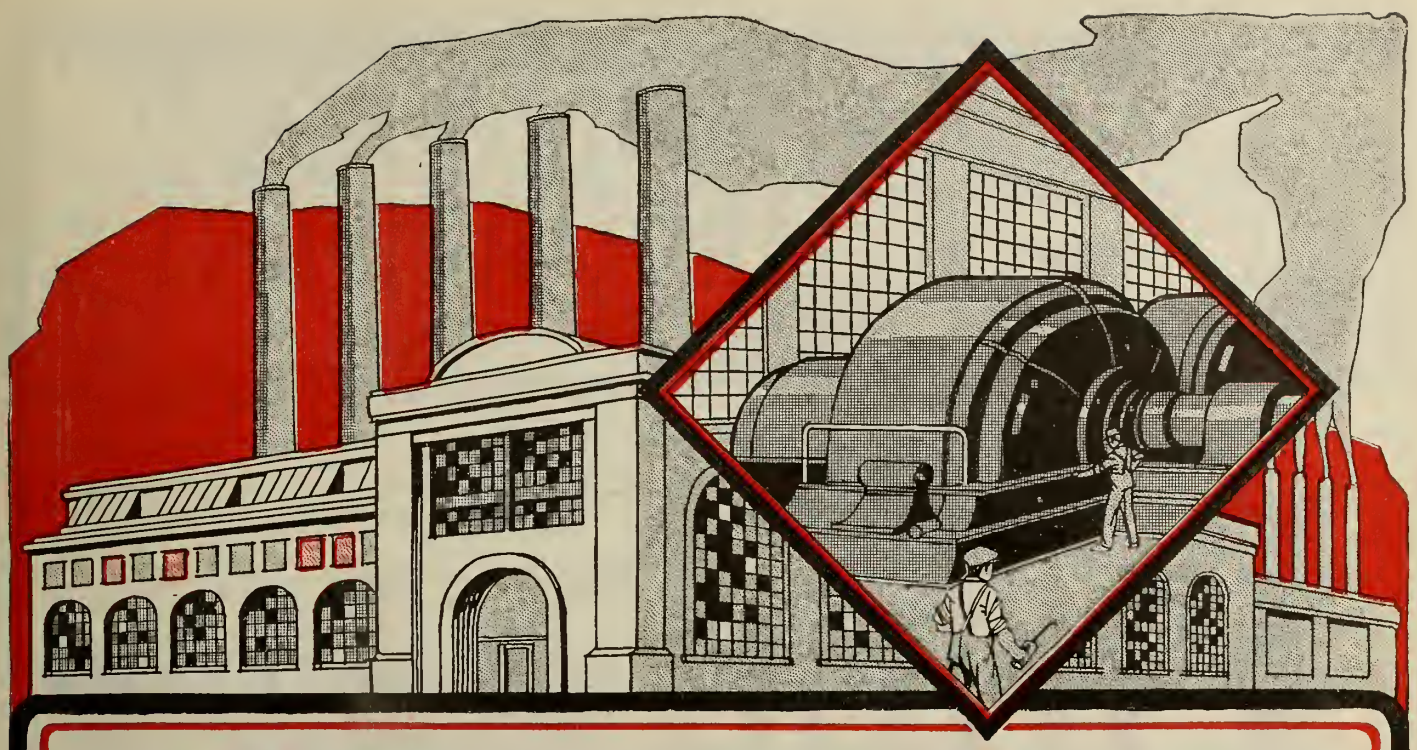
Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway London, W.C. 2, England

TRADE JENKINS MARK Jenkins Bros



IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine Oil
Imperial Ario Compressor Oil

Steady, Dependable Power

INDUSTRIAL success is based on power—steady, dependable power. Every mechanical unit in your plant—engines, dynamos and machines—must give 100% efficiency and therefore must be carefully and properly lubricated with lubricants of correct body.

When choosing your lubricants, you cannot afford to consider any factor other than quality. Good lubricants, like those in the Imperial line, are always most economical. They cost less per lubricating hour because they last longer; they do not wear or burn out as do poor lubricants.

Imperial Lubricants are right. They never vary in quality and will give you continuous satisfaction and better dollar-for-dollar value. They are made only from the best crudes obtainable and are as perfect as science and experience can make them.

Look over the list on the left. Among those lubricants you will find the right lubricant for every moving part of every machine in your plant. Their use will enable your plant to give steady, dependable power under every service condition.

We invite you to consult with our Lubrication Engineers. Their advice or assistance is yours for the asking. Address us at 56 Church Street, Toronto, or at any of our branches.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

LINDE

Sets the Standard for

REFRIGERATING AND ICE MAKING MACHINERY

100 ton Linde Refrigerating Plant in Operation.

Makers of Quality Machinery in Canada Since 1895.

Linde Refrigerating Machinery is Made for all Refrigerating Purposes and Will Meet Your Requirements

in

Economy, Efficiency and Service!

Strength, excess loading capacity, simplicity of operation are features of LINDE equipment. If LINDE equipment costs you a little more to install, it costs you a good deal less to operate and maintain. **This is true economy.** LINDE Machines can always be depended upon for a long period of efficient, economical service. **Full data on request.**

The Linde Canadian Refrigeration Co., Limited

37 St. Peter Street, MONTREAL

TORONTO **WINNIPEG** **VANCOUVER**

Every Part of Every FRICK INSTALLATION Must Be Perfect in order to maintain

FRICK SUPERIORITY

That is why Frick Refrigerating and Ice Making Equipment proves a profitable investment wherever installed.

The entire Frick line, from the smallest to the largest plant, from the smallest part to the largest part in each plant, is designed to meet our strict standard of Durability—Efficiency—Economy. Every part must be perfect in order to maintain the well-known FRICK Superiority.

Therefore, when you purchase FRICK Equipment you are assured of perfect service regardless of the unforeseen overload demand that might be placed on it sometime—assured of continued operation without danger of breakdowns in the midst of a busy season—assured of economical operation at all times—and a long life. Frick Equipment has been standing up under the above conditions for nearly a half-century, day after day, year after year, under the most severe conditions.

You can't go wrong when you specify "Frick Equipment." **Catalog on request.**

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

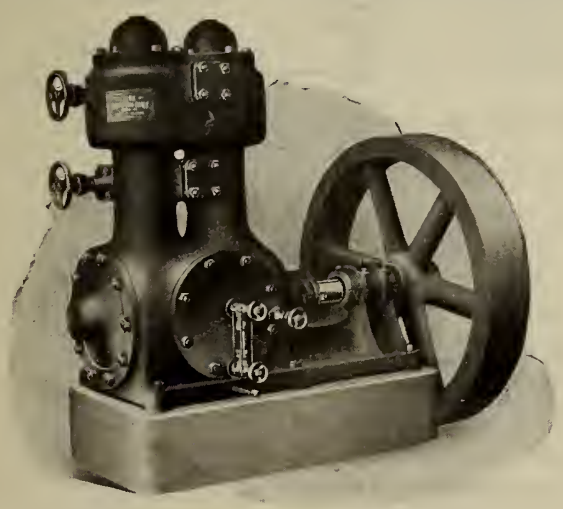
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1862
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

York Refrigerating Machinery

QUALITY—SERVICE



From the very beginning we have been building **quality** and **service** into our Refrigerating Machines. This has resulted in increasing sales of our products and increasing satisfaction on the part of our customers.

With a York Refrigerating Plant you can improve the quality of **your** product as well as the measure of service **you** render to your trade.

Any firm that installs a Refrigerating Plant is looked upon by the trade it serves as a progressive firm. Give MECHANICAL REFRIGERATION a chance. In these days of keen competition it is the progressive owner who survives and profits.

Write us for information and prices.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY

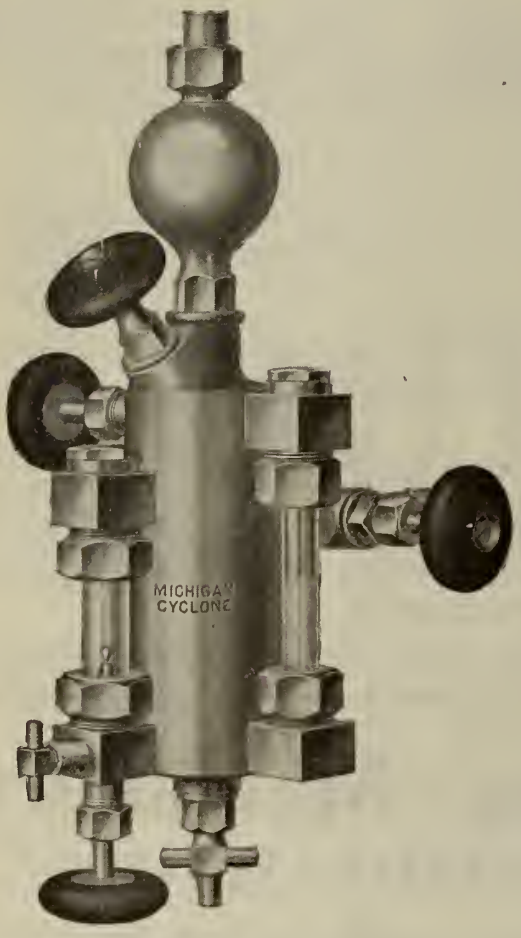
YORK, PA.

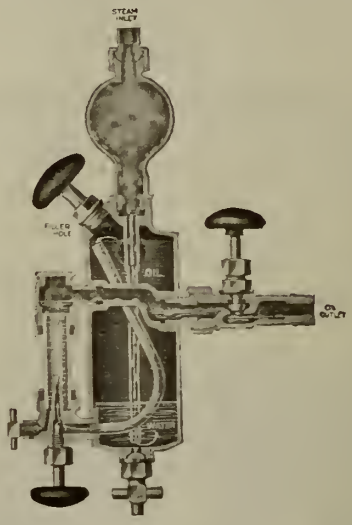
Canadian Representatives:

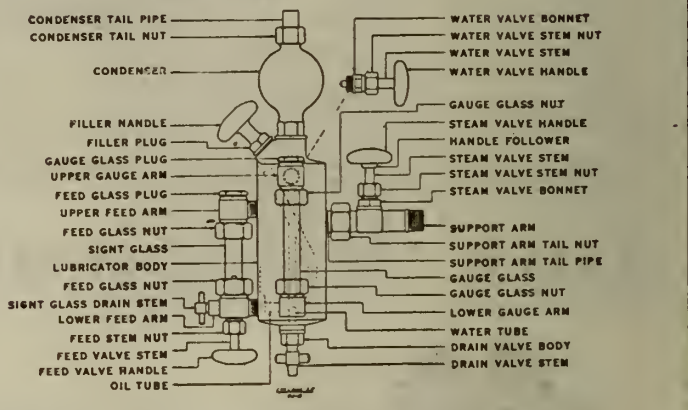
Canadian Ice Machine Company

WINNIPEG, 85 Lombard S TORONTO, 82 Chestnut St. MONTREAL, 324 Craig St. West CALGARY, 605 Second St.

MICHIGAN
Cyclone Lubricators







The Michigan Cyclone Lubricator Keeps the Oil Warm

The distinctive feature of the Michigan Cyclone Lubricator is the large heating channel or caliduct which passes through the body from the support arm to the upper sight feed arm. This cored passage is a part of the original casting and in addition to its function as a heating chamber, it serves to strengthen the construction by binding and bracing the walls of the body. It will also be noticed that the main portion of this passage-way is considerably higher than the point of steam supply, thus making it self-draining and insuring that this heating chamber is always filled with live steam.

As the internal tube which delivers the oil to the lower sight feed arm rises within the body nearly as high as the filler opening, it will be seen that the oil is always fed from the upper portion of the body. In the Michigan Cyclone Lubricator the oil in the upper portion of the body is always kept in a heated and thoroughly liquid condition, by reason of this large, well designed, self draining heating chamber. Our Lubricators will, therefore, feed the heaviest oil freely and regularly, even in very cold weather.

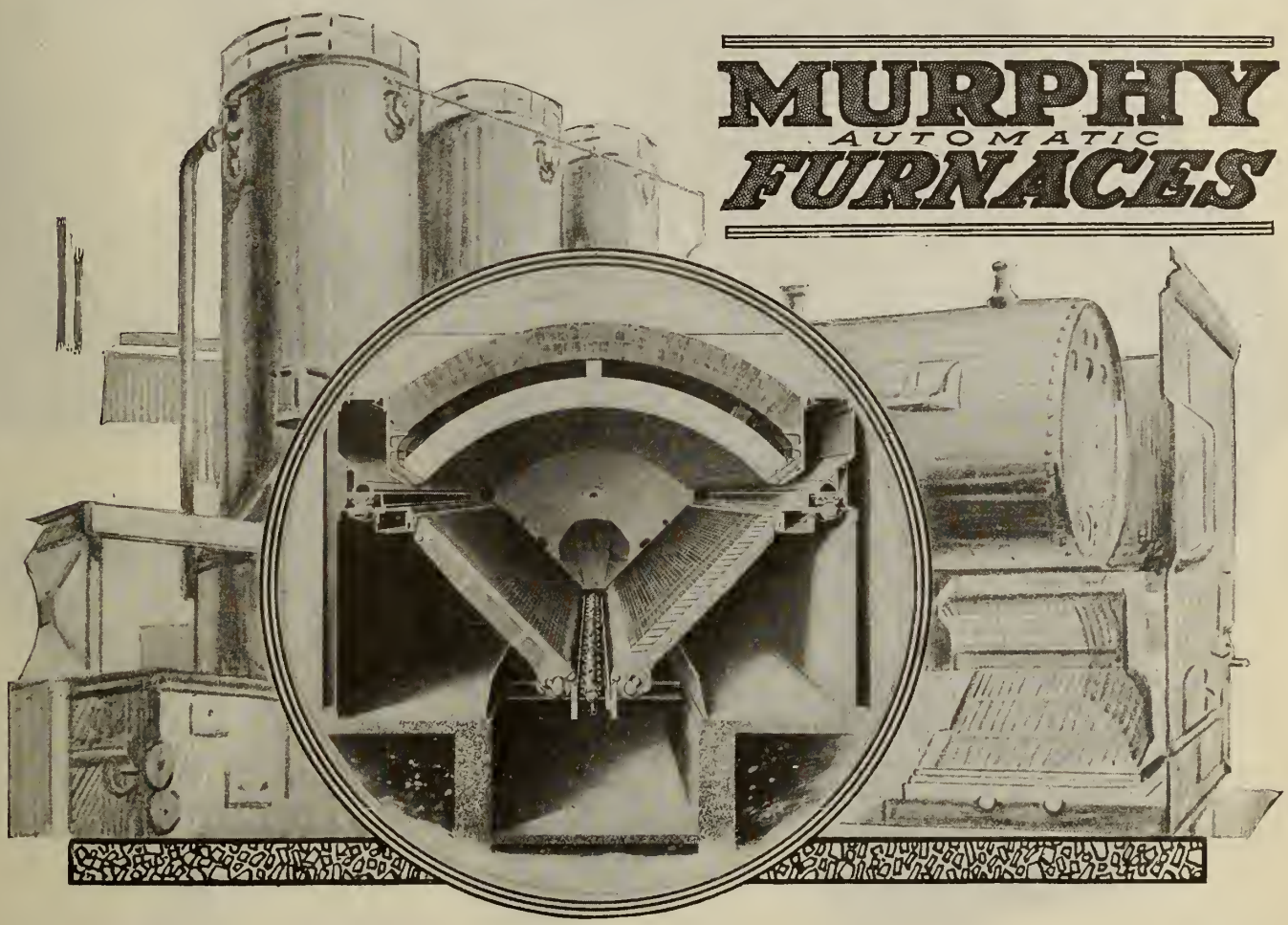
Manufactured by

Michigan Lubricator Co.

Detroit, Mich.

SOLD BY LEADING JOBBERS EVERYWHERE

For any type of Boiler



Any boiler from 50 H.P. and up can be equipped with the Murphy Furnace. The smaller plant can therefore enjoy all the economical advantages of the larger plant without resorting to forced draft.

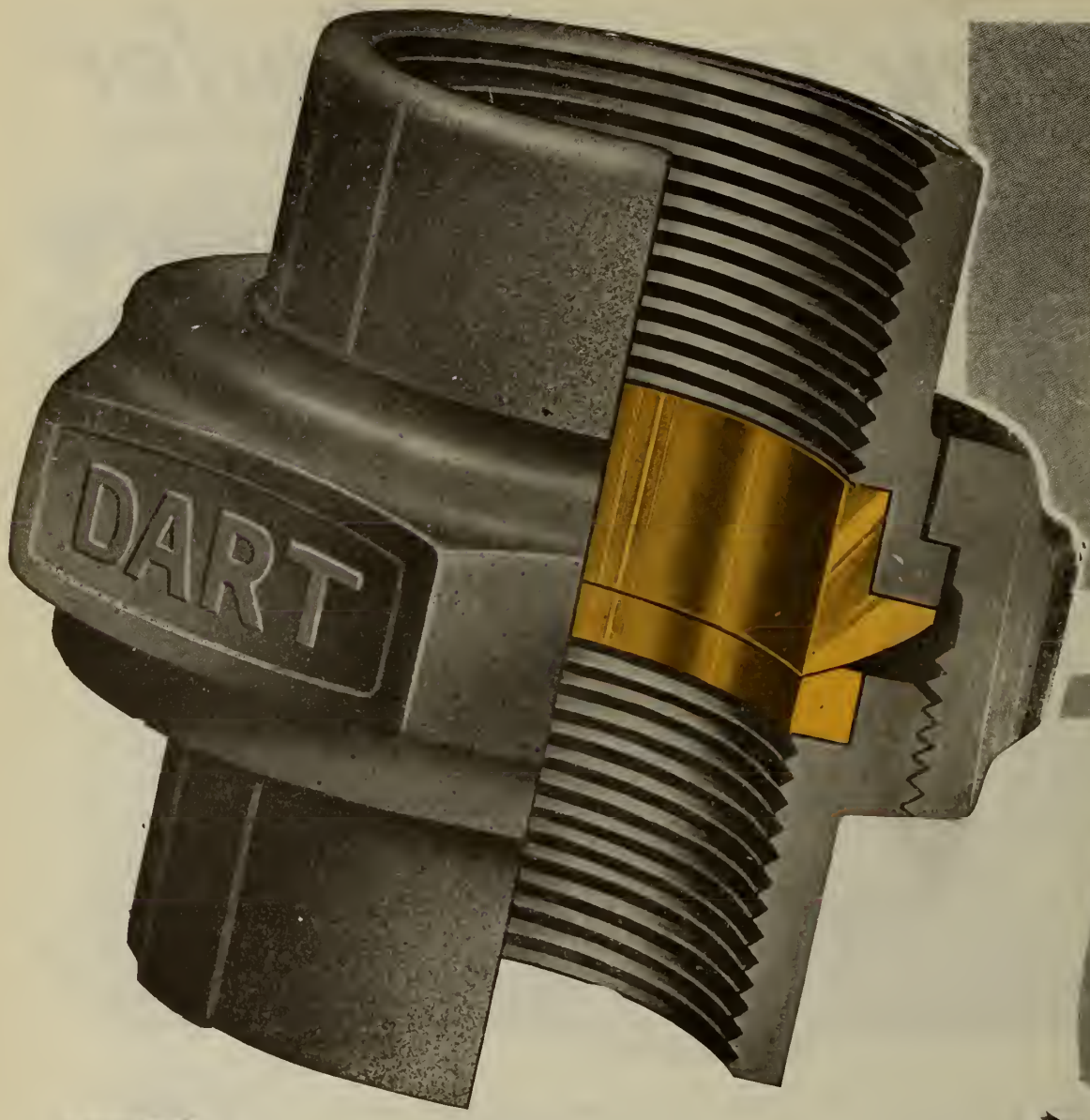
The money you save on auxiliary equipment goes far toward paying for an installation of Murphy Furnaces.

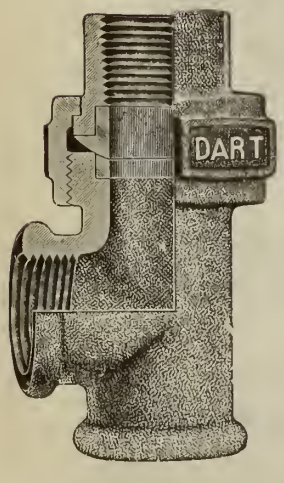
Couple Natural Draft with Murphy ability to *burn any fuel that has heat in it* and you have a simple explanation of Murphy economy in hundreds—yes, thousands of plants.

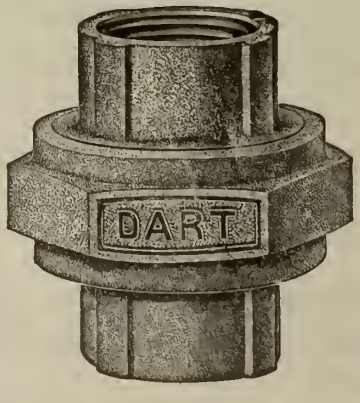
If your boilers are 50 H.P. or larger you should write us. Catalog HM-10 places you under no obligation. Send for copy and see how easily the Murphy Furnace can be installed under any type of boiler.

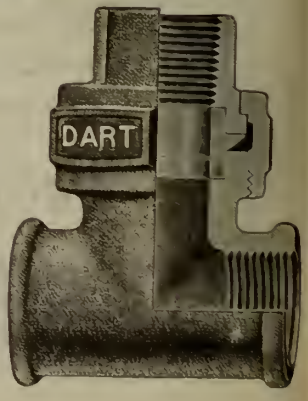
MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT









The Joint is

Bronze to Bronze

Both Face and Seat

DART

Union Pipe Couplings

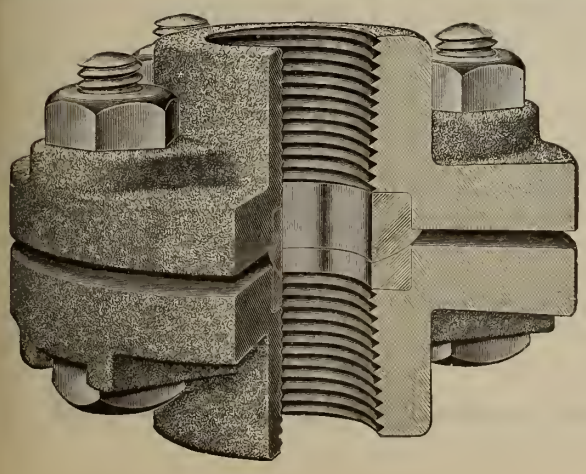
Trouble-Proof and Economical.

The Bronze Face and Seat last indefinitely — There is no rusting or corroding at the Joint, no deterioration.

The Heavy Iron Parts will not stretch or pull apart. Never Scrap Dart Unions. Use again.

YOUR JOBBER HAS THEM.

Manufactured by Dart Union Company Limited, Toronto, Canada



STAY TIGHT *Permanently*

THE KEY TO SUCCESS

EXPERT KNOWLEDGE

OF THE PROCESS OF COMBUSTION AND BOILER ROOM MANAGEMENT is absolutely essential for success in the power plant engineering field today. The man that the big fellows are looking for is the man who, first of all, can utilize the last heat unit in the coal he burns under his boilers.

The Hays School of Combustion has provided the means by which this expert knowledge can be easily acquired by any one who will spend a few hours of his spare time to master the simple, interesting and easily understood lessons provided. The correspondence method of instruction is used, which permits any man to proceed according to the time available and his previous study of the subject. It teaches you all about the most up-to-date practice, all about fuels and how to obtain combustion efficiency, and all about boilers and furnaces and how to operate them economically. Every essential detail is supplied in this course, and in such a manner that you will find it more interesting than your favorite novel.

GREATER REWARDS

ARE WITHIN THE REACH OF THE COMPETENT COMBUSTION ENGINEER at the present time than in any other line of endeavor connected with the power plant field. Men who can select the proper kind of coal for each particular plant and condition, determine how it can be most efficiently burned, and, in the final analysis, **GET RESULTS**, with a minimum expenditure for fuel, are the fellows for whom the demand is, and will be, unlimited. If you want to be listed with the top-liners, this is your opportunity.

For the fireman, steam engineer, master mechanic or technical man, or for the young man seeking a lucrative calling, the sure job and the big pay, with all the accompanying advantages, there is no field so ripe—where the prospect of rapid advancement and quick returns is so promising. Employers are seeking greater efficiency in the operation, equipment and supervision of power plants. They want better trained men in the plants and more combustion engineers for consulting and construction work, giving opportunity for every grade of ability. If you have the foresight and ambition to train yourself, the opportunity is yours.

The course is written and arranged by Jos. W. Hays himself—in his well-known interesting and effective way of conveying the desired information. There is not a dull or uninteresting line in the whole course. The practical value of the course is unquestionably assured by the staff of Advisory and Reviewing Editors given below.

Josepb Harrington David Moffat Myers

Fred R. Low

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The cost is nominal—Payments may be divided up to suit your circumstances—Success is assured—Fill out the coupon and get in the BIG PAY Class.

Hays School of Combustion

STATE-LAKE BUILDING

Chicago, Illinois

CUT OUT AND MAIL

Hay's School of Combustion,
State-Lake Bldg.,
Chicago, Ill.

I am interested in the study of Combustion efficiency and would like a free copy of your prospectus.

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St. and No. .....

City ....State .....

Position .....

Company .....Date .....

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The A·R·WILLIAMS MACHINERY Company Limited

ST. JOHN, N.B. TORONTO, ONT. WINNIPEG VANCOUVER

Canada's Leading Machinery House

Are You An Engineer?

One of the most prominent Engineering Authorities once wrote: "A very important part of an Engineer's training is to know:

WHERE to Find
WHAT He Wants
WHEN He Wants It."

Do *YOU* know *WHERE* to get *WHAT* you want?

Do *YOU* know that *"WILLIAMS"* have *IN STOCK STEAM ENGINES, all sizes,* 1 to 1000 horse power?

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Do *YOU* know that "Williams" have *IN STOCK MOTORS AND GENERATORS,* 1-4 h.p. to 200 h.p.?

Do *YOU* know that "Williams" have *"IN STOCK" A SERVICE DEPARTMENT* giving competent, unbiased engineering advice?

Do *YOU* know that "Williams" have *"IN STOCK"* The largest line of *POWER PLANT SUPPLIES* in Canada?

Now we've told you *WHERE* to get it. Won't you tell us *WHAT* you want?

WRITE OR PHONE POWER PLANT DEPARTMENT

THE A. R. WILLIAMS MACHINERY CO., LIMITED

TORONTO CANADA

THE A. R. WILLIAMS MACHINERY CO. LTD
64 FRONT ST., W. TORONTO, ONT.
SALES SUPPLY DEPARTMENT SERVICE

A SHORT CUT TO
PROMPT AND SATISFACTORY SERVICE

WE carry the largest stock of power plant supplies in Canada, and it is not necessary for our customers to distribute their buying all over the country, thereby piling up large freight costs.

CONCENTRATED BUYING IS AN ULTIMATE GAIN

BECAUSE we handle all the well-known lines of POWER HOUSE Equipment through our supply Department Sales Service and can save you dollars.

HERE is part of our extensive list of power house supplies:—

Jenkins & Penberthy Valves.
Penberthy Injectors and Oil Cups.
Rainbow Sheet Packing.
Spiral Hydraulic and Flax Packings.
Pipe and Pipe Fittings.
Empire and Anderson Steam Traps.
Chain Tongs and Stillson Wrenches.
Oster and Jardine Stocks and Dies.
American Steel Split Pulleys.
Hyatt Roller Bearings.
Reeves' Wood Split Pulleys.
"Victor Special" Balata Belting.
Extra, Single and Double Leather Belting.
Hangers, Couplings, Collars.
Wright and Harrington Chain Blocks.

Phone, Write or Wire Your Orders—Immediate attention.

THE A. R. WILLIAMS MACHINERY CO., LIMITED
Toronto, Halifax, Montreal, St. Johns, Winnipeg Vancouver.

AMERICAN STEEL SPLIT PULLEYS

THE A. R. WILLIAMS MACHINERY CO. LTD

64 FRONT ST. W. TORONTO, ONT.

SALES SUPPLY DEPARTMENT SERVICE

For Power Transmission, Conveying and Elevating

"VICTOR SPECIAL"
BALATA BELTING

STRONGEST BELT IN THE WORLD

Waterpoof, Flexible, Durable, Tractive, Adaptable, Straight

FACTORY: EASTON, PA.

VICTOR BALATA AND TEXTILE BELTING CO.

NEW YORK, N.Y. 38 Murray St. | BOSTON, MASS. 87 High St. | CINCINNATI, O. 212 E. 2nd St. | CHICAGO, ILL. 167 N. Market St.

All belting is manufactured under our own supervision and in our own factories, from the raw cotton to finished product.

We manufacture also: Canvas Stitched Belting, Solid Woven Cotton Belting, Balata Valves for Cold Water Pumps

A BIG SAVING OVER THE COST OF LEATHER AND BETTER RESULTS

Stocks carried by our Canadian Agents

THE A. R. WILLIAMS MACHINERY CO.
LIMITED

TORONTO, ONT., MONTREAL, P.Q., WINNIPEG, MAN., VANCOUVER, B.C., ST. JOHN, N.B., HALIFAX, N.S.

THE A. R. WILLIAMS MACHINERY CO. LTD
64 FRONT ST., W. TORONTO, ONT.
SALES SUPPLY DEPARTMENT SERVICE

A Good Foundation For Your Choice

Are these fittings installed in your plant?

THE EMPIRE STEAM TRAP is made by The American District Steam Co., as are also the other fittings on this page. These traps are strictly a low pressure trap. The seamless electro-plated copper floats used are all tested to a pressure of 150 lbs. The trap has two inlets; one on either side, making it convenient for any piping arrangement. The automatic air valve operates by expansion, thereby preventing an air pocket.

DOUBLE EXPANSION JOINT

Expansion Joints for any Traverse and Pressure

THIS improved type of double expansion joint is especially suitable for underground steam pipe lines and is usually furnished with service or lateral opening and with anchorage as shown in the illustration. If desired, joints are furnished without anchorage, or service openings. All joints are thoroughly packed ready for use before shipment. Companion flanges, bolts and gaskets extra.

THE ST. JOHN STEAM METER

THIS meter indicates the amount of steam passing through it at any time and records on paper chart the amount of steam that has passed through during any given time. Made in sizes from 1 inch to 6 inches inclusive and for any pressure from 10 to 250 lbs. and superheat.

STEAM PIPE CASING

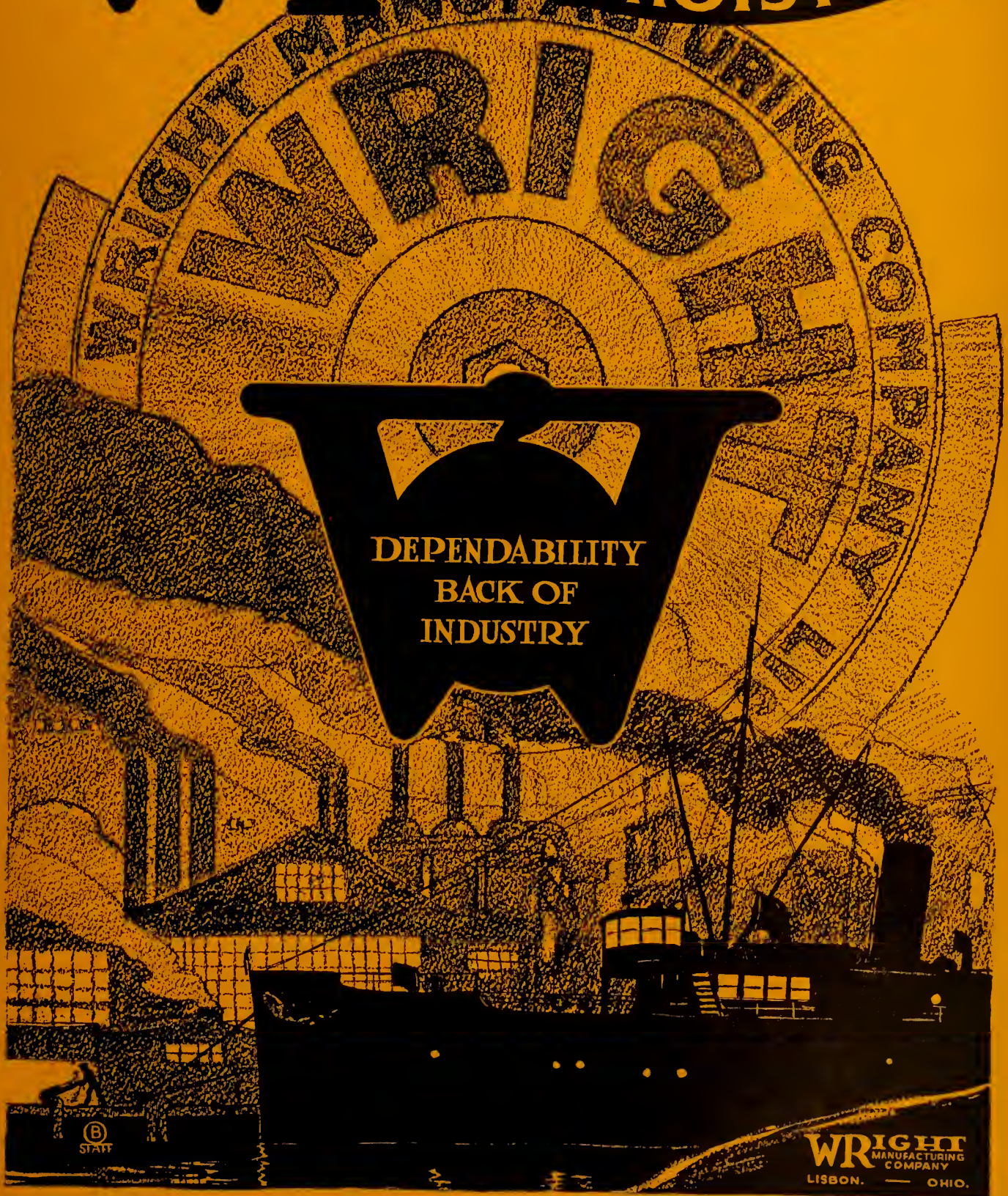
This Standard steam pipe casing is made from sound, thoroughly kiln-dried white pine, or cedar staves bound together with steel wire. Sections do not exceed 7½ ft. in length and are joined by means of mortise and tenon. Each section is given a thorough coating of pitch and sawdust, and the casing is lined with AAAA charcoal tin plate.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.

Canadian Representatives:

The A. R. WILLIAMS MACHINERY CO., Limited
Toronto, Halifax, Montreal, St. Johns, Winnipeg, Vancouver
PHONE OR WRITE SUPPLY DEPARTMENT

WRIGHT HOIST



Canadian Distributors: THE A. R. WILLIAMS MACHINERY COMPANY, Limited

THE A. R. WILLIAMS MACHINERY CO. LTD

64 FRONT ST., W. TORONTO, ONT.

SALES SUPPLY DEPARTMENT SERVICE

Class B. Fig. 33

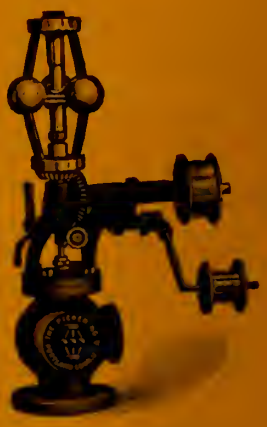
PICKERING GOVERNORS

with patented

BALL RANGER SPEED CHANGER

Greatest in Efficiency and Durability because jointless construction, reducing friction to a minimum.

Pickering principle insures closer regulation and widest range in adjustment of engine speed secured through our patented Ball Ranger.



Class A. Fig. 34

SOLE BUILDERS

The Pickering Governor Co. - Portland, Conn., U.S.A.

CANADIAN AGENTS

The A. R. Williams Machinery Co., Limited

TORONTO HALIFAX MONTREAL ST. JOHNS WINNIPEG VANCOUVER

AMERICAN-MARSH PUMPS

SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanics' Supply Co., Quebec, Que. Gorman, Claney & Grindley, Limited, Edmonton and Calgary.

JEFFREY EQUIPMENT

For Handling and Crushing Coal

In All Sizes of Power Plants

JEFFREY PIVOTED BUCKET CARRIERS
for large and medium sized plants. Built in Standard sizes to handle from 30 to 160 tons per hour. Catalog 210-2.

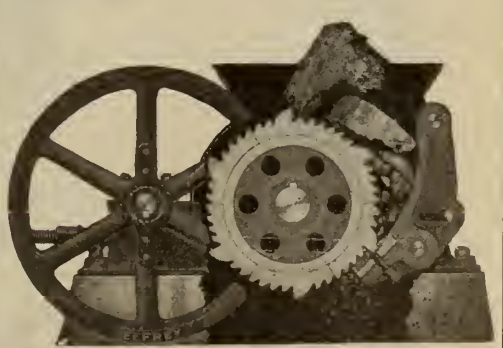
Pivoted Bucket Carriers
V-Bucket Conveyers
Scraper Conveyers
Belt and Apron Conveyers
Bucket Elevators
Coal Crushers
Truck and Wagon Loaders
Weigh Hoppers—Valves—Spouts, etc.
Chains, Sprockets, etc., for all elevating and conveying purposes.

Write for Catalogs.

Producer House equipment in Glass Plant showing **Jeffrey Bucket Elevator**, which carries coal from Jeffrey Crusher and distributes by chutes to bunkers. Catalog 244-2.

Showing track Hopper used in connection with Plate Feeder and Apron Conveyer, which feeds the Elevator. Catalog 258-2.

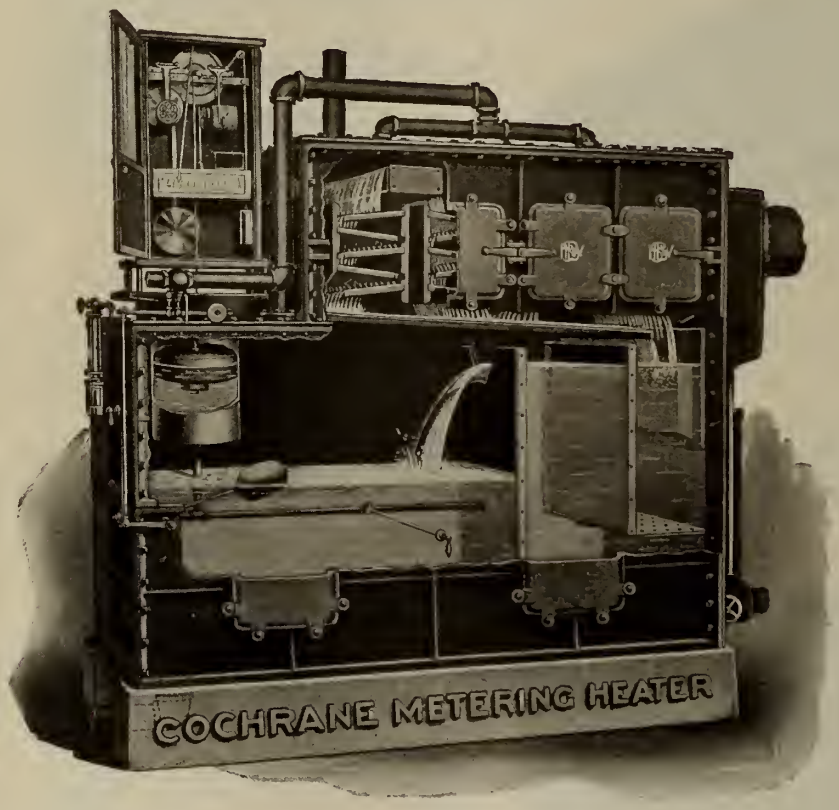
The Jeffrey Mfg. Co.
Canadian Branch and Warerooms
MONTREAL



JEFFREY SINGLE ROLL COAL CRUSHER
One operation reduces Lump or Run-of-Mine Coal to the proper size for maximum stoker efficiency.

Write for Catalog No. 141-2.

Finding and Stopping Waste in Modern Boiler Rooms



KEEPING BOOKS WITH THE BOILER

How many pounds of water are your boilers evaporating per pound of coal?

Are they doing 6 or 7 pounds, or just a shade better, or are they up to the top notch, say 10 or 11 pounds of water evaporated per pound of combustible?

The Cochrane Metering Heater tells how much you are getting for your money

Send for Catalogue No. 820

Other Cochrane aids to boiler room economy include open feed water heaters, steam stack and cut-out valve heaters and receivers, metering heaters, and independent meters. Sorge-Cochrane hot process water softeners, steam and oil separators, and multiport back pressure, atmospheric relief, flow and check valves.

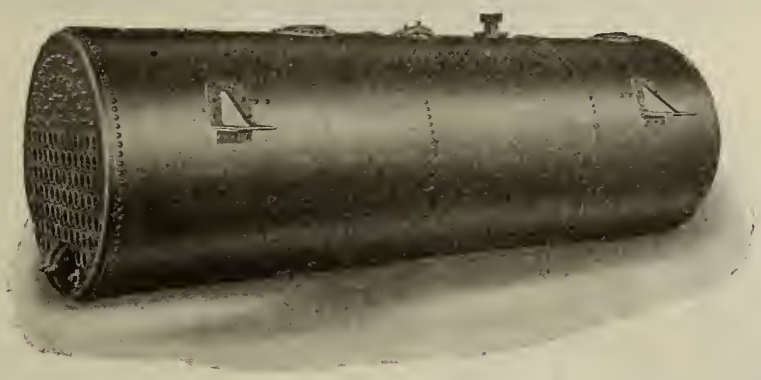
Power Plant Equipment, Mining, Crushing, Hydraulic and Milling Machinery, Contractors' Plant and Architectural Bronze and Iron Work

CANADIAN ALLIS-CHALMERS LIMITED

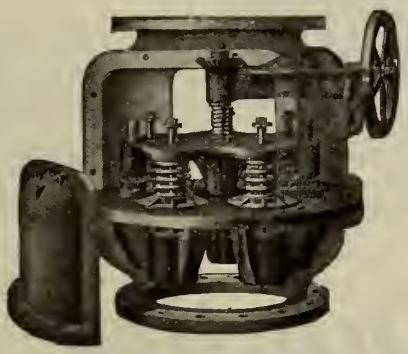
Head Office: TORONTO

Branch Offices: Montreal, Quebec, Halifax, Sydney, St John, Ottawa, Hamilton, London, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Nelson, Vancouver and Victoria

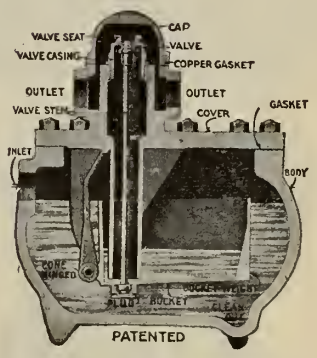
Reliable Power Plant Equipment



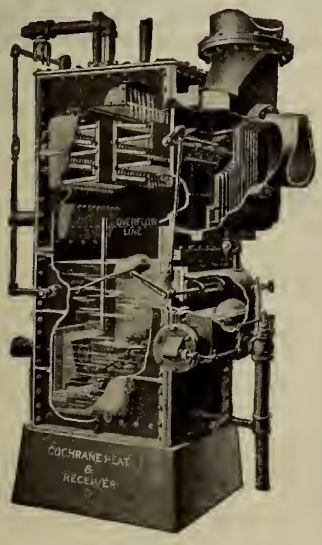
Manufacturers of Water Tube, Horizontal Return Tubular and Locomotive Type Boilers



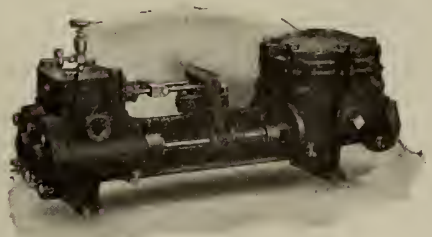
Multiport Back Pressure Relief Valve



Squires Steam Traps



Cochrane Feed Water Heaters and Metering Tanks



Boiler Feed, Underwriter Fire, Turbine, and Centrifugal Pumps

Cochrane Steam & Oil Separators

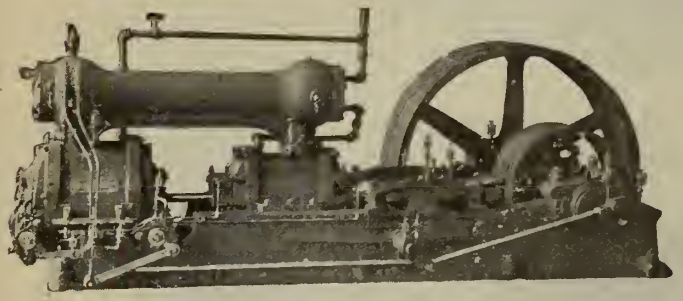
CANADIAN ALLIS-CHALMERS

Head Office: TORONTO LIMITED

Branch Offices: Montreal, Quebec, Halifax, Sydney, St. John, Ottawa, Hamilton, London, Cobalt, South Porcupine, Winnipeg, Calgary, Edmonton, Nelson, Vancouver and Victoria

NORWALK
AIR & GAS · COMPRESSORS

For Reliability



100-lb. Air Compressor

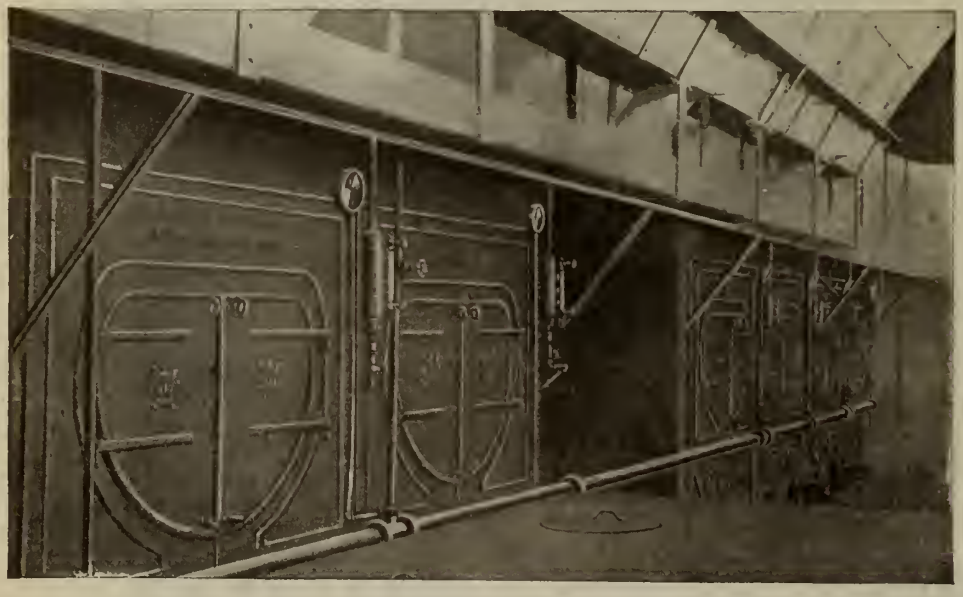
THE first essential in a compressor is utmost reliability. This is the uppermost thought in the mind of every buyer—and for forty years the uppermost thought in the construction of every Norwalk.

There's an illustrated bulletin for each branch—air, oxygen, hydrogen, acetylene gas and carbonic acid gas. Write for one or all.

THE NORWALK IRON WORKS CO.
Pioneer Builders of Compressors
SOUTH NORWALK, CONN.

ANY·CAPACITY ANY·PRESSURE

High Quality Boilers



We make all types for all duties.

Our facilities are complete.

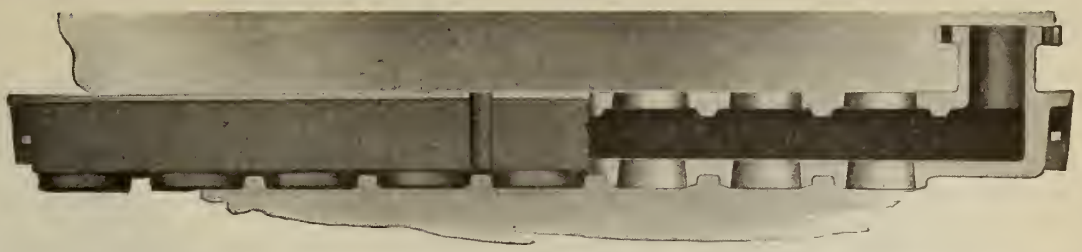
Our shop practice is strictly up-to-date.

Cut shows one of our typical installations.

Engineering & Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

Article No. 3

Top Headers



are constructed with tapered sockets to receive the tapered ends of the tubes. Directly above the sockets are hand holes used for inspecting, cleaning or removing damaged tubes. These hand holes are closed by internal lids, the construction of which is shown in right hand cut. The lids are passed inside the header, through a master lid hole and drawn into place by means of a yoke and key-bolt. They are then held in place by friction and by the water pressure inside the economizer.

The top headers are extended as shown so that the end tube may be cleaned or removed without disconnecting the branch pipe.

GREEN'S ECONOMISER, LIMITED.
TORONTO

Why Lay Up Fire Brick Again —And have the same trouble year in and year out?

The ordinary brick lining with its joints gives way under the varying furnace temperatures, crumbles and falls down. With Betson's Plastic Fire Brick you can practically eliminate this maintenance of brick work.

BETSON'S REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF

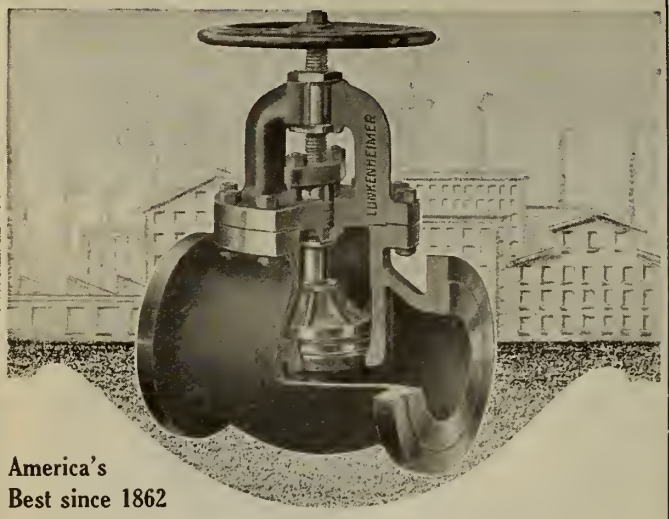
is the pioneer and tried boiler refractory material, and has twenty years of practical experience behind it. Betson's takes up expansion and contraction internally. It is easy to lay up. It forms a monolithic lining without joints and there is nothing to work loose or fall down. It can be used for the entire boiler—furnace, door arches, rear arches, baffles, bridge walls, etc.

Let us quote you on Betson's Plastic Fire Brick for your boiler needs. Or send for our practical booklet to-day.

Canadian Distributor:

International Chemical Company

44-46 Lombard St. Toronto, Canada



America's
Best since 1862

LUNKENHEIMER

Iron Body Bronze Mounted

Globe, Angle and Cross Valves

These valves give lasting satisfaction in service,—a fact vouched for by users everywhere. Their extreme strength and durability, due to high quality materials and correct design, is a source of economy in plant maintenance.

Lunkenheimer "Valve-iron" was formulated especially for valve service; it is close-grained, has high tensile strength and does not contain the excess of impurities common in ordinary grades of cast iron.

The trimmings are made of a high grade bronze, having exceptional wear-resisting qualities.

Constant checking of the mixtures by our laboratory division and careful tests and inspections before and after assembling, maintains the high standard by which Lunkenheimer valves are distinguished.

Specify LUNKENHEIMER and insist on having the genuine. Your local dealer can supply you; if not, write us.

Write for descriptive literature.

THE LUNKENHEIMER CO.
—"QUALITY"—

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, O., U.S.A.
New York Chicago Boston London

13-14-43

Upright Boiler With Extension Shell

We also make

Gas and Gasoline Engines, Tractors, Hoisting Engines, Steel Storage Tanks, Locomotive Boilers, Marine Boilers, Return Tubular Boilers, Pulp Digesters, Grey Iron and other Castings, Grate Bars, etc.

E. LEONARD & SONS

LIMITED

Engine and Boiler Manufacturers

London, Canada

Agencies: MONTREAL, WINNIPEG, ST. JOHN, N.B., CALGARY, TORONTO, VANCOUVER

MAPLE LEAF BRAND Stitched Cotton Duck BELTING

Made in Canada

Sets a standard in economy, strength and durability

It grips the pulley positively and is absolutely true running.

At a recent test Maple Leaf Brand Belting stood a breaking strain 50 per cent. greater than leather and 25 per cent. greater than rubber.

Costs less than leather, rubber or balata belting.

It's the best belting to use whether for transmission of power or conveying purposes.

Trying means convincing.

Write for samples and prices.

MAPLE LEAF BELT DRESSING
The Best for all Kinds of Belts

Dominion Belting Co., Limited

HAMILTON, CANADA

Quebec Branch—51 Duluth Building, Montreal

Republic Flow Meters

It takes fuel to produce steam—steam to produce power—power to produce every finished product. Steam is as worthy of consideration as any raw product—the amount produced is a check on fuel; the amount used is a check on power. Meter the output of boilers and you have a guide to firing and a means of detecting and correcting errors in boiler and settings. Meter the amount of steam consumed by power units and departments and you have a cost record that shows how much fuel goes into the finished product.

Three Main Sources of Fuel

The Indicating Instrument

The Integrating Instrument

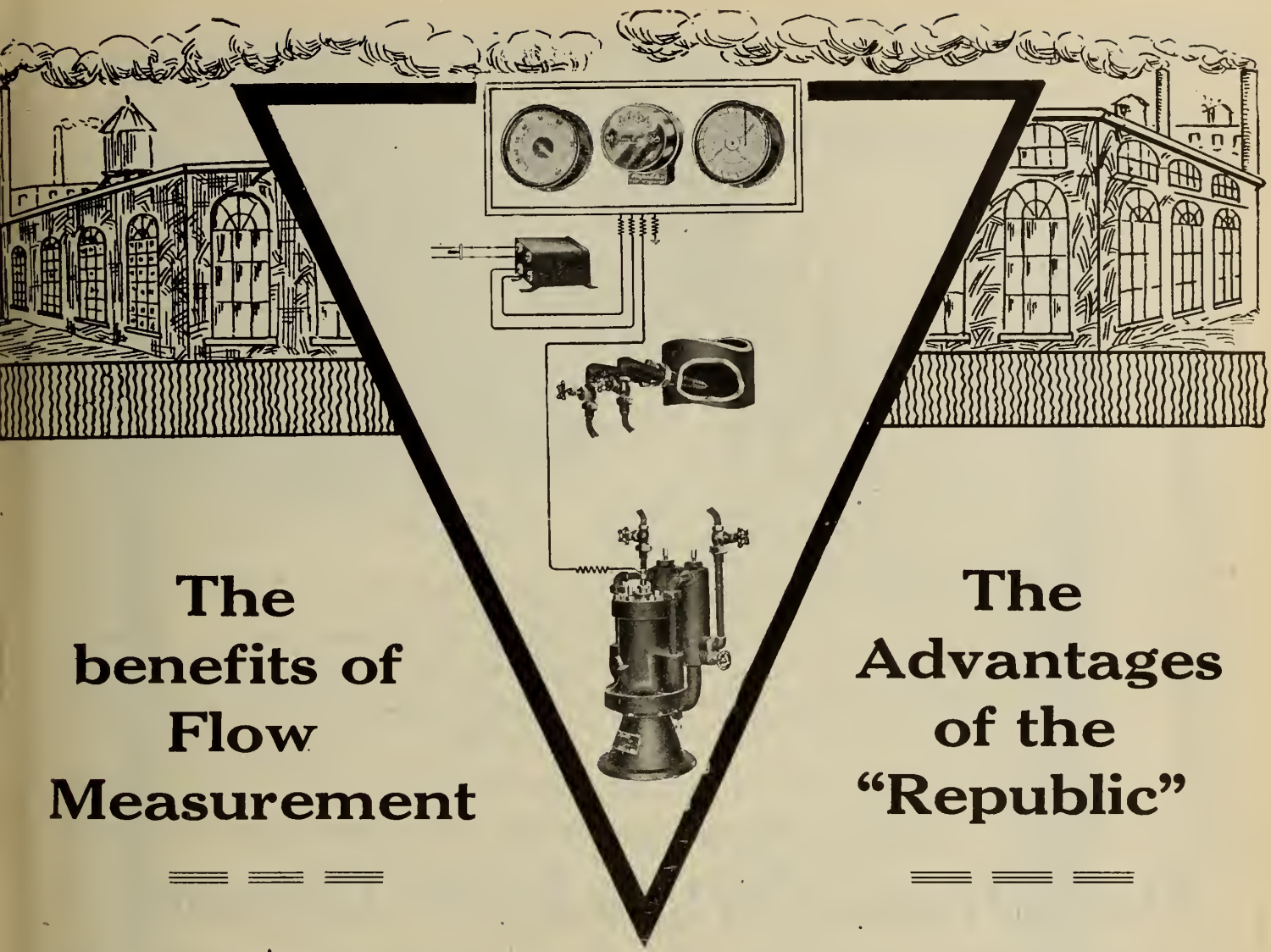
The Recording Instrument

Republic Flow Meters, by combining the known principle of fluid flow with electrical operation—an exclusive feature of the Republic — have made the measurements of steam flow universally practical in plants of every size, presenting every imaginable condition.

The reading instruments of Republic Flow Meters may be located any desired distance from the point of measurement—electrical operation makes this possible and insures greatest accuracy. Therefore, no matter how inaccessible the point of measurement or how many departments are to be metered in the most complicated system, Republic Meters indicate at a convenient, central point the three main conditions that enable you to prevent fuel waste.

Combustion efficiency is indirectly (but none the less effectively) indicated by the constant record of individual boiler output shown on the indicating instrument of the Republic Flow Meter. This Record is a constant guide to the fireman.

Republic Flow Meter Company,



The benefits of Flow Measurement

The Advantages of the "Republic"

Waste and their Prevention

Boiler efficiency is gauged by the graphic record and integrated total of output of individual boilers. Comparison of the records of different boilers is one of the most valuable aids in correcting errors in boilers and in determining the capacity at which highest efficiency with maximum fuel economy is attained. This comparison further permits properly dividing the load between different units.

Power costs are arrived at by consulting the reading instruments connected with meters attached to the steam line. The record of steam consumption by departments is particularly practical with the electrically operated Republic System.

Whether an elaborate system (as outlined above) is necessary in your plant, rests with your plant conditions. We will advise you as to the type of Republic System that will be of greatest value to you.

Investigate!

HAMILTON TRUST BUILDING
57 QUEEN STREET WEST

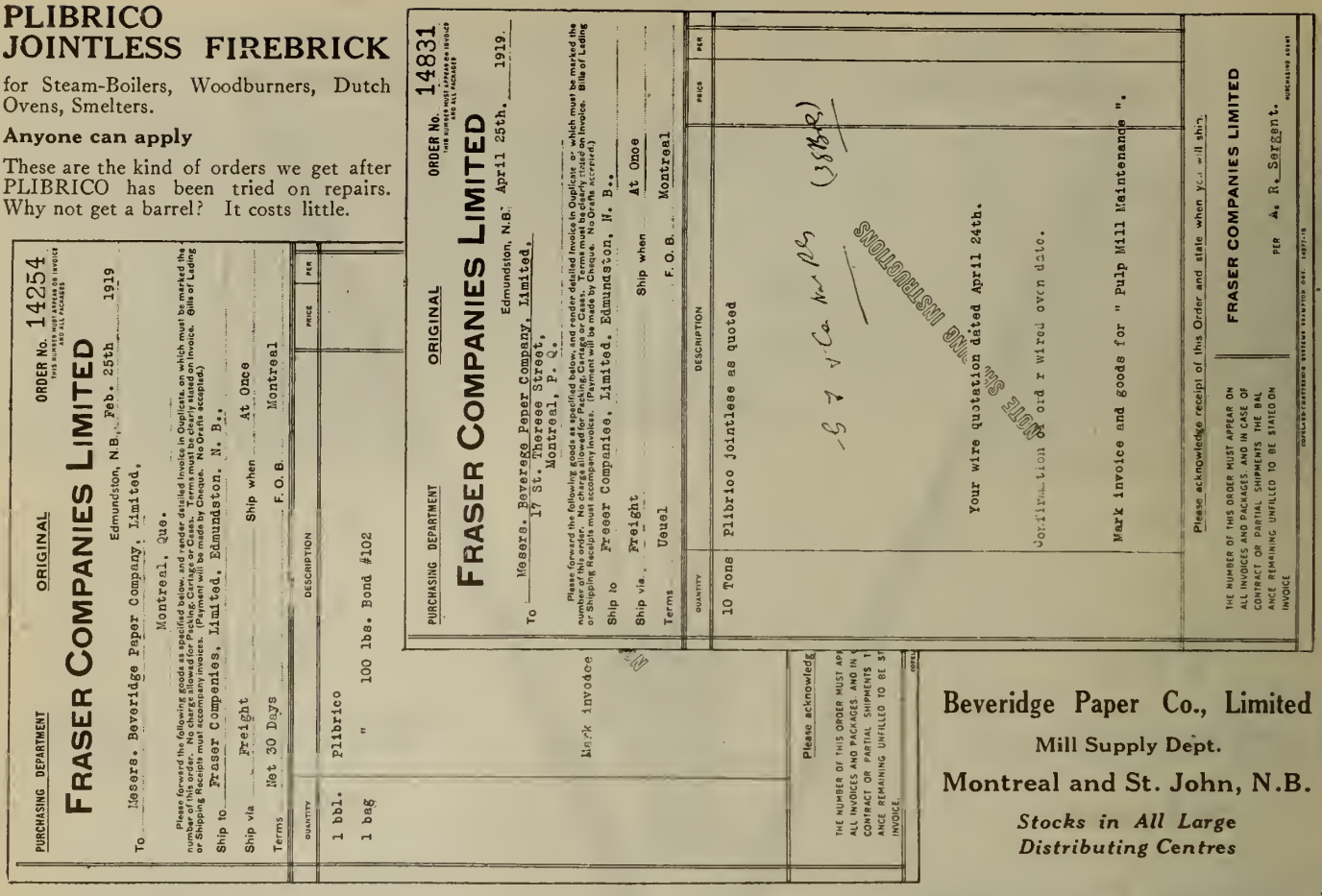
Toronto, Canada

PLIBRICO JOINTLESS FIREBRICK

for Steam-Boilers, Woodburners, Dutch Ovens, Smelters.

Anyone can apply

These are the kind of orders we get after PLIBRICO has been tried on repairs. Why not get a barrel? It costs little.


PURCHASING DEPARTMENT — ORIGINAL — ORDER No. 14254

FRASER COMPANIES LIMITED

Edmundston, N.B., Feb. 25th 1919

To Messrs. Beveridge Paper Company, Limited, Montreal, Que.

Please forward the following goods as specified below, and render detailed invoice in Duplicate, on which must be marked the number of this order. Terms must be clearly stated on invoice. Bills of Lading or Shipping Receipt must accompany invoices. (Payment will be made by Cheque. No Drafts accepted)

Ship to Fraser Companies, Limited, Edmundston. N. B.

Ship via Freight — Ship when At Once

Terms Net 30 Days — F.O.B. Montreal

QUANTITY	DESCRIPTION	PRICE	PER
1 bbl.	Plibrico		
1 bag	" 100 lbs. Bond #102		

Mark invoice

Please acknowledge

THE NUMBER OF THIS ORDER MUST APPEAR ON ALL INVOICES AND PACKAGES. AND IN CASE OF CONTRACT OR PARTIAL SHIPMENTS THE BALANCE REMAINING UNFILLED TO BE STATED ON INVOICE.

PURCHASING DEPARTMENT — ORIGINAL — ORDER No. 14831

FRASER COMPANIES LIMITED

Edmundston, N.B. April 25th, 1919.

To Messrs. Beverage Paper Company, Limited, 17 St. Therese Street, Montreal, P. Q.

Please forward the following goods as specified below, and render detailed invoice in Duplicate, on which must be marked the number of this order. Terms must be clearly stated on invoice. Bills of Lading or Shipping Receipt must accompany invoices. (Payment will be made by Cheque. No Drafts accepted)

Ship to Fraser Companies, Limited, Edmundston, N. B.

Ship via Freight — Ship when At Once

Terms Usual — F.O.B. Montreal

QUANTITY	DESCRIPTION	PRICE	PER
10 Tons	Plibrico Jointless as quoted		

Your wire quotation dated April 24th.

Confirmation of ord r wired even date.

Mark invoice and goods for " Pulp Mill Maintenance ".

Please acknowledge receipt of this Order and state when you will ship.

THE NUMBER OF THIS ORDER MUST APPEAR ON ALL INVOICES AND PACKAGES. AND IN CASE OF CONTRACT OR PARTIAL SHIPMENTS THE BALANCE REMAINING UNFILLED TO BE STATED ON INVOICE

FRASER COMPANIES LIMITED

PER A. R. Sargent.

Beveridge Paper Co., Limited

Mill Supply Dept.

Montreal and St. John, N.B.

Stocks in All Large Distributing Centres

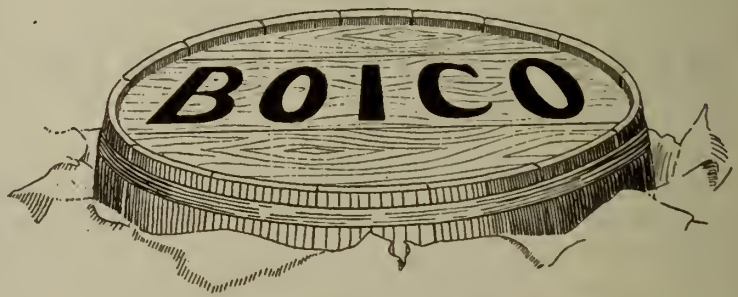
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

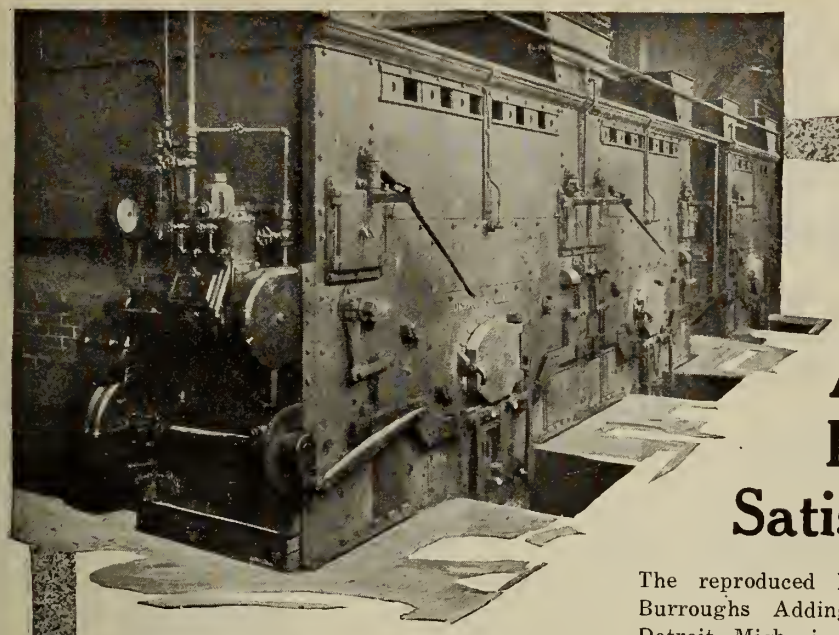
Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec



Another Proof of Satisfaction

The reproduced letter from the Burroughs Adding Machine Co., Detroit, Mich., is self-explanatory. The DETROIT "V" TYPE STOKERS were installed in 1917 as part of the equipment used to determine whether power could be made for the factory cheaper than it could be bought.

The stokers ran true to their builders' claims as usual, and were instrumental in bearing out the engineer's predictions that the project was bound to succeed. That the Burroughs Adding Machine Company was satisfied is conclusively proven by the fact that a repeat order for Detroit Stokers for a new boiler has just been received.

Ask for the Bulletin.

DETROIT STOKER COMPANY

DETROIT - - MICH.

BRANCHES:

Chicago, Cleveland, Cincinnati, New York, Pittsburgh, Buffalo, Philadelphia, Boston

Burroughs Adding Machine Company

CONSTRUCTION ENGINEER
DETROIT MICHIGAN

June 12, 1919

Detroit Stoker Company
Detroit, Michigan.

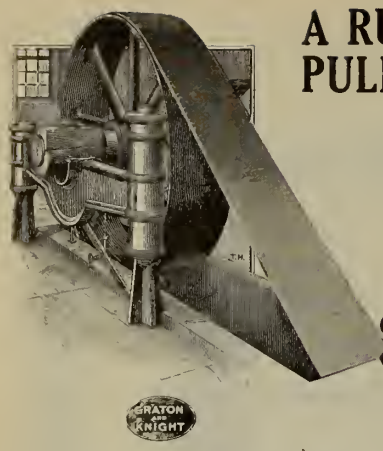
Gentlemen:- Attention Mr. W. H. Riecks.

Answering your inquiry as to the Detroit Stokers we have installed in our power plant, we are pleased to advise that we have found them to be as efficient as we expected. They have proven to be satisfactory in every respect.

Yours very truly
BURROUGHS ADDING MACHINE CO.
BY V. D. M.
CONSTRUCTION ENGINEER.

CSR:O

DETROIT V STOKER



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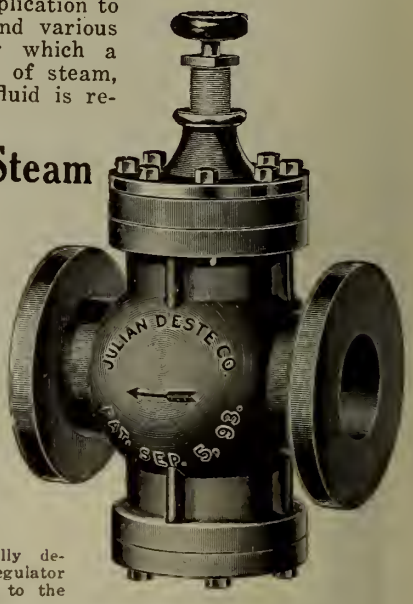

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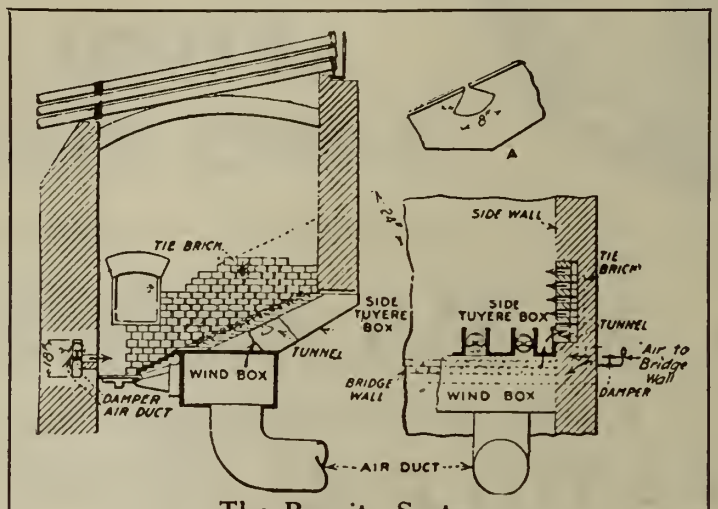

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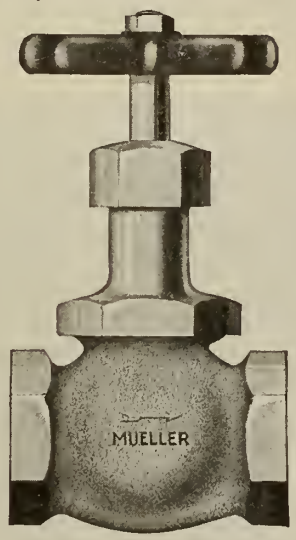

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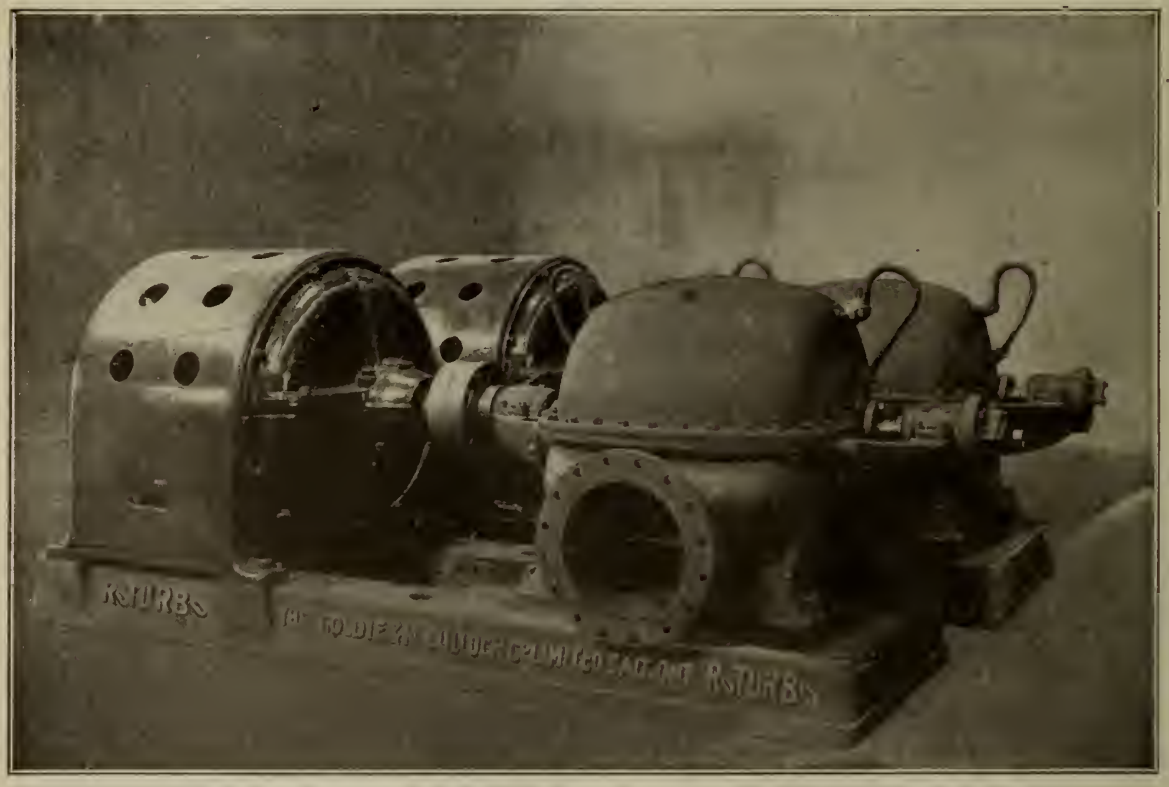

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Establisher 1907 — Published Semi-monthly

Mechanical Equipment of a Modern Dairy

The Dairy Business Has Developed Into a Branch of Applied Engineering Unique in Many Respects—This Article Describes Some of the Apparatus and Engineering Equipment Found in One of Modern Type.

By W. F. SUTHERLAND

THE milkman of former days with his measures and open can of milk has vanished from the streets of most of our cities, and rightly so. Milk is known as one of the best culture mediums for bacteria and other low forms of life dangerous to man so the distribution of milk in open containers was a constant invitation to disease. Contrast this with present day methods where milk is placed in cans, sterilized and sealed at the dairy, rushed to the city by motor truck and train and is finally delivered at the customer's door pasteurized and in sealed containers.

And in the handling of milk in the dairy, mechanical equipment is used throughout and, as may well be imagined, the power plant necessary for refrigeration purposes and for steam generation plays an important part. This article deals with some of the features of interest seen in the plant of the Farmers' Dairy Co., Ltd., at Toronto, Ont.

Since most of the equipment has to do with the direct handling of the milk, the various features of the plant will be described in order as they come into play.

Receiving

Conveyors save much human effort and expensive labor, and wherever possible are used in the present instances. As a result practically no lifting is needed from the time the milk enters the dairy in cans until it leaves bottled in the drivers' rigs.

Motor trucks are used for the collecting of milk cans from the farmers up to a radius of about 17 miles and are also used for the picking up of that part of the supply brought in by train. Standard sized cans are used, each one holding about 82½ lbs. of milk. These are loaded on a Mathews gravity conveyor and while passing to the weighing scales, have the seal, placed on by the farmer, removed and also his tag. When this is done one man empties them into a tank scale built by the Toledo Scale Co. And these scales automatically register the weight of the milk and a record is kept by the same attendant who removes the farmer's tag.

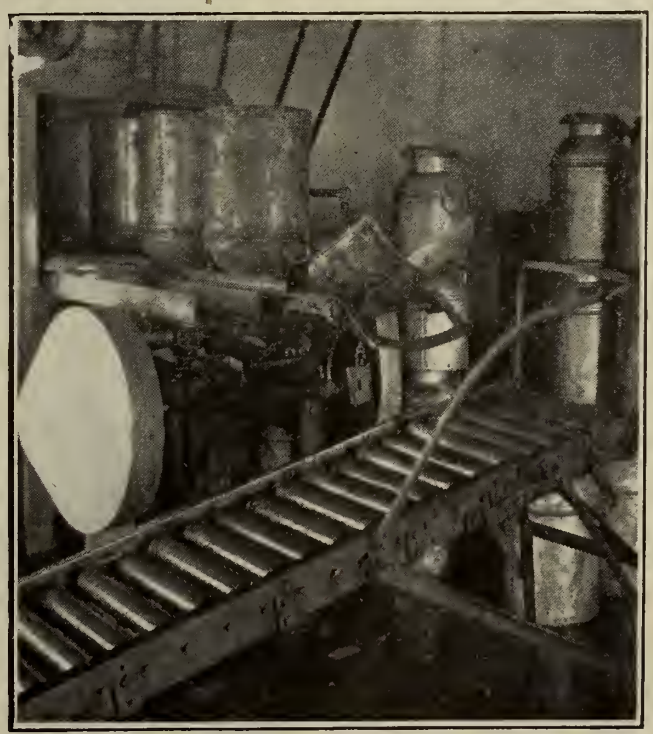


FIG. 1—CAN WASHER, DISCHARGE END SHOWING CAN TILTER AND CONVEYOR.

The cans, now empty, are placed on another conveyor, if it can be called such, for it is nothing but two pieces of flat iron set on edge with a pipe guard at each side. The milk dripping from the empty can furnishes the lubricant for easy sliding.

In an adjacent room, another attendant gives the can a bath outside and places it upon the travelling bed of a washing machine. The can is placed upside down and its cover also in the same position on another conveyor alongside.

Three water tanks are provided in this machine, the first supplying water at about 100° F., the second at 140° F., and the third at 180° F. The water is pumped from these tanks by three centrifugal pumps made by the Smart-Turner Machine Co., Hamilton, and having a capacity of 200 Imperial gallons per minute each. The discharge from these pumps terminates in nozzles under the travelling conveyor on which the cans and their covers are placed and the hot water is forced into them under a head of 40 ft. Since the cans travel only intermittently, each one is subjected to the three streams of hot water for an interval. After being washed they stop over a jet of live steam where they are sterilized and then over a blast of hot air supplied by a blower and heating coils. This thoroughly dries them inside and they emerge from the washer.

The ordinary milk can has a recessed bottom and this collects some water while the can goes through the washing machine. To get rid of this, an ingenious device has been rigged up which automatically tips the can, throwing the water out and up-ends it into a short conveyor, from which it is removed, sealed and returned to the farmer.

The centrifugal pumps, blower and an exhauster for the

removal of steam are driven by a 7½ h.p. motor. Each pump has a thermometer on the discharge side and the temperature is kept constant by a steam jet in each tank. Make up water to the amount of about 2 gallons per minute is supplied by the hot water system in the boiler room and soda is used in the first tank to cut the dirt.

Returning to the milk which we left in the scales; after weighing, it is run out into a second tank at a lower level, from which it is pumped to the pasteurizing room, two floors above, or into milk storage tanks on the next floor. The pump which performs this work has some features of in-

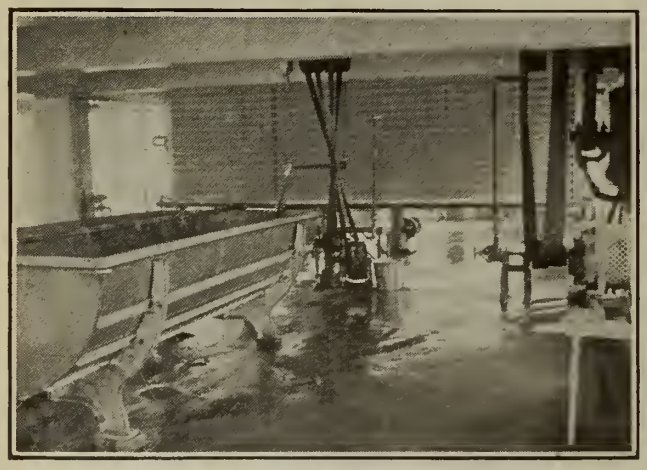


FIG. 2—MILK PREHEATER.

terest. The steam end is standard but the milk end is entirely of brass and so arranged that it can be entirely dismantled in a few minutes for cleaning. This is done every night, and throughout the plant, all piping handling milk, is so arranged with unions and caps that it can be taken down, washed with hot water and sterilized with steam. The piping evidently is of heavy copper, tinned inside and out, and the fittings are of brass, heavily nickeled. The milk pump above described is made by O. H. Burrell and Co., Little Falls, N. Y.

The bulk milk storage room contains three copper tanks heavily tinned which hold 160 cans each. All have agitators to keep the cream from rising to the top. A one and one-half horsepower motor drives the agitators through worm gears and also a brass gear pump, which delivers the milk from the tanks to the pasteurizing room above. The milk storage room is cork insulated with refrigerator doors and is maintained at a temperature of 40° Fah. by means of the cold air system which will be described under the power plant.

Pasteurizing Room

The milk from the weigh scales or the storage tanks, as the case may be, is received in a receiving vat shown in the illustration and holding 50 cans. This has also an agitator driven by worm gear from a line shaft. In passing, it may be mentioned that the plant layout throughout, is so designed as to keep the milk in constant circulation, no chance being given for the cream to separate.

From this receiving vat the milk is pumped over a preheater shown in the illustration. This preheater consists of sixteen 3-in. copper tubes, 14 ft. long, arranged in a vertical stack and divided into two sections with heavy brass headers. The milk flows from a distributing trough on top to a receiving trough below, and is raised in temperature from 40° Fah. to 120°. Water is used as a heating medium and on entering is at a temperature of about 140°. About 50 gallons per minute are required. This quantity is variable, depending on temperature conditions and is controlled by hand. The preheater works on the counter flow principle, that is the hottest water meets the hottest milk.

The pump used in pumping the milk from the vat to the preheater is quite novel in construction, and, like the other pumps handling milk, permits of ready dismantling. No valves are used, but the flow of milk is produced by a combined reciprocating and rotative motion of the piston about its axis, the piston being shaped so that it uncovers the suction and discharge ports at the proper part of the stroke. To effect this motion of the piston, the piston rod is coupled to the crank disc by a ball and socket construction, the crank shaft being set perpendicular to the piston rod, which continues on past it to a bottom guide.

After having been preheated the milk is filtered through special filter cotton and then flows to the pasteurizers, of which there are five. These hold fifty cans of milk each. The milk, while being heated in them, is kept constantly in motion by means of a copper worm driven through gears and belt from a line shaft below. This worm also serves another purpose, that of heating, for by its revolving motion it draws in hot water from a tank on the end of the pasteurizer, circulates it in the copper worm and discharges it at the other end, from whence it returns into the tank again. The water is maintained at the proper temperature of 170 deg. Fahr. by a small steam jet. In these pasteurizers the milk is held at 142 deg. Fahr. for 30 minutes, during which time all bacteria, etc., are killed. The hot water overflow from the tanks is returned to the basement tank of the plant hot water system. Tycos recording thermometers are installed on each pasteurizer.

The copper coils in the pasteurizers are also used for another purpose, that of cooling the milk after pasteurizing. Cold water circulated through them brings the milk down to 130 deg. Fahr. before discharge. Much trouble was experienced in finding a suitable packing for the stuffing boxes on the ends of the worm shaft, through which the water flows in and out of the pasteurizer. A flax and rubber packing is now used and no trouble is encountered.

From the pasteurizers the milk flows by gravity to the coolers, of which there are two, situated one-half floor below the pasteurizer room. Each cooler consists of twenty-four 2½ in. copper tubes heavily tinned inside and out. The milk flows over the outside and city water is taken through the top sixteen, the lower eight tubes being brine cooled. The water passes into the tubes at the bottom, emerging at the top, so that the coolest

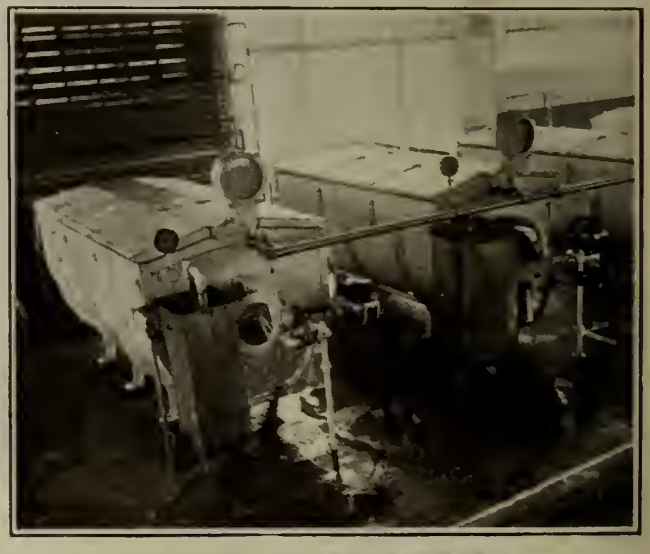


FIG. 3—TWO OF THE PASTEURIZERS.

water is adjacent to the coolest milk. These coolers can handle easily 74,250 lbs. of milk in eight hours.

The flow over the coolers is intermittent and is controlled by an automatic hydraulic regulator devised by Mr. Cairns. Fig 5 shows a diagrammatic view of the arrangement. A copper float is located in the milk

receivers at the bottom of one of the coolers and is attached to a ¼-in. ball-cock. This ball-cock is connected to a ¼-in. pipe line connected in turn to the city water service through a ¼-in. pet-cock and gauge. When the milk rises to a predetermined level, the float rises and

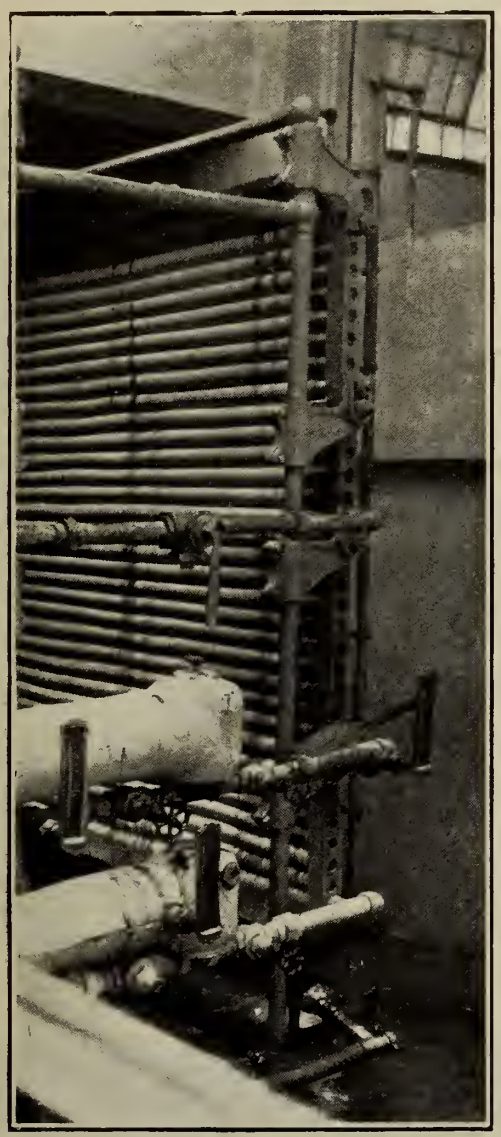


FIG. 4—ONE SECTION OF MILK COOLER.

allows the ball-cock to open, letting the water run to waste. As the water wasted is greater in amount than is supplied to the system by the pet-cock from the city water system the pressure drops. The pressure in the regulating system actuates two hydraulic plungers of 1 and 3 in. strokes. These plungers operate valves which control the flow of cooling water through the cooler and also the flow of milk over it. When the milk level rises the ball-cock is opened and the pressure falls, the weights pulling the valve-operating links down, thus closing both valves. When the milk level drops the reverse action takes place and the water and milk valves open.

The water valve is an ordinary whistle valve, while that on the milk feed is of somewhat unusual construction. By reference to Fig. 5 it will be seen to consist of a cross capped at the lower end and terminating at the top in an open copper pipe. The inside of the tee, which is of brass, is smooth and inside it travels a short piece of copper tubing, which forms the valve. This tube is connected to a piece of ¼-in. brass pipe, which in turn is connected to the lever and hydraulic cylinder. The copper tube is long enough to reach above the level of the milk in the pasteurizers and thus no packing is required. The cap on the bottom of the cross is easily removable and the milk flowing through the valve eddies down into this recess, thus sweeping out any stagnant milk.

The hydraulic cylinders are adjusted for one-inch travel and the pistons are packed with two leather cups, which have proved entirely satisfactory.

The coolers serve to reduce the temperature of the milk from 120 deg. to 32 deg. F., and from them the milk flows to the bottling machines on the floor below. These machines will fill any sized bottle, from the small cream bottles to a one-quart milk bottle. The bottles are placed in the machines by the attendants and pass to the filling nozzles or valves, where they are elevated and filled. The larger sizes are filled in stages and air is vented through a small tube, which passes through the milk above. The bottles are finally capped and are placed in crates and go to the milk storage room. The Universal filling machines have a capacity of 45 bottles of milk per minute each and are each driven by a ¾ h.p. motor through a chain drive.

Skim Milk

While on the subject of milk and cream it may be well to mention what is done with skim milk. The disposal of this has been a matter of speculation to the writer for some time, and at last his curiosity is appeased. Formerly it was allowed to run to waste, but it is now poured into a vat in the basement, and a certain amount of sulphuric acid is added. This precipitates the casein which is filtered and pressed free from whey, dried, powdered and sacked for shipment to other firms. These take it and use it in the making of buttons, billiard balls, milady's ivory toilet articles, etc.

A churn room also forms a portion of the equipment with milk conditioners, two one thousand pound churns and separators, etc. This equipment is shown in Fig. 8.

A laboratory is also necessary for milk testing. Dirt, bacteria and acidity must all be closely checked if good milk is to be sold at all times.

Prohibition and Buttermilk

The bottled milk, together with milk pasteurized, cooled and placed in milk cans for restaurants and the wholesale trade is kept in a large milk storage room, ready for the drivers. The temperature of this room is maintained at about 40 deg. Fahr. by means of the cold air system to be described later. In this room also, but-

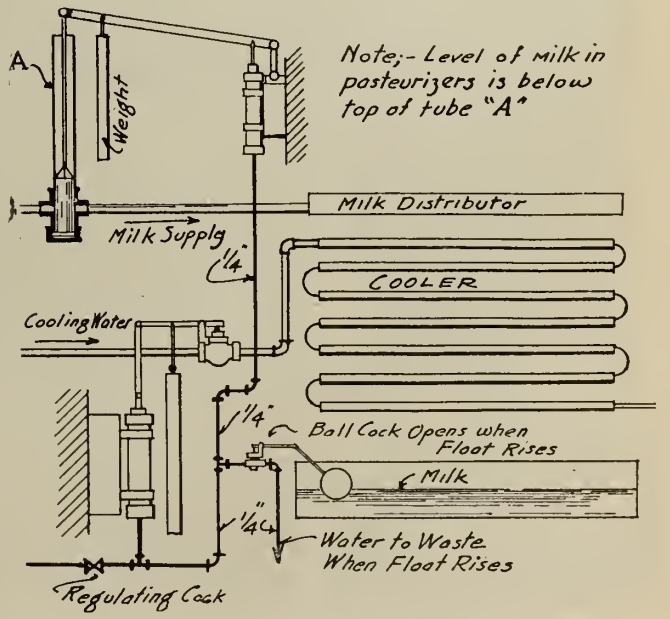


FIG. 5—DIAGRAM OF AUTOMATIC CONTROL FOR MILK AND WATER FLOW TO COOLER.

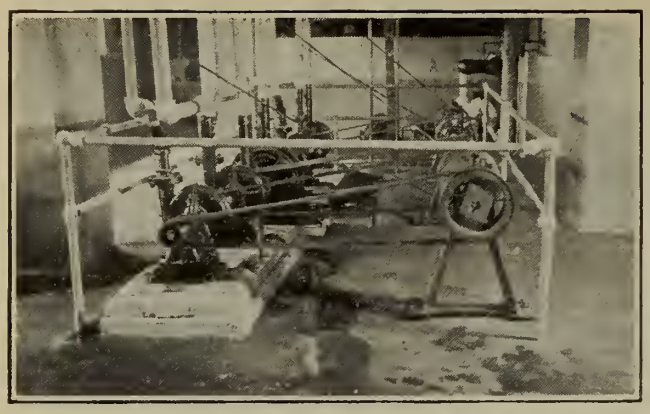


FIG. 6—PUMPS FOR BOTTLE WASHER.

termilk is bottled and placed in cans. It is a noticeable fact that sales of this beverage have increased very materially since the stuff with a kick to it can no longer be had unless by ways dark and devious.

Drivers receive their supplies through small doors opening onto a loading platform, in which are short lengths of Mathews gravity conveyor.

On their return they unload the empty bottles in cases onto another conveyor, which carries them into the bottle wash-room. The bottle washer, in some respects, resembles the can washer described above, consisting as it does of an intermittently travelling conveyor above plates containing wash water nozzles. The cases of empty bottles are turned upside down on an iron frame, placed on a rack and shoved into the machine by a pusher. The track consists of rollers at the sides and interference with the water jets is obviated.

Four tanks, each holding about 75 gal. of water, are located underneath the washer and four centrifugal pumps downstairs in the basement force 250 gals. of water each under 35 ft. head through 3-16-in. nozzles, one for each bottle. The bottles stop over each station, of which there are eight, two for each tank. These thoroughly clean the inside of the bottle, while three other sprays wash the outside. The first tank contains water, which is lukewarm; the second water at about 110 deg. Fahr.; the third at 140 deg. Fahr.; and the last at boiling point. The proper temperature is maintained in each by means of steam jets. Make-up water flows into the hottest tank at about 4 gallons per minute and equalizing pipes are arranged between the tanks, the overflow, together with the scum and dirt, flowing away to the sewer.

Emerging from the washer the bottles are turned right side up by an attendant and placed on a gravity carrier, which takes them to the filling room. This conveyor is fed by a pusher mechanism similar to that used for the washing machine. While on this conveyor the bottles pass over a duct, through which cool air is blown, passing up and around the bottles. This cools and also dries them, ready for filling.

Pumps For Bottle Washer

Perhaps the most interesting feature of this bottle-washer is the battery of pumps located in the basement and shown in Fig. 6. Four Goulds' centrifugal pumps each deliver 200 imperial gallons per minute against a pressure of about 30 lbs. The four are belt-driven from a shaft by a 25 h.p., 3-phase, 25-cycle motor, which, from the same shaft, also drives the automatic pusher mechanism or feeders for the washer and conveyor above. The shaft hangers are bolted to the floor and are of the S K F ball bearing type. Beardmore waterproof leather belting is used.

Refrigeration

The refrigerating system may be divided into two parts, one which supplies cold brine to the milk coolers, etc., and the other which supplies cold air to the bottled milk storage and to the milk storage room.

Two 8-ton Brunswick compressors are installed for the brine system. These are of the twin cylinder, vertical, hot gas type, the cylinders being water jacketed.

The Brunswick Manufacturing Co., New Brunswick, N.J., use a number of novel features in the construction of these machines. The necessary reciprocating motion of the pistons is secured not by cranks, but by eccentrics, through which the shaft passes. These eccentrics are of cast iron and the eccentric straps are also of the same material. The wrist pin and eccentric strap are all one piece and the eccentric is made with a projecting hub which runs in the bearings. Thus all the shaft has to do

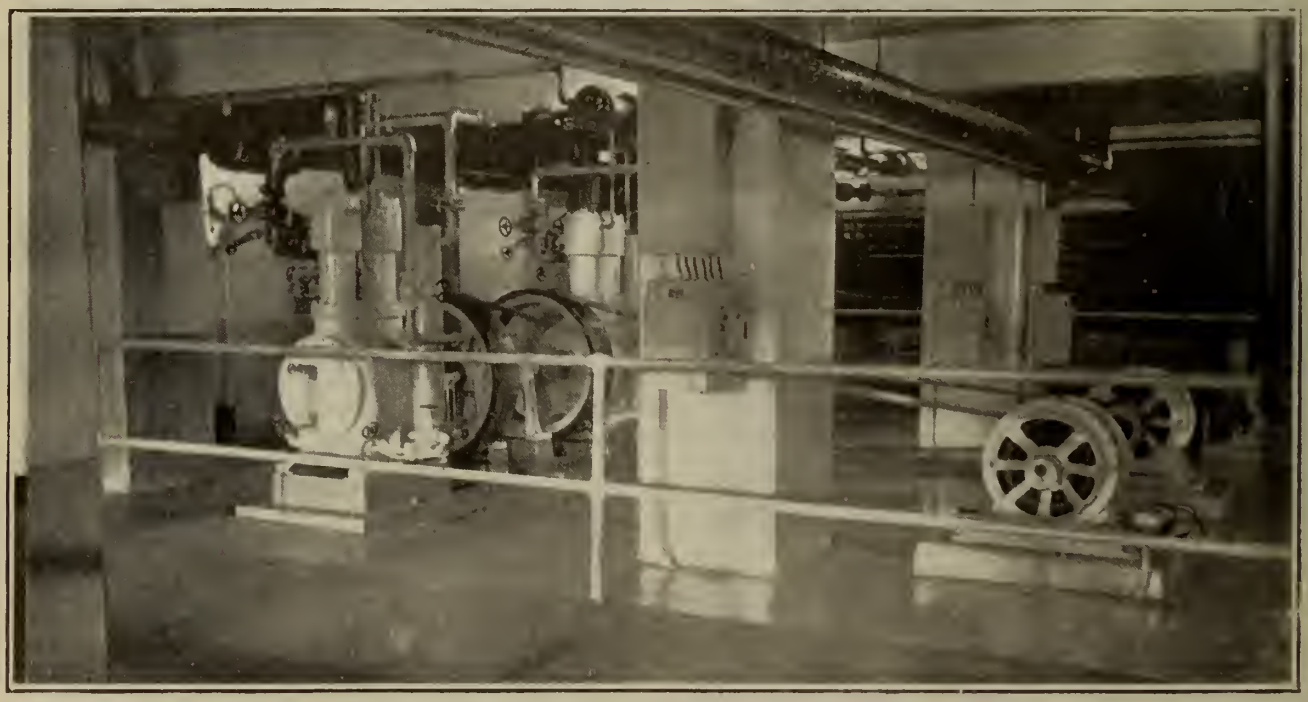


FIG. 8 TWO OF THE AMMONIA COMPRESSORS AND THEIR DRIVING MOTORS, TOGETHER WITH STARTING COMPENSATORS ON COLUMNS.

is to transmit the necessary turning torque and is relieved to a large extent of bearing stresses.

An oil collector is placed on the discharge side of the compressors to collect any oil entrained in the gas. The oil is returned to the crank case, which is enclosed.

Another feature of interest is seen in the outboard bearing. Contrary to usual practice, the shaft runs in a cast iron sleeve, and while this at first sight might be expected to lead to trouble, none has been experienced.

Each of the two 8-ton machines is driven by an 8-in. Beardmore heavy, single-ply, waterproof leather belt from a 15 h.p. Lincoln motor. This installation is seen to advantage in Figs. 8 and 9.

For the supplying of cold air to the milk storage rooms a 12-ton compressor of the same make and type is provided. This machine is driven by a 25 h.p. motor, a 10-in. double-ply belt being used.

Brine System

Two Smart-Turner centrifugal brine pumps, each of 75 gal. per min. capacity, circulate the brine from the brine tank to the milk coolers above. These pumps have a 5 h.p. motor belted to each. Two brine tanks are provided with a total capacity of 700 cu. ft. These are insulated by Armstrong cork. One tank has three sections of double pipe brine cooler submerged in the brine ,while the other one contains two. The return line of the brine circulating system comes back through the double pipe brine cooler, in at the bottom and out at the top, discharging into the body of the tank, which acts as a storage. The discharge and return lines of the brine system are cross-connected through a relief valve, so that any excess discharge over that required by the milk coolers is taken care of.

Blast Room and Cold Air System

The blast room, which supplies cold air to the bottled milk storage and to the reserve milk rooms, contains four stacks of direct expansion coils, containing 3,600 ft. of 2-in. pipe. Air is taken in from the top of the milk storage rooms by a Sheldon fan driven by a 3 h.p. motor and is discharged into the blast room. The air is delivered across the coils, which have a set of three heavy galvanized baffle plates and returns to the storage rooms through ducts in the hollow tile walls, being delivered near the floor on the opposite side from which it was taken away. The blast room is 26 ft. by 10 ft. in size

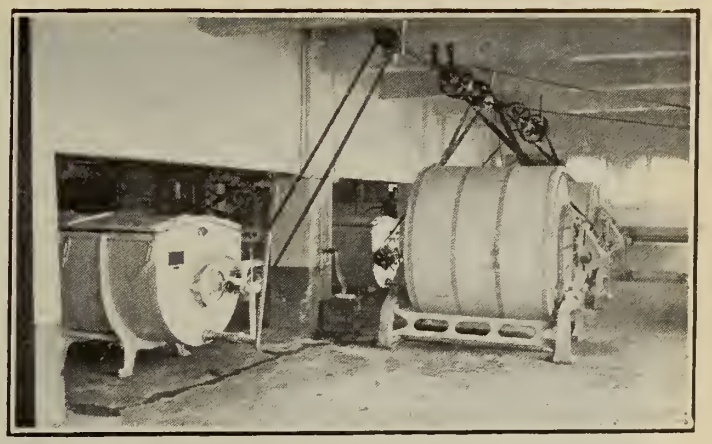


FIG. 7—CHURN ROOM SHOWING MILK CONDITIONER AND CHURNS.

and the walls are built up of 4 in. Armstrong cork, plastered inside and out. The fan and air ducts are insulated with felt covered by canvas and painted.

Outside air is used for cooling purposes during the colder months of the year, being taken in through an opening to the outside in the suction line to the fan.

The storage rooms contain a total of 25,000 cubic feet of space and the walls are constructed of hollow tile with 2 in. of Armstrong cork insulation on both sides, plastered over with cement plaster.

All doors to the blast room and storage rooms were supplied by the Jamison Cold Storage Door Co., Hagerstown, Md.

A small Smart-Turner pump, driven by a direct connected one h.p. motor, serves to remove condensed moisture from the blast room and for emergency use a Penberthy water ejector is also provided.

The ammonia condenser is of double pipe counter flow type and of Brunswick make. Ammonia enters at the top and the water at the bottom, the condensed ammonia flowing out at the bottom into a receiver. The condenser is three stacks wide, each stack being eleven pipes high. The inner pipes carrying the cooling water are 1¼ in. dia., while the outer ones are 2 in. The condenser is 18 ft. long. City water is used for cooling. The exhaust from the small steam-driven milk pump upstairs on

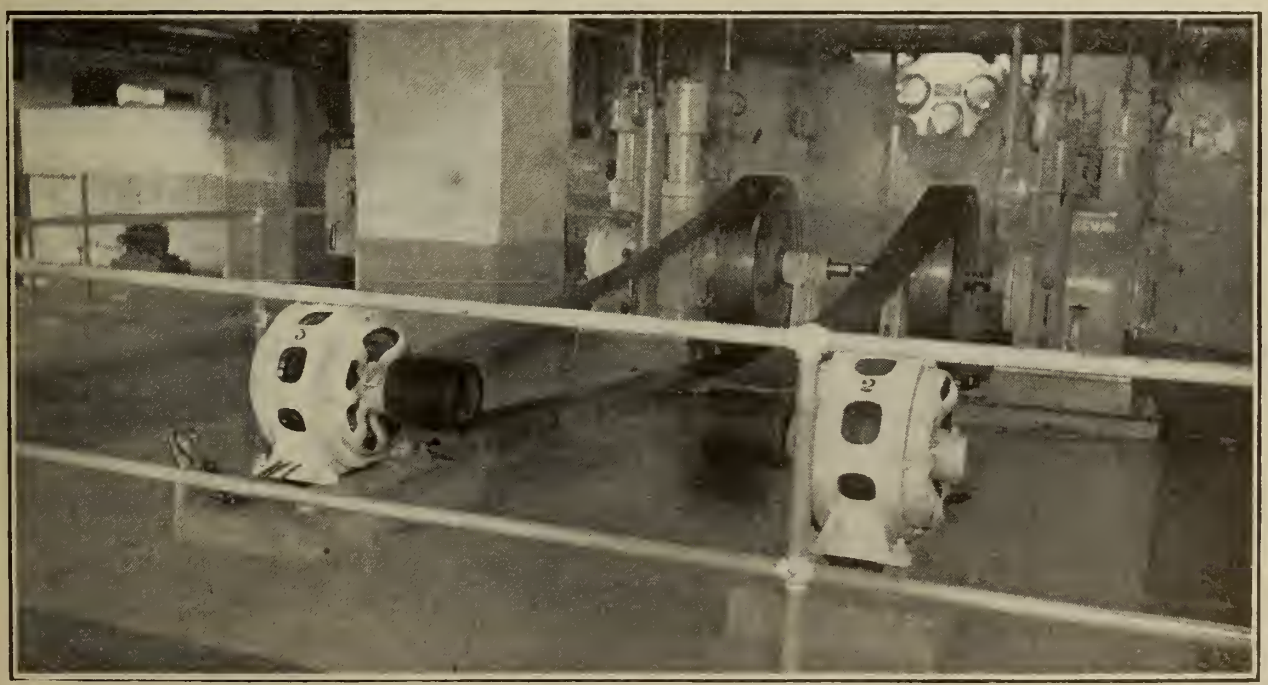


FIG. 9—MOTOR DRIVE FOR AMMONIA COMPRESSORS.

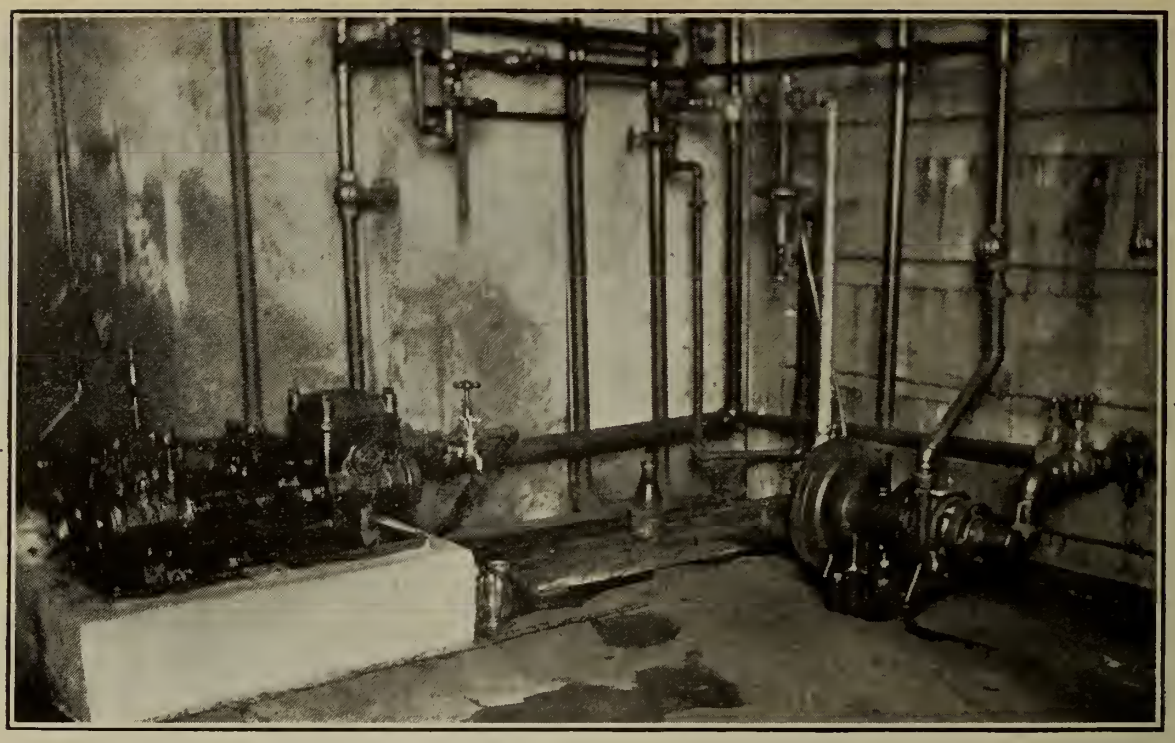


FIG. 10—COPPUS FEED WATER PUMP AND TANK.

account of its intermittent character and oily nature is of no use, and so is turned into the discharge line from the condenser, where it is condensed and carried away to the sewer.

Expansion Header

The liquid line from the receiver is led to an expansion header at a spot conveniently near to both the brine and blast room expansion coils. Here nine leads are taken off, five for the brine system and four for the blast room. Next to the welded steel header on each line is placed an ammonia valve and immediately above them the expansion valves proper. When these latter have been properly adjusted they are never touched, any cutting out or in of sections of the expansion coils being done by the ammonia valves.

Extra heavy pipe is used throughout on the ammonia system and scale traps are provided at each compressor and at the expansion header. Armstrong cork insulation is used on all liquid lines and returns to the compressors as well as on the brine circulating system.

The compressors on the brine system and the blast room are ordinarily run separately, but provision is made for cross-connecting when necessary.

The jacket water from the ammonia compressors is led to one of the columns and runs to waste through sight feed flows, one for each compressor mounted on it.

Boiler Room

For heating purposes during the winter months and for supplying the large quantities of steam and hot water necessary for plant operation, two 50 horsepower Jenckes return tabular boilers are installed. These boilers have individual settings and are fitted with Cyclone shaking grates. For overload conditions and also for use when the natural draft is poor, due to a hill back of the plant, Coppus undergrate blowers are fitted.

The main stop valve to each boiler is of Jenkins make, and 3½-in. Lunkenheimer non-return valves are also fitted. The steam header is dripped at three places in its length, the two drips in the boiler room being taken care of by an Anderson trap, while the third one at the far end of the basement is also fitted with a trap of the same make.

Four different methods of feeding the boilers are available, city water pressure, a Penberthy injector, a 4½ x 2¾ x 4 in. Smart-Turner duplex pump and a Coppus turbine-driven feed pump. The latter is in regular use, the other apparatus being maintained for stand-by service.

The tank from which the boiler is fed and from which other plant requirements for hot water are met is of cypress, 3 in. thick and 7 ft. by 8 ft. by 6 ft. high, holding 2,083 gallons. The boiler feed pump suction line has a vertical riser terminating in a funnel at the top higher in level than the water in the tank. This is used for feeding boiler compound when required. No regular compound is used for a soda preparation. "Wyandotte," made by the Ford Co. Wyandotte, has been found to answer the purpose quite satisfactorily. This material is in common use for laundry and dairy purposes.

The Coppus pump is operated against a head of 100 lbs. and is of sufficient size to feed 1,000 boiler horsepower, the excess delivery over that required by the boilers going to supply other plant requirements. A Mason excess pressure regulator set at 110 lb. and in-

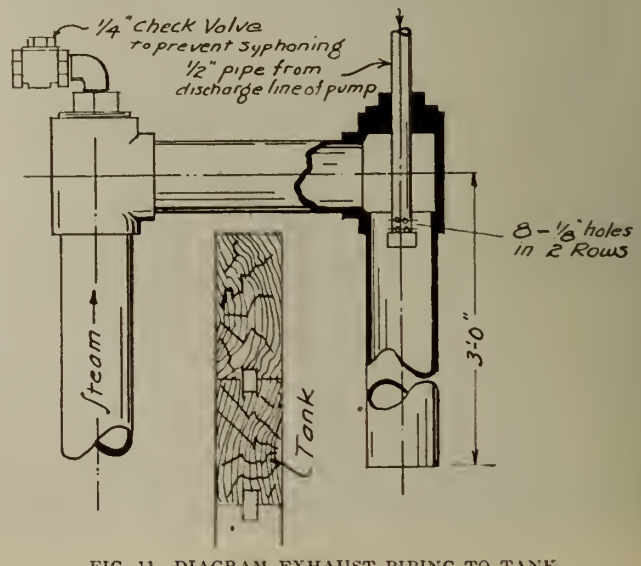


FIG. 11—DIAGRAM EXHAUST PIPING TO TANK

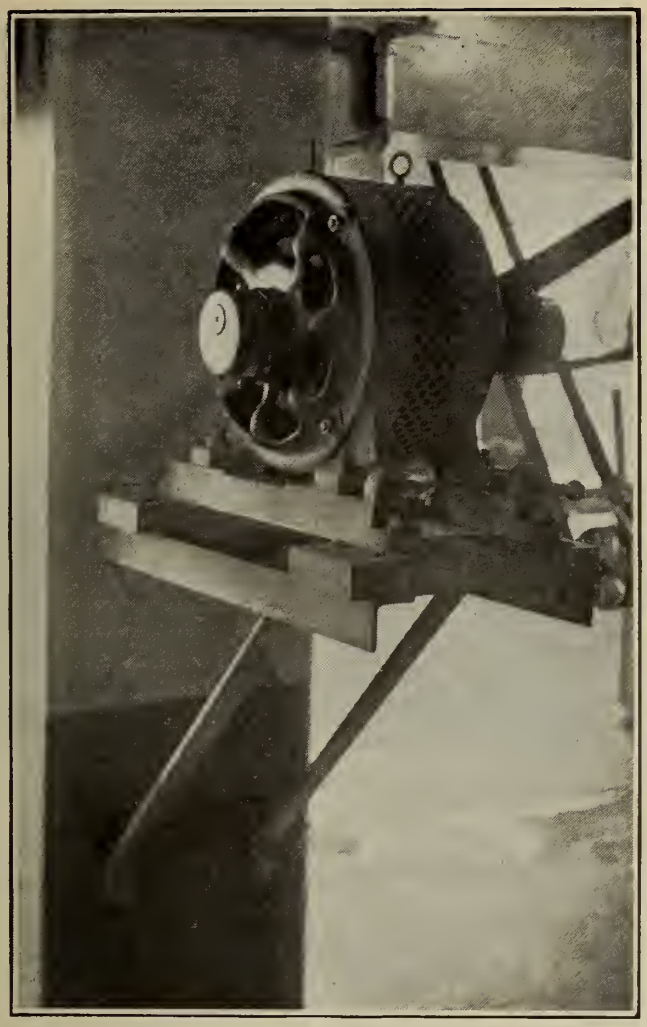


FIG. 12—MOTOR BRACKET ON CONCRETE COLUMN.

stalled on the steam line controls the speed of the pump and thus its delivery.

The pump drawing its supply from the hot water tank delivers water at 140 deg. Fahr. to the boiler, lavatory service, make-up for can and bottle washing machines and also forty gallons per min. to the milk preheater. The water which goes to the preheater returns to the tank and the overflow water from the pasteurizers is also recovered. The make-up water supply is drawn from the ammonia condenser cooling water waste.

Exhaust steam from the Coppus pump is used to heat the water in the tank. Fig. 11 shows the arrangement of the exhaust piping. The exhaust terminates 3 ft. below water level and a tee is installed at the top. In this tee a one-half inch pipe has been inserted, capped at its lower end and drilled with eight one-eighth in. holes immediately above the cap. The one-half inch line takes water from the discharge line of the pump and this water injected under pressure serves to condense the steam and prevents disagreeable noise so common when steam is introduced into a body of water. The other tee shown in the figure has a one-quarter inch check valve opening inwards attached. This serves to break any vacuum formed when the turbine is shut down.

The correct water level is maintained by the boiler room attendant and he is warned of the need for replenishment by steam blowing into the boiler-room, quite a simple low water alarm. The tank being below sewer level a connection is made from the discharge line to the sewer for the emptying of the tank when necessary.

The Dunham system, installed under the supervision of the C. A. Dunham Co., is used throughout the main dairy building and the stables some distance away. Steam at boiler pressure of 90 lb. is reduced to the proper pressure by Fisher reducing valves, and the 4x4x8 in. Bawden vacuum pump is controlled by a Fisher regulator. The condensate from the heating system is returned to the hot water tank, while the exhaust steam from the vacuum pump and the duplex feed pump passes through an oil separator into the heating system.

A Turnbull hydraulic lift is used for hoisting ashes to street level. Carey's insulation is used throughout on steam lines.

The steam fitting, plumbing and heating were installed by A. Welch and Sons, Toronto. The dairy apparatus and refrigeration were installed by the W. A. Drummond Co., Toronto. The packing used on all ammonia flanges is Garlock No. 900, a hydraulically compressed asbestos packing. Practically all motors, some twenty-two in number, are of three-phase, 25-cycle, 550-volt type, made by the Lincoln Electric Co., Toronto.

Organization

The Farmers' Dairy Co., Ltd., is an organization composed entirely of milk producers, no one having any financial interest in the company except farmers. Milk is received principally from the shareholders, although some is obtained from other sources. Started ten years ago, the industry has shown a remarkable growth. At the start, less than 1,000 lbs. of milk was distributed per day, and at the present time a quantity of approximately 100,000 lbs. is handled in the same time. The present plant is, of course, a gradual development through the en-year period, and further extensions are contemplated. Mr. Robert Cairns is mechanical superintendent.

Fly-wheel Explosion

ON August 15th the fly-wheel of a 250-h.p. Filer and Stowell Corliss engine in the Sattley Building, Racine, Wis., exploded with a terrific crash, demolishing a large part of the building, killing one man and injuring three others. The building, which houses a number of manufacturing concerns, rocked as if an earthquake had struck it and the employees scattered in all directions.

The cause of the accident was evidently a deranged governor as the engine attained a terrific speed before the wheel let go. Herman Kobal, assistant engineer, was seated directly behind the wheel and when the engine began to race and the generators began to throw their windings he started to get out. He had just got outside when the wheel let go and a piece came through the wall and struck him, killing him instantly.

The cylinder dimensions of the engines was 22 by 44 in., it operated at 90 r.p.m. and 125-lb. steam pressure, and was installed 14 years ago. The fly-wheel was 14 ft. in diameter with a 26-in. face and weighed 8 tons. Belted to this was a 200-kw. d.-c. 125-volt generator and one 150-kw. a.-c. 220-volt generator with revolving fields.

Pieces of the wheel went into the Wallis Tractor Factory, tore a hole through a 12-in. wall and then struck the machine at which William Dedrichs was working. His machine was wrecked and he had to be taken to a hospital. A post 12 in. in diameter was splintered into fragments so small that not a piece of wood was left larger than half an inch. The damage is estimated at $35,000.

One piece weighing more than a ton went about five hundred feet in the air, and landed in the yard of a foundry company which is 350 ft. from place where it started from. Another piece crashed through a six-inch brick wall and going in a southerly direction landed on top of a tractor some distance away. The tractor was badly wrecked and the same piece also took off part of an overhead runway in its flight.

The generators are a total loss as the windings on the armature of the d.-c. machine was thrown out completely and the frame cracked. The revolving field of the alternator left the spider and the frame on this machine was also cracked.—*The National Engineer.*

Auxiliary Apparatus of the Steam Power Plant

The Modern Power Plant Has Many Accessories Not Dreamed of by the Engineer of a Few Years Back—These Articles Will Review and Illustrate the Various Types of Auxiliaries

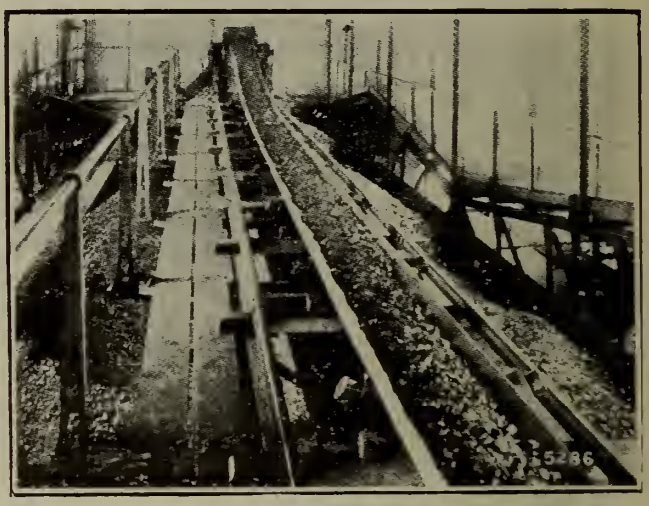
By T. H. FENNER, Associate Editor

AUXILIARY appliances cover a very wide field in the modern industrial power plant, and it is sometimes a moot point as to what can be classified under this head. From the writer's point of view, any machinery or appliance apart from the main boilers and engines can rightly be called auxiliary machinery.

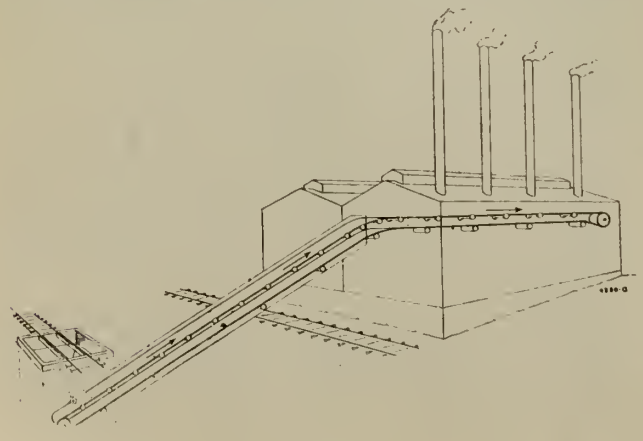
The engineer who possesses a broad knowledge of the various types of auxiliaries and accessories, and their applications to a particular problem, is in a position to make his advice valued. If to this knowledge he adds a grasp of the commercial possibilities and can show where a comparatively large outlay can justify itself to the owner or manager, he will have no trouble in introducing economical improvements into his plant.

It may be conceded at once that practically every piece of auxiliary apparatus on the market has some point of merit, otherwise it could not survive. Generally, when any of the better known makes of traps, pumps, injectors, fans, or whatever it is, falls down on the job, the fault is not with the machine, but the treatment it receives. Too often, in going through a power plant, one sees an expensive piece of machinery standing forlorn and idle. Enquiry elicits the information that "It's no —— use, and never was." Probably the next day one sees the identical appliance functioning in a most efficient manner in a similar plant and under similar conditions to those seen the previous day. Obviously the fault is not with the machine.

Another handicap which auxiliary machinery too often suffers under is that due to pure cussedness of human nature. For instance, if a piece of machinery is bought and installed when the chief engineer has set his heart on a different make, the chances of the installation making good are very poor. Again, an engineer may install a certain auxiliary, and leave the plant. The man who follows him may favor another make, and will too frequently try to make the one installed prove his contention that it's no good. Of course, this is not universal, but there is enough of it occurring to cause trouble. An instance along these lines, although not exactly concerned with auxiliary machinery, occurs to my memory. A certain type of watchman's flash light, which was operated by a storage battery, or rather storage cell, contained in an aluminum case, was purchased for the night watchmen's use. These batteries could be charged during the day and would burn continuously for about 12 hours. As they were only used about 3 hours each night, this left an ample margin. However, before the lights were purchased the head watchman had heard a man with some authority in the plant say they were no good. The head watchman always made a point of being in agreement with this particular person, so the word went out to all the watchmen that the lamps were no good. The result was they weren't. The watchmen finally refused to use them, and they were returned to the power house store. Those lamps were as good an article for the purpose as could be found, but they didn't get a chance. The mistake, of course, was in the management not insisting on their use even if it involved the dismissal of the watchmen. However, it goes to show what prejudice can do to an article.

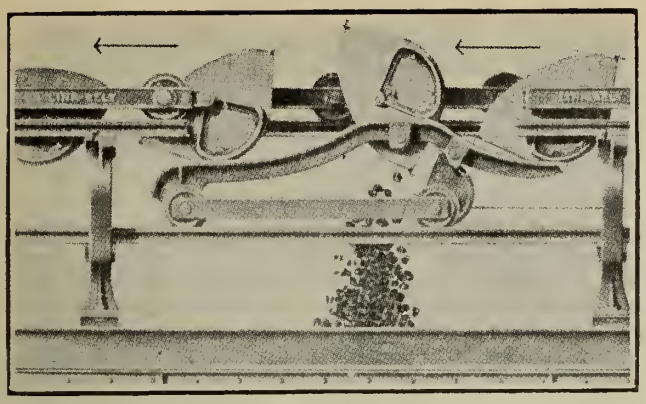


BELT CONVEYOR IN BUNKER LINK BELT COMPANY.



BELT CONVEYOR FROM OUTSIDE STORAGE LINK BELT CO.

A lot of equipment that a comparatively short time ago was looked upon as a luxury, yet only for the large and expensive plant is now acknowledged to be a necessity for economical working. It is not a great many years ago that the average stationary engineer looked upon CO_2 indicators, recording thermometers, feed water meters, etc., as being very pretty, but of little real value. This view is being very rapidly changed, and there are few engineers who would refuse to install any of these instruments if they had the chance. At the same time, increasing power costs have made plant managers more eager to invest in instruments and machines for increasing the efficiency of operation. High-priced and hard to obtain common labor has led to the much wider adoption of mechanical coal and ash-handling machinery. The mechanical stoker, which can burn with success a low grade coal, is coming more and more into use. Fans and turbine blowers have also become a necessity where cheaper grade coals have to be burnt. Where the size of the plants warrants it, economizers are being installed in the uptakes. Feed water heating apparatus, various types of return traps for handling condensation, vacuum pumps in connection with heating systems are almost universal. Manufacturing processes have necessitated the introduction of special machinery in the power house, outside of the main units, such as air compressors and high pressure hydraulic pumps and accumulators. Water filtration systems and chlorinating appliances for drinking water are also in evidence in some cases. Central lubricating oil pumps, supplying lubricating and cylinder oil to all the units in the plant are another refinement.



SHOWING METHOD OF UNLOADING PIVOTED BUCKET.

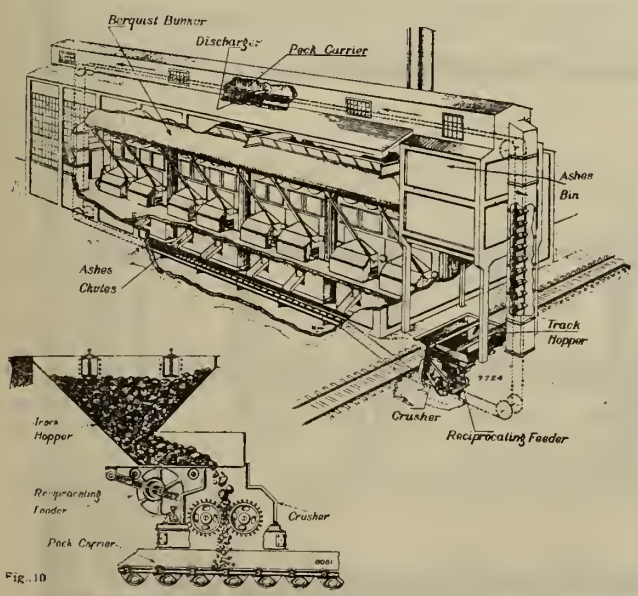
The absolutely necessary appliances, such as feed pumps, and condenser circulating pumps are, of course, always with us, while various types of feed regulators, high and low water alarms, are found in steadily increasing numbers.

Coal and Ash Handling

The logical place to start the consideration of a steam power plant is in the boiler room, and as the initial source of power is the coal, handling the coal is the first thing we shall consider.

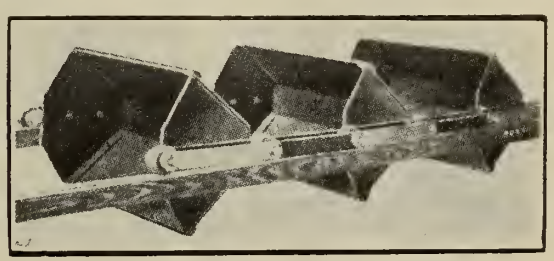
There are in this country more of the one boiler type of plant than any other. These plants employ perhaps one man, who looks after boiler and engine, and in some cases two men, an engineer and fireman. As many of these small plants handle fuel other than coal, such as sawdust, shavings, tan bark, etc., the problem of economical handling does not enter. In the plants of this size burning coal, the small amount of coal burned does not justify the installation of machinery to handle it. In some cases, for instance, where boilers are situated in the basement of a building, the ashes have to be elevated to the street level. If it is an office building, the usual plan is to use an ordinary elevator, of the hydraulic plunger type, which also serves the building in general. There may be a small bucket and chain elevator, dumping into the cart drawn up in the street outside, or in some cases, the most primitive appliance of all, a pair of blocks, and hand-power to elevate the ash bucket.

The handling of ashes is often a question in small and medium-sized plants, where the coal handling practically takes care of itself. This can be readily understood. The coal in most cases can be drawn to the bunker or directly



BOILER HOUSE WITH PECK CARRIER AND OVERHEAD BINS.

in front of the boiler and dumped within easy reach of the fireman. On the other hand, the disposal of the ashes often means the transporting of them a comparatively long distance from the boiler room. In a small plant, the cost of this handling by hand labor may easily be very high in comparison to other power costs, while the coal-handling cost is but small. A cheap and efficient arrangement in a case of this kind is the ordinary I-beam and electric trolley. The writer is personally acquainted with several plants where this arrangement is in use. One in particular is a good example. The boilers are of the vertical type, 28 feet high over all, the boiler and engine room being some ten feet below the street level. Coal is brought into the yard in carts, which simply dump into the bunker, which opens into the boiler room. For bringing the coal to the boiler front, a four-wheel truck, on ball bearings, is employed. This truck holds a known quantity of coal, so that it forms an accurate means of measuring by simply keeping a tally. The side of the truck is hinged, allowing it to drop down, which makes it partially self-unloading. For handling the ashes, a bucket is used which runs on rollers and fits under the fire door. It is large enough to contain all the ashes pulled when cleaning fires. About 16 feet above the floor level the I-beam is installed, and this runs across the boiler room and out into the yard. A Sprague Electric Company travelling trolley of 1 ton capacity runs on the beam and is controlled from the floor by means of wires attached



GRAVITY CONVEYOR BUCKETS.

to the switches. There are four controls altogether, hoisting, lowering and travelling either way. The man on the floor hoists the bucket of ashes, and runs it to the door, when the man in the yard, usually the carter, takes charge of it and places it in position over the cart. The bucket is pivoted below its centre of gravity, and the opening of a catch allows it to dump. This makes a very convenient and cheap arrangement of low first cost, and little expense for upkeep. The same plan, with modifications to suit local conditions, is in use in many plants, and for the small concern, is hard to beat.

When we consider coal handling, the first question to be considered is that of storage. If the plant is so situated that coal can be obtained daily by cart from a local dealer, a large space for storage is not required. On the other hand, if coal is brought in direct by rail, or boat, storage is an absolute necessity. No plant can expect to receive coal regularly by rail, especially in the winter, and in the case of coal coming in by boat, it is usual to procure sufficient supply in the summer to carry on through the winter.

In the case of the small plant, such as was just mentioned, storage facilities would not be more than sufficient for two or three days. Even when the storage bin was nearly empty the coal would be comparatively close to the boiler room, and the amount of handling required not much greater. However, when the necessity of storing quantities of 1,000 tons and over exists, the question of moving this coal becomes an expensive one. The wheeling of coal in barrows from bins to boiler room is not only expensive in labor, but is wasteful in coal. There is always a certain amount being lost by spilling from barrows, and being trod into dust on the floor, especially with the smaller types of coal. If in addition the ashes

are handled by being pulled out of the fire onto the boiler-room floor, there is an almost certain further loss by coal going out with the ashes.

In the ideal installation the coal should never be touched by hand from the time it arrives in the yard by train till it is delivered as ash into the car again. In some large stations this condition is practically fulfilled, but in the smaller plants the cost of the necessary equipment can not always be justified. However, there are few plants where some form of mechanical handling cannot be introduced to advantage.

It is usual to arrange, where coal is delivered by rail, for the cars to run up on a trestle and dump their contents into the bin below. When the coal is in gondola cars this involves practically no work in the car itself, but trimming is necessary in the bin. This is the first handling. If the car is a box car, some shovelling will be necessary in unloading. After the coal is trimmed into the bin it must be wheeled from there and deposited in front of each firing door. After the coal is burned the remaining ash must be removed from the fire, and wheeled out of the boiler-room, a more or less distance.

Suppose we have a plant of four H.R.T. boilers, rated at 125 h.p. each, or 500 h.p. total. This plant would require two firemen and one trimmer during the day, and during the winter months a trimmer would be necessary at night. During the working day about 20,000 lbs. coal would be burnt, and according to the quality of coal about 2,000 to 4,000 pounds of ashes would be handled. If the plant is closed down at night there will be only one man needed in the boiler-room to keep steam handy, and have everything ready for starting up in the morning. For three months of the year a trimmer will also be necessary on account of the heating proposition. If now equipment can be installed to eliminate the trimmer during the day and the night trimmer during the winter months, a saving of, roughly, $20 per week all the year round, and $40 a week for three months can be made. This would amount to $1,250 a year. A saving of this much justifies an investment of $6,000 to $8,000. This amount in a plant of this size would supply a full mechanical equipment, which would effect a larger saving than that estimated.

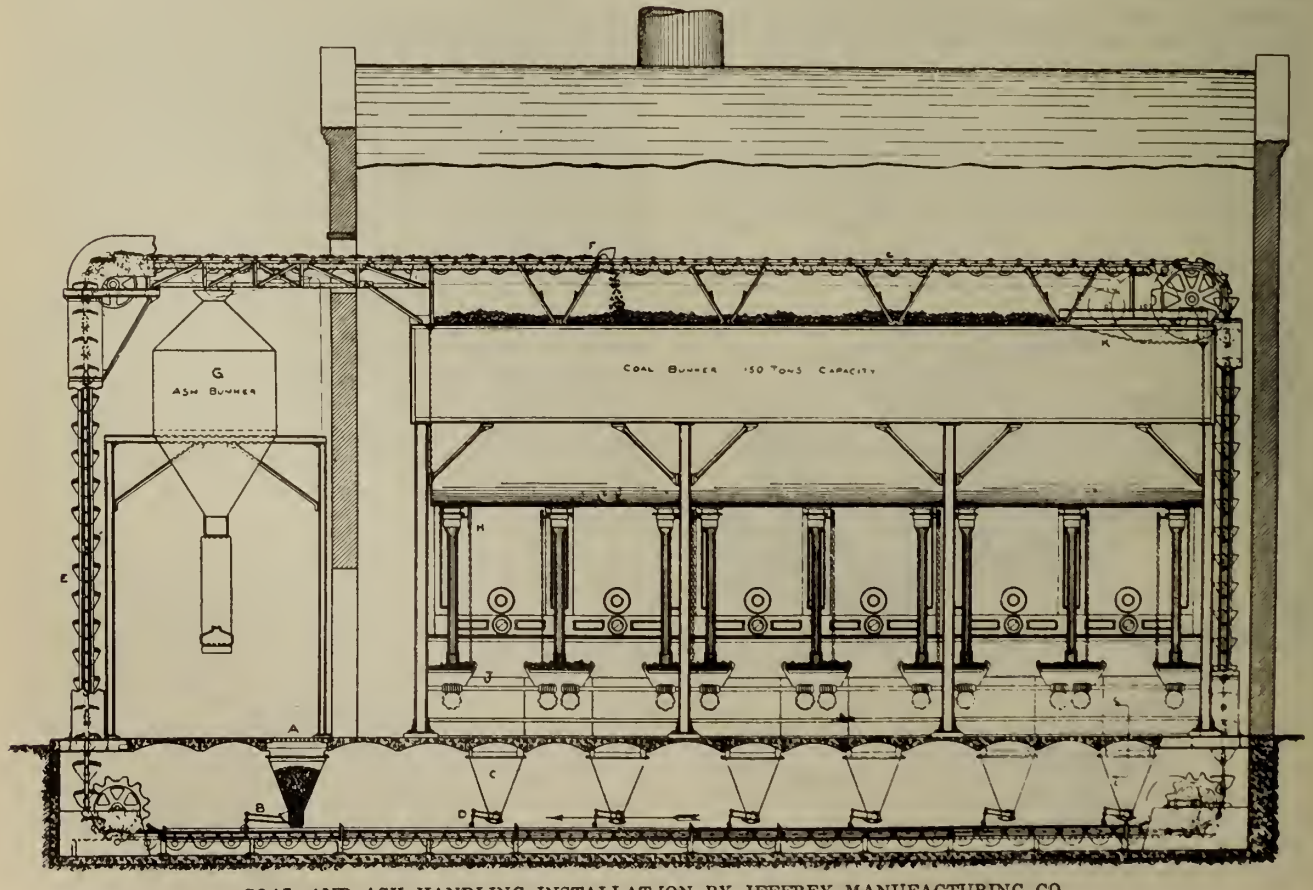
The chief means adopted for handling coal automatically is by elevators of the belt, bucket, or flight type, while the ash-handling is effected by bucket elevator, spiral conveyor, suction, or pneumatic elevators. Some of these will be described in this article.

The Belt Conveyor

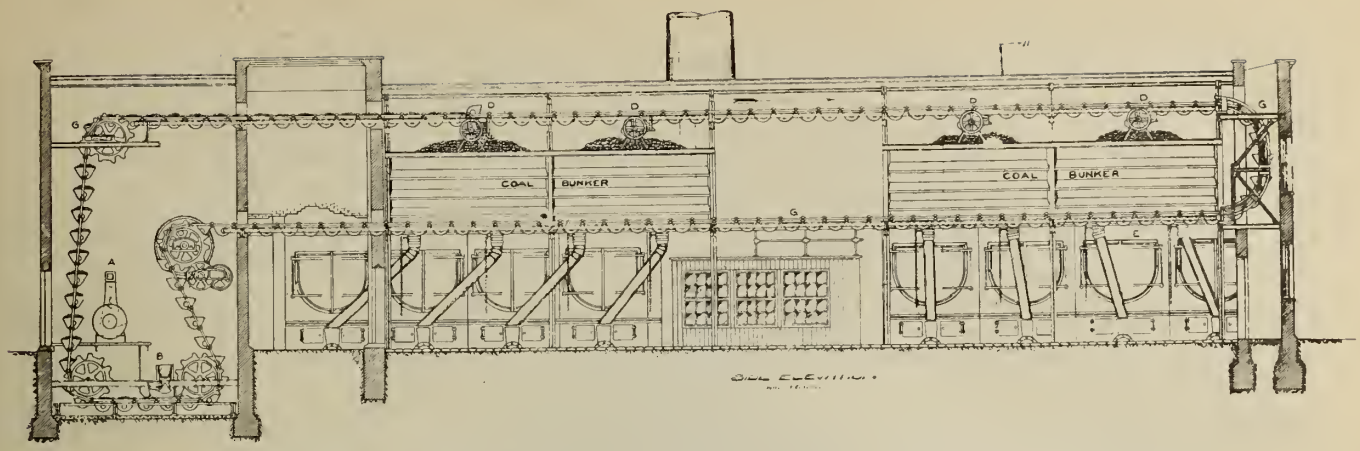
The belt conveyor consists essentially of a broad rubber belt, travelling over rollers. The coal is carried in bulk on the surface of the belt. The guiding rollers are usually arranged in groups of three, the centre one being horizontal, while the two side ones are inclined at an angle of from 15 deg. to 30 deg. This keeps the contents from spilling over the edge of the belt while in transit. For conveying coal long distances, as from an outside storage to a bin in the boiler room, this type of conveyor is very suitable. It will deliver to an overhead bin where the distance is sufficiently long to allow the elevation to take place at a slight incline. Obviously, this type of conveyor cannot be used where the inclination would be higher than the natural angle of repose of the coal. Owing to the cost of the material, this type of conveyor is rather high in first cost, but maintenance should not be very high, and the capacity is greater in proportion than a flight or bucket conveyor, owing to the continuity of carrying surface. We show typical cases in our illustrations, which are obtained through the courtesy of the Link Belt Co., Chicago. The coal is discharged from the belt at any desired point by a tripper, which can be moved along to the spot required. The tripper consists of two pulleys, so arranged that the belt passes over one and back around the other, the effect being the same as if the belt ended at that spot.

Gravity Discharge and Bucket Types

The greater part of the elevator and conveyor equipment for coal is of the above type. Fundamentally ,the principle of the gravity discharge and bucket elevator is the same. Containers are spaced at even distances along



COAL AND ASH HANDLING INSTALLATION BY JEFFREY MANUFACTURING CO.



INSTALLATION AT HIRAM WALKER DISTILLERY—JEFFREY MANUFACTURING COMPANY.

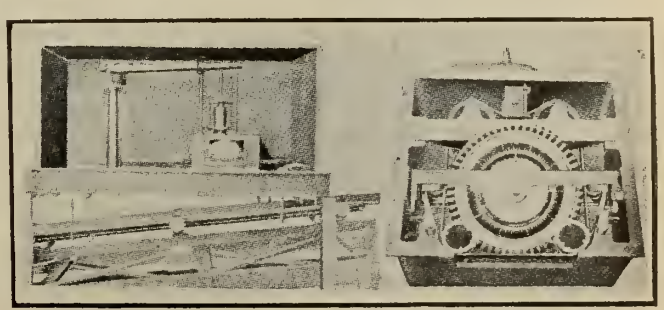
an endless chain, which is carried on horizontal tracks and vertical guides, so as to be capable of both elevating and distributing the coal over a space governed by the distance apart of the vertical legs. The chain is composed of flat steel bars, secured to chilled iron or steel rollers. The containers are secured to the links, either rigidly or on a pivoted bearing. Here lies the chief difference between the gravity discharge and the bucket elevator. The containers on the bucket elevator hang always vertically, and must be tipped by some outside agency before they will discharge. The containers on the gravity discharge type are rigidly secured to the links in such a way that when the chain is ascending the bucket will be vertical, thus holding its contents. As the chain runs over the top guide pulleys, and starts its horizontal run, the buckets turn with the chain in such a manner as to dump their contents. To distribute the coal at desired points a sheet steel upper run is constructed, with gates at certain distances, which can be opened by suitable means from the boiler-room floor. The power for driving is usually furnished by a small motor, and this is always set at the top of the elevator leg. The motor drives direct through spur gears to the main driving sprockets of the elevator.

The problem usually is to bring the coal from the cars to storage, and also to deliver from storage to boilers. The particular plan adopted will depend on the nature of the building and storage. Supposing the plant is one where the cars can deliver the coal directly into an inside storage. The problem then is to distribute the coal in the storage and to the boilers. To do this, a flight conveyor is used in conjunction with a bucket or gravity elevator conveyor. The flight conveyor is a form of scraper, the flights or drags, of malleable iron, being secured at distances of about twelve to eighteen inches apart, on an endless chain. The cars discharge into a hopper, which delivers the coal onto the flight conveyor, this in turn delivering to the boot of the bucket or gravity discharge elevator. The coal is then elevated to the desired height, and discharged either into an overhead bin, or direct to spouts leading either into the stoker hoppers or onto the boiler-room floor. Alternatively it may be discharged back into the building storage to be reclaimed as necessary. To do this, the lower run is encased in a tunnel, and placed a little below the floor level of the storage. Quick acting gates are placed at frequent intervals along the tunnel, which can be operated from the inside. The coal flows through these gates by gravity into the conveyor, and is then carried up to the delivery spouts. In the case of the storage being of necessity outside the building, it may be delivered to an overhead bin by means of a belt, as previously stated, or by a locomotive crane delivering to the hopper used for the cars. Another plan is to build an overhead rail, and use a small electric hoist and grab bucket to carry the coal to the overhead bin in the boiler room. Sometimes the overhead bin is built outside at the end of the boiler-room, and the coal carried in and distributed by an electric hopper direct to the stoker spouts. We show several illustrations of various arrangements of conveyors.

As one of the principal points in handling coal is to know how much of it is being used, some form of weighing machinery is necessary. A track scale to weigh the coal as it is delivered is a very good means of making sure receiving what is paid for. That of itself is not enough. It is important that the coal being delivered to each boiler should be known, so that a check on the performance of each unit can be kept. This can be done by suitable weighing machines connected with the delivery spout from the conveyor, or situated at some point where two conveyors cross. Most of these scales are automatic in their action, and are very reliable. In the writer's opinion, the scale should always be included in the conveyor plant, as the slight extra cost involved is well worth while. The correct weighing of coal delivered to a boiler is very difficult without some special means of this kind. The type used is generally one with two hoppers, containing a known quantity of coal. When the top hopper is filled, the feed is shut off, and a gate opens automatically, allowing the coal to feed into the lower hopper. This is also fitted with a gate, which can open only if the outlet is free underneath. If not, it holds the coal until the space underneath is cleared, when it dumps. An automatic counter is fitted which records the number of times the hopper empties itself. Other machines are made for weighing the coal as it passes over the conveyor, and contain an integrating device to count the number of pounds passing over. The illustration shows one type of these scales. The method adopted is to hang a short section of the conveyor on rods connected with the beam of the scale. This section is balanced by an iron float in a cylinder of mercury. The movement of this float affords a direct measurement of the varying weights passing over the floating section, and then the speed at which the conveyor is running must be taken into account. The integrating device does this.

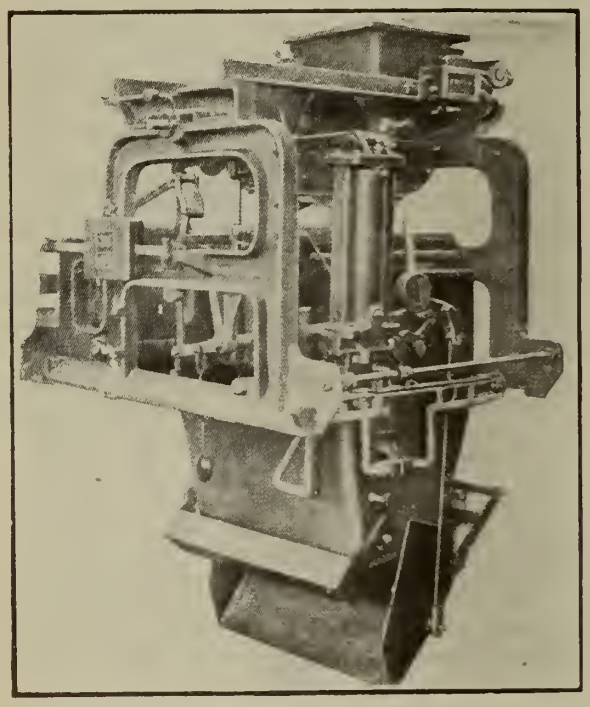
Ash Handling

The handling of ashes, when performed by hand labor,



WEIGHING MACHINE ON CONVEYOR.

is one of the most unpleasant and costly jobs about the plant. Machinery that dispenses with the necessity of this labor is a double blessing. Besides the conveyor systems used for coal, a different type altogether is employed for ashes. In marine work an ejector worked by a blast of steam is used, but in land practice, a steam jet is used to cause a vacuum in a pipe, and the ashes are drawn through by atmospheric pressure. In some plants the coal-handling conveyor is also used for ashes, the lower run of the conveyor being used for this purpose. In others a special conveyor is used to handle ashes alone. The ashes are usually taken from a pit under the boiler, and elevated to a storage bin, from which they can be loaded into the cars direct. In other cases, no storage is provided, space being valuable, and the ashes are elevated directly into the cars. Some installations have in use a spiral screw in a shallow pit directly under the fire doors, and the ashes are raked out of the fire onto a grating, through which they feed onto the screw conveyor. This pushes them along into the boot of an elevator. Where mechanical stoking is used, particularly of the chain grate type, the ashes drop over the back end of the grate, and roll down an incline to the conveyor. Belts are naturally of no use for this work, the nature of the material handled being too destructive. Owing to the wetness of the ashes and their corrosive action, cast or malleable iron make the best resisting material for the conveyor. The flight conveyor can be used for removing the ashes from the boiler front to the elevator leg.



AUTOMATIC COAL WEIGHING HOPPER.

In installing ash conveying machinery it is necessary to consider whether the ashes have to be removed at the moment of cleaning fires, or if they can be allowed to accumulate during the day and be removed at night only. If the coal-handling machinery is fully occupied during the day in supplying the coal, but is idle during the night, arrangements for storing the ashes during the day and removing them by the coal-handling machinery at night is most economical. Sometimes the coal conveyor is more than ample to handle the load during the day, and can be utilized for ash-handling at intervals. If the plant works day and night, fully employing the coal-handling machinery, separate means for dealing with the ashes must be installed. It is impossible to lay down any definite rule for determining the type of installation. Every plant must be considered on its own conditions, and the various factors of first cost, maintenance, etc., taken into account. There are cases where an installation of mechanical equipment is justified, even when it will show a very small actual saving. In plants where labor is difficult to obtain and hard to keep, due to local conditions, mechanical equipment will ofttimes be the means of ensuring continuity of operation. Smooth-running and freedom from annoying stoppages in the power plant are worth money to the production end, and in this way money invested in boiler-room equipment gives a return in dollars and cents.

Before installing mechanical coal and ash-handling machinery, the problem should be put up to the makers of this equipment. Their wide knowledge and experience of different installations make them very well qualified to advise the plant owner, and to assist the plant engineer in the choice of the most suitable equipment.

ELECTRIC TOOL TEMPERING

Successful attempts have been made to employ an electric tool tempering furnace in the Westinghouse Works. The barium-chloride and salt principle is utilized and the furnace consists of an outer shell, a cast iron cylinder packed with fire bricks and an occasional layer of asbestos. The heat is supplied by two pairs of electrodes built in on opposite sides of the walls of the inner chamber. The electrodes operate on a 16 to 30 volt alternating current circuit. After starting up salt is fed into the furnace, which on melting completes the circuit, and a mixture of barium-chloride is then fed in. It has been found in practice that there is great ease of control of the heat and that good work can be performed at a comparatively low cost of operation.

FROM A CALF'S DIARY	FROM A DITTO DIARY
Kicked over my pail of mash.	Kicked for half an hour about my job.
Got my head caught in a bucket.	Got my head full of thoughts of how undervalued I am.
Yelled like blazes for mother for an hour.	Yelled like blazes at everybody who didn't please me.
Rolled my eyes at a little boy and frightened him.	Rolled a cigarette so as to have it ready for the first opportunity to get a few puffs at it.
Experimented on how far I could spraddle my legs.	Experimented on how far I could go doing nothing and get away with it.
Tangled myself in ten feet of rope.	Tangled myself in mental trash.
Nibbled at a small green apple and had a tummy ache.	Nibbled at a small green apple and added a disordered stomach to my other disqualifications.
Refused to be hugged by an impudent hired man.	Refused to be mindful of all the comfortable conditions under which a man works in these times.
Hoard's Dairyman.	From *Threads*

Mechanical Features of an Office Building

Oil Fuel and Complete Equipment Make Power Plant Unusually Interesting to Engineers

The Welfare of Office Employees Has Been Well Taken Care Of.

By W. F. SUTHERLAND

THE modern type of office building erected to-day for the use of industrial firms and business men has little in common with those formerly built. Aside from the excellent working conditions with which the occupant is surrounded a greater degree of interest in his or her physical well being or comfort is manifest. One of the most excellent examples of this type of office building is that of the Imperial Oil Co., on Church St., Toronto, where a gymnasium, a squash court, shower baths, etc., have been incorporated into the building design for those who wish to use them. The mechanical features of this plant are also of more than passing interest to the engineer, for it is seldom that a power plant reflects the attention to detail appearance seen in the present instance.

Heating Plant

Heating is done by a combination of direct radiation and the plenum system. Direct radiation is used for all the main offices, while for basement rooms, squash court, gymnasium, etc, etc., and for the lavatories warm air is supplied by air washing and heating apparatus of the usual type made by the Carrier Air Conditioning Co. of America, 39 Cortlandt St., New York. The usual tempering coils, air washer baffles and main heating coils are fitted and the fan is driven by a 5 h.p. Sprague variable speed motor. The spray pump is driven by a smaller 2.5 h.p. Peerless Motor. Fresh air is drawn in from the roof through a fresh air duct and after being humidified and warmed is distributed throughout the building where required by a plenum chamber and the usual air ducts.

The air temperature is regulated by automatic temperature controlling apparatus made by the Power Regulator Co., New York. Thermostats are located on the incoming cold air side of the tempering coils and also on the outgoing side of the main heating coils. These serve to control the temperature through remote controlled valves on the main steam lines. A uniform temperature is thus secured at all times, no matter what the condition of the air outside.

As mentioned above direct radiation is employed for the heating of the main offices, etc. The Dunham vacuum sysem, installed under the direction of the C. A. Dunham Co., Ltd., Toronto, is used and the excellent arrangement of the piping vacuum and feed pumps, together with the Fisher regulators, will be seen from Fig. 2. Two Blake and Knowles vacuum pumps are employed, each being fitted with a Fisher regulator as shown. These pumps are 8 x 8 x 12 in size and discharge into a hot water receiver above the feed pumps. This receiver is fitted with a float actuating the steam valves on the feed pumps so that they are only running when there is water in the receiver. When the receiver is empty the pumps automatically cut off. The feed pumps, of which there are two, are of the Worthington duplex type, 5½ x 3 x 5 in. in size.

Boilers

For the supplying of steam to the heating system and also to take care of the future power load if an isolated plant is ever thought desirable, two Heine boilers of 195 B. H. P. each are installed in a double setting. These boilers are fitted with circulating blow-offs, etc., and the breeching is carried over to a steel stack 3 ft. 6 in. diameter, which is carried to the roof in a brick well. The pressure carried at present is 65 lbs. with provision made for an increase to 125 lbs. when power is generated in the future. This pressure is reduced to a proper value by means of a Fisher reducing valve.

The boilers are oil fired and the installation presents many features of interest. Perhaps the most noticeable feature to the casual visitor is the extreme cleanliness of the plant in general. The floor throughout is of red tile and the entire absence of ashes and other dirt always present when coal is used makes it easily possible to keep the boiler room, and the apparatus installed in it, spick and span.

Four Simplex oil burners, two to each boiler, are installed. These burners are made by the Standard Oil Burner Co. of Oakland, Cal. Each burner is fitted with a one-half horsepower direct current motor, which serves to drive the blower for air supply and gear type oil pump, both mounted on the motor shaft. The oil pump pumps direct from the oil tank and the surplus over that which is allowed to flow through the regulating valve, flows back through a return header to the oil tank.

The whole mechanism is mounted on a swinging plate

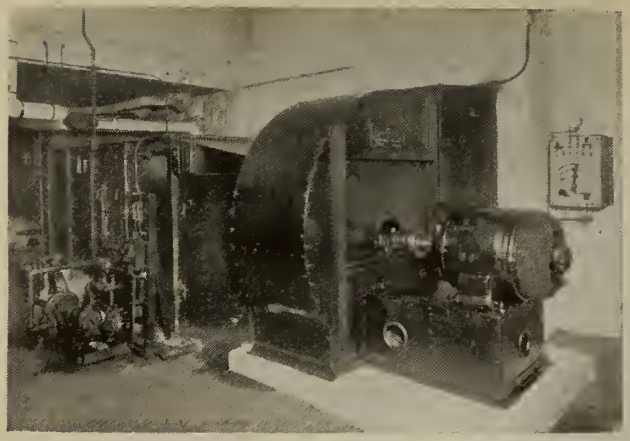


FIG. 1—CARRIER AIR CONDITIONING APPARATUS.

hinged to the boiler front so that when the burner is cut off it can be swung away and the illiptial hole, shown in Fig. 3, closed with a plate. This prevents injury to the burner from the incandescent brickwork of the connection chamber. Each motor is fitted with a starting rheostat and knife switch, this equipment being mounted on a marble panel adjacent to the boiler front.

Electrical connection is made to the motor by flexible conduit and the oil connections are made through a special union which permits the burner to swing easily through the necessary angle. Fig.3 shows the front elevation of boilers and the different positions in which the burners are shown enable their details to be made clearly visible.

The oil tank supplying fuel oil to the burners is placed three feet below the basement floor and is capable of holding 2,015 Imperial gallons of oil. It is 15 ft. long by 5 ft. diameter and is provided with dished heads.

A small coal fired heater and a hot water tank are provided for the furnishing of hot water to wash basins, shower baths, etc.

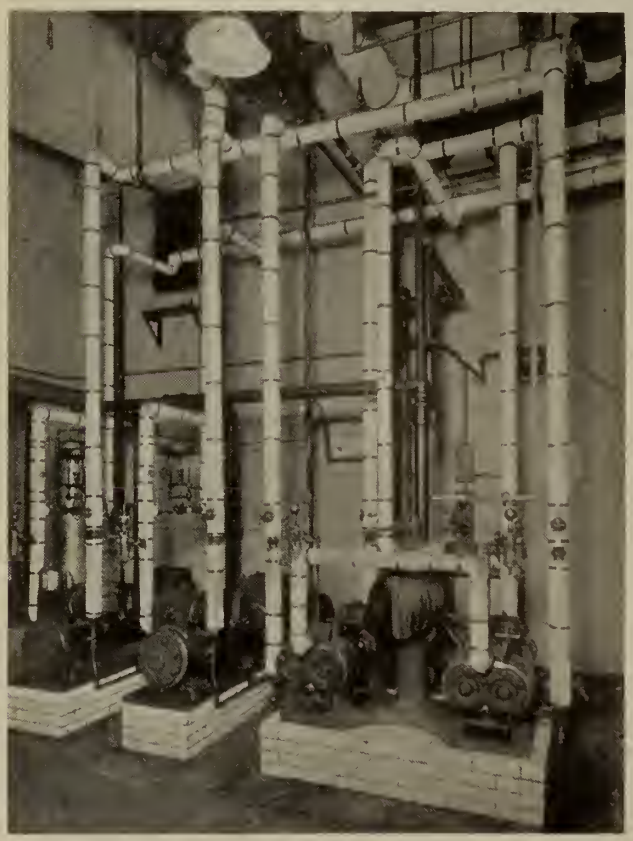


FIG. 2—BOILER FEED AND VACUUM PUMPS, NO. 1 DUNHAM VACUUM HEATING SYSTEM.

The drinking water is all filtered and cooled. Two sets of Loomis-Manning Filters, installed by the Loomis-Manning Distribution Co., Philadelphia, are used. These serve to render the water sparkling, clear and free from any contaminating influence. From the filters the water passes to a cooler operated by a small York vertical two cylinder ammonia compressor. This compressor is driven by a Westinghouse 5 h.p. d.c. motor. A Worthington single stage centrifugal pump driven by a one h.p. motor circulates the drinking water through the system. By keeping the water in constant circulation, it is always at the proper temperature at the faucets and no water need be run off to waste on account of its being too warm. The drinking water faucets are entirely separate from wash basin faucets, and the piping has no connection with the lavatory supply.

In connection with the wash basins throughout the building, it is interesting to note that they are fitted with special faucets made by The H. Mueller Mfg. Co., Ltd., Sarnia.

FIG. 3—BOILERS SHOWING OIL BURNERS. THE ONE ON THE LEFT IS IN RUNNING POSITION, THE TWO MIDDLE ONES SHUT DOWN AND SWUNG OUT, AND THE RIGHT-HAND ONE SWUNG CLEAR AROUND TO EXPOSE FIRE HOLE.

These work on the self-closing delayed principle so that they can be adjusted to remain open for any length of time desired. By this means the basins can be filled to any depth desired without danger of flooding and without the necessity of keeping the faucet open by hand as is the case with all other self-closing faucets.

Two fire pumps are installed, each of the two stage type made by Worthington, and each driven by a Sprague 7½ h.p. d.c. 230 v. motor. These pumps serve to fill two tanks on the roof of the building and are arranged for automatic or manual operation. The starting mechanism is unusually complete and the switchboard of Cutler Hammer make, in addition to the control apparatus for the motors, is fitted with tank indicators and bell alarm.

A low voltage storage battery system is installed and furnishes control for the automatic feature of the fire pump installation, high and low water alarm, elevator signal lights and other features of a similar nature.

Two duplicate 18 volt batteries are installed and a one h.p. Sprague motor-generator set is used for charging. The battery switchboard carries battery charging switches, generator circuit breaker ammeters, voltmeters and the usual feeder circuit knife switches.

A marble distribution board also forms part of the electrical equipment. Energy for power and lighting is obtained from the central station through a 110/220 volt d.c. service. This board presents a very neat appearance through having all the fuses mounted on the back and only the knife switches showing.

Mr. Maxwell Mongraw is Chief Engineer, and Geo. Bains, Plant Superintendent.

The installation of this power plant was done by W. J. McGuire, Toronto.

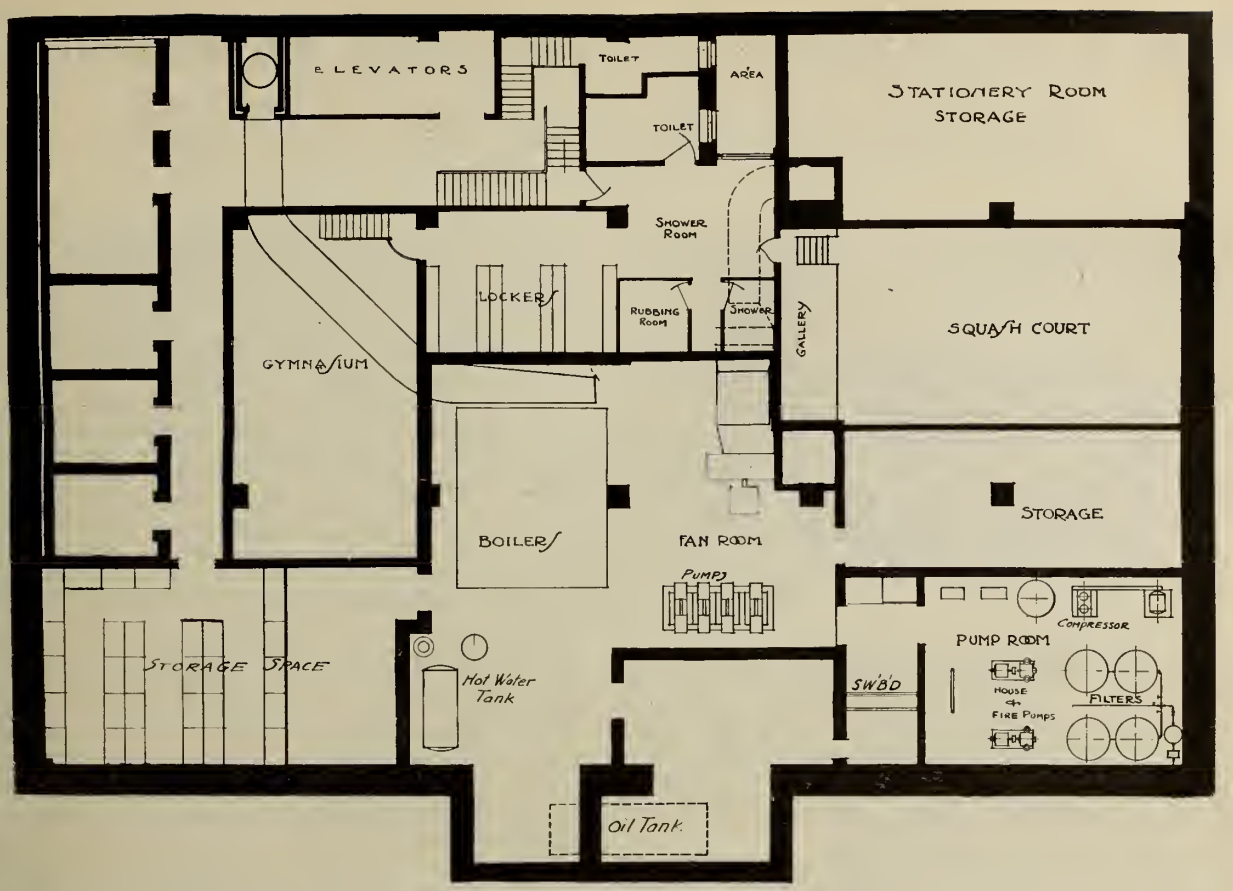


FIG. 4—BASEMENT PLAN SHOWING POWER PLANT EQUIPMENT AND OTHER FEATURES.

A Revolution in Wireless Telegraphy

The more closely the subject is studied the more apparent it is that the three-electrode thermionic vacuum tube has wrought a revolution in wireless telegraph methods. Until the year 1914 all the most powerful transmitting stations in the world generated waves by sparks, and signals were received at nearly all stations by means of crystal or magnetic reflectors. The spark methods of generating waves involved the use of very large antennæ for spanning great distances, and at receiving stations which wished to listen to stations more than even a hundred miles away very large aerial structures were necessary. To-day, most of the high power stations are continuous wave stations, while at the receiving end new modes of detecting these continuous waves have been introduced. This is where the three-electrode tube enters the arena, and has almost removed the necessity for any antennæ at all at receiving stations. For example, under reasonable weather conditions, it is quite easy to listen to the messages coming from stations on the other side of the Atlantic by using a receiving circuit of which the receptive element is a small coil of wire 3 or 4 feet square. Thus, so far as receiving goes, it is impossible to intercept practically all the great stations on one-half of the globe by means of apparatus contained wholly in one room, or even in a cupboard. This does not mean that the use of an antennæ for reception is abolished; on the contrary, when these highly magnifying methods are put into operation with large antennæ for the purposes of reception, the range over which signals can be received is extended very far beyond what it was in 1913, and in consequence it is possible under reasonably good weather conditions to receive at the antipodes the signals from a modern high-power station. In accomplishing this the magnifications in use amount to several hundred thousand-fold. All this is the work of a thing which looks like an ordinary electric light bulb with a few extra pieces of metal in it—the three-electrode tube.

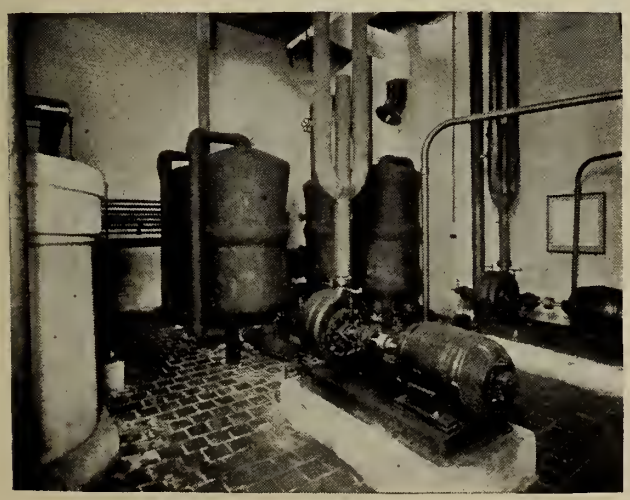
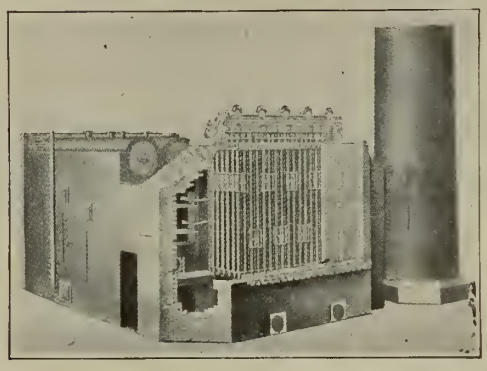


FIG. 5—SHOWING FIRE PUMPS AND FILTERS FOR COOLING WATER.

This is not all the story, for when the tube is made in large sizes it can be used for producing alternating current of high frequency and of considerable power, and then it can be employed for transmitting electric waves. Moreover, by giving another aspect to its functions, the triode can be used for modulating the alternating current just spoken of, and so for impressing upon the waves the human voice. In this way speech has been transmitted freely across the Atlantic, being received, it need hardly be said, at the distant end by the aid of other of the protean properties of the ubiquitous three-electrode tube. In passing, it is worth remarking that the process of thermionic evaporation briefly mentioned above is really, in the opinion of Dr. Eccles, a method of obtaining electricity from matter without the use of moving parts—that is, without machinery.

The Economizer in Power Plant Operation--I.

The Following Article Reprinted From a Paper Read Before the Boston Section of the A.S.M.E. Gives Some Valuable Data on Economizer Operation



EVERYWHERE abroad—in England and throughout the leading countries of the Continent, the economizer is considered a necessary accepted part of the equipment of every steam plant, and its use is steadily growing throughout the world. In Germany, commercial coal averages between $4 and $4.50; but in England, the home of economizer origin, coal sells at 75c to $3.00 per ton, depending upon nearness of mines.

Here, as in the United States, coal comparatively costs about the same, yet several engineers and owners consider the economizer utility doubtful, and even some prominent men consider it to be altogether dispensable. The reasons that are advanced more than any others by these opponents are commonly:

First. Complication and expense for providing space.

Second. The draft is so seriously affected that extraordinarily high and costly chimneys must be installed to offset the economizer effect, or else powerful artificial draft apparatus must be installed.

Third. The feed water can be as highly heated as desired more simply and at less outlay by means of waste from auxiliaries.

There can be added other objections, but they would appear to be only important to some individual proposer, the more common reasons have been chosen.

Simplicity cannot be denied as a desideratum, but no one here would choose the simple life of Diogenes in his tub, although admitting the difficulty of determining the elimination of many things from his home. Therefore, above simplicity we prefer the possession and care for articles that appeal for their beauty, for comfort, for labor-saving, for economy, etc. Civilization is complex. Economy that does not sacrifice reliability is a higher attainment towards the ultimate of human efficiency than an attainment of merely stern simplicity.

Complication and Expense for Providing Space

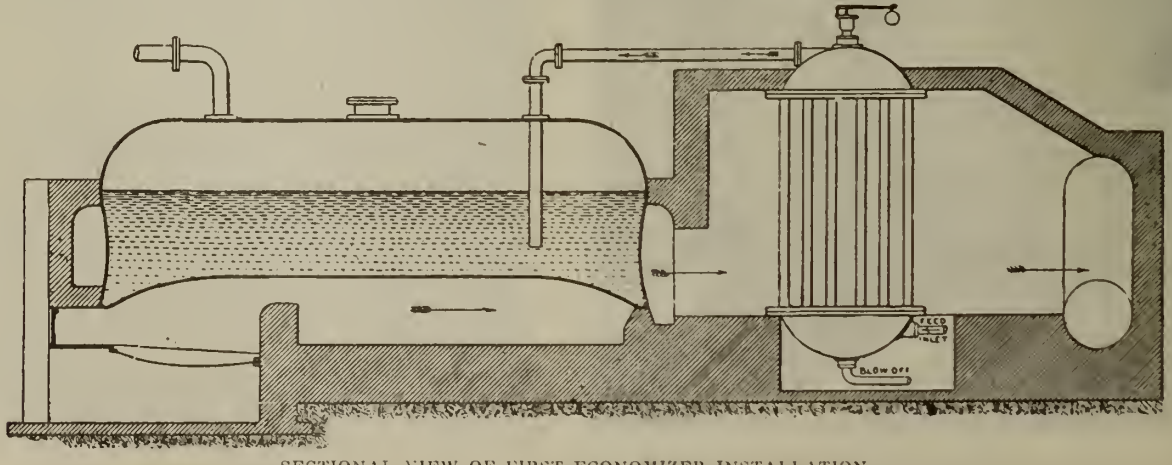
The economizer is not signally different to any other adjunct found in the power plant. Any apparatus or even recording device has its in and outgoing attachment connecting it with the plant. Economizer connections once made seldom need any further concern for adjustment or handling. The feed water supply is regulated in the same manner and the draft likewise day in and day out precisely as if the plant had no economizer. The piping and flue connections are not troublesome to the engineer capable of designing intricate power station equipment.

Perhaps the complication in mind is the occupation space and building features. The answer to this is, that a consulting engineer or architect is engaged upon the supposition that he is able to design a plant or building that will satisfactorily incorporate and house the necessary and desirable features needed to uses of the owners.

With reasonable study, it is seldom that the cost of the boiler building cannot be kept to the same expense with economizers as without them. Space above the floor can in some way be engineered and the room below the economizer well utilized. Instead of a higher boiler building, inexpensive skylight scuttles or skylight monitors, which also give added daylight and ventilation, can be built above the machine for tube removal. Even special outside buildings can be designed to usefully utilize the space underneath the economizer for fire pumps, lockers and baths for firemen, or for store parts, an often unthought of provision.

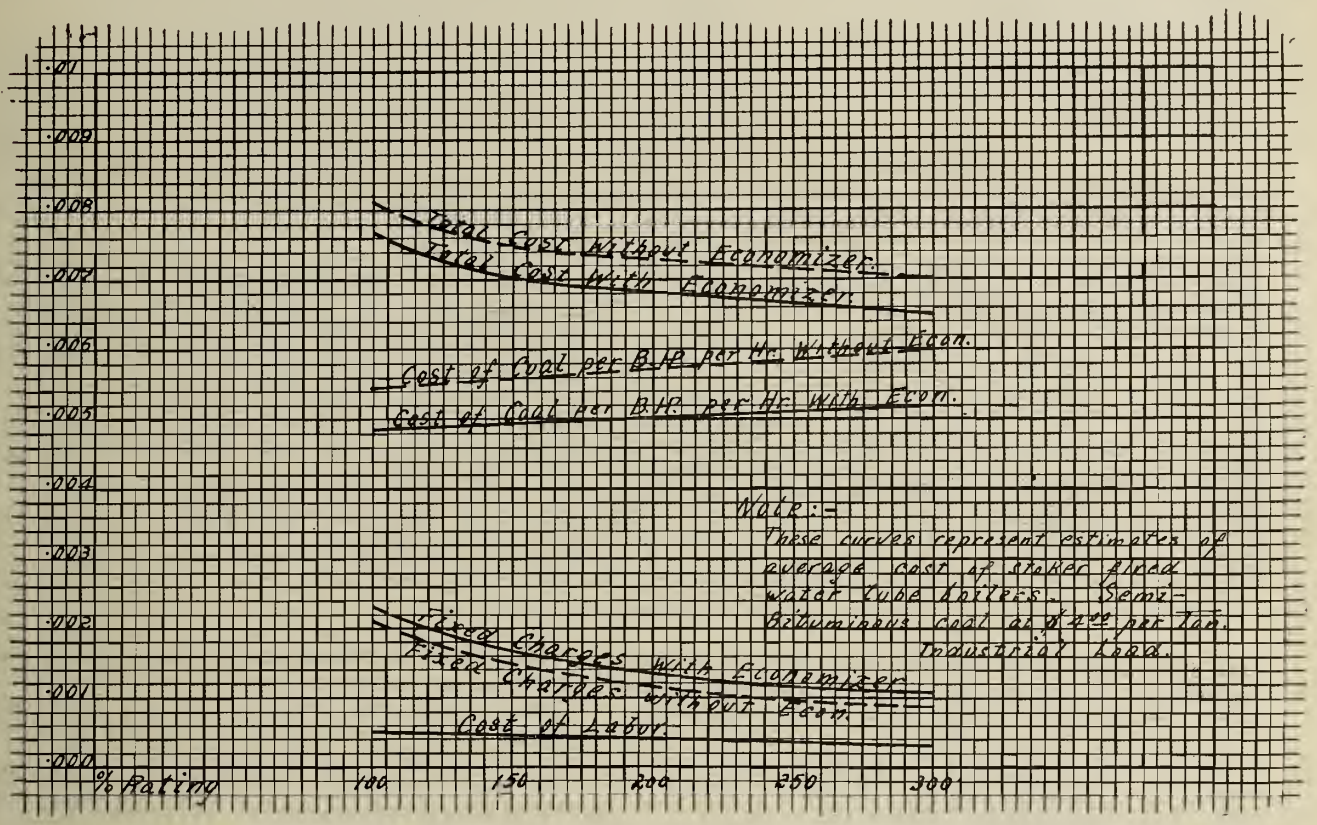
What a person believes in with all his heart and wishes to accomplish he will usually succeed in doing, even though physical or financial restrictions prescribe certain limits, while without that spirit the slightest encounter of difficulty appears insurmountable. Many economizers have been put into stations where the original consulting engineer had no use for them and seemingly thought there was no possible space to employ them.

When some economizers do not work well under ordinary conditions of draft or to over-load, or with stokers, the man with the ideals and perception will not accept those results with content, but inquires the wherefore that these tests and results fell short of a better attainment found elsewhere.



SECTIONAL VIEW OF FIRST ECONOMIZER INSTALLATION.

Referring to the chart herewith: "Cost of Steam to Boiler Rating." This is an interesting study showing if an economizer was introduced it would lower the cost of coal line about 10 per cent., and probably better, keeping this line more even and reducing the ascending coal cost shown.



CURVES SHOW FIXED CHARGES, TOTAL COSTS AND COST OF COAL WITH AND WITHOUT ECONOMIZERS.

It has been assumed that equipment is figured for boilers, stokers, building, chimney, etc., without economizer at $47 per B H.P. If we add 11 per cent. for economizer installation, or $5 per B.H.P., it would raise the fixed charge line accordingly, and, as the total cost line is obtained by the addition of the 3 curves below, it has a marked lower position by effect of the lowered cost of coal. This new line looks handsome and worth trying to obtain.

Examples of insufficient draft are as frequently found in the average old plant without economizers as with them. Examples of going plants operating economizers successfully, with ordinary chimney heights, are to be readily found everywhere under all varieties of conditions—all types of boilers—all types of grates and stokers —all kinds of coal, etc. All of which should teach that finding an economizer plant at fault in the matter of draft, the instant conclusion that the apparatus is the cause of the trouble, would be a rash judgment. It may be true in some rare instance that cutting out the economizer has improved the draft, due, not to the effect of the apparatus, but to poor engineering design of angles and openings into the economizer. This has been proved when these conditions are altered, by the economizer going back into use with better results than ever. When a plant has grown so that the gas volume really overcrowds in the economizer chamber, then a remedy is easily had by allowing the gases from one or two boilers nearest the stack to go direct without passing through the economizer at all, thus reducing the volume to be handled through it to the proper limit of its ability. Simple as this sounds, it is seldom thought of, as the growth has been gradual for years with satisfactory results for most of the period until the owner discovered the economizer restriction, when his cure has been to arbitrarily cut it out altogether, or until this remedy or some other even more simple change is suggested to effect the desired improvement. It is a matter of surprise how often the draft difficulty has been found to lay elsewhere than in an economizer.

In 1891, Mr. Geo. H. Barrus had noted this very point in his book, "Boiler Tests," that it took actually more draft to operate the plant without an economizer than with it, and comments on this as follows:

"It is important to note the effect which the use of the heater has upon draught. The amount of draught suction which existed in some of the above examples and in one additional example, together with information regarding quantity of coal burned and other matters bearing on the question, are given in the accompanying table.

"The effect of a reduced temperature of the escaping gases, which always accompanies the employment of the heater, is seen in every one of these instances to reduce the draft power of the chimney. In Boiler No. 59 the temperature is reduced from 645 degrees to 365 degrees and the draught from 41/000 of an inch to 32/100 of an inch, or 22 per cent. This is with an eighty-foot chimney. In the last case a reduction of temperature from 575 degrees to 373 degrees is accompanied by a reduction of draught from 97/100 of an inch to 69/100 of an inch, or 29 per cent. This is with a 140-foot chimney. Although the general effect of the flue heater in this respect is unfavorable, a large amount of draught is required to operate the boiler, in every instance where the average draught is given, when the heater is thrown out of use. This is not due to any peculiar action of the heater, but evidently to the increased quantity of coal which must be burned in order to make up for its absence."

The fuel bed resistance would be less to produce a given boiler output, because there is less coal used and hence the less resistance as noted by Mr. Barrus. This is just as true with stokers as without them. It is just as true for overload conditions as for normal. To develop overload conditions, it does take enormous draft pressures to get the needed air through the thick fuel bed. Provide therefore such proper pressure if you will,

	No of Test	3.	4.	5	6	7	8	9	10	
	Date.	May 7 03	May 8 03	May 12 03	May 13 03	May 14 03	May 15 03	June 4 03	June 5 03	
1	Boiler Number	#1 Unit 7 BH	#1 U. #1 BH	#1 U. #1 BH	#1 U. #1 BH	#1 U. #1 BH	#1 U. #1 BH	#1 U. #1 BH	#1 U. #1 BH	Coal used on tests 3, 4, 5
2	Duration of Test (Hours)	10 Hours	10 Hrs.	10 Hrs.	10 Hrs.	10 Hrs	10 Hrs.	10 Hrs.	10 Hrs	6, 7, 8 was # 2
3	Pressure of Air	14.74	14.81	14.92	14.86	14.78	14.70	14.84	14.93	Buckwheat from the
4	Average Boiler Pressure	94.40	96.65	94.20	95.50	95.14	96.90	97.3	96.1	N. American Coal Co
5	" Draft (Inches. of Water)	.73	.51	.63	.63	1.21	43	.48	.57	
6	Type of Grate	Yingling	Yingling	Ynq	Ynq	Ynq	Ynq.	Ynq.	Ynq	Whenever dry coal is
7	Grate Area in Square feet.	72	72	72	72	72	72	72	72	mentioned, the moisture
8	Heating Surface of 2 Boilers. Sq Ft	2454	2454	2454	2454	2454	2454	2454	2454	as obtained by drying
9	" " " Economizer - -	2880	2880	2880	2880	2880	2880	2880	2880	the coal (12) has
10	Lbs. of Coal Burned	12470	3666	11380	8130	14928	8090	15460	14132	been deducted.
11	" " " per Sq Ft. Grate Surface per hour.	17.3	13.4	16.0	11.3	20.7	11.09	21.47	19.62	
12	% Moisture obtained by drying Coal.	2.98	3.84	2.55	3.42	3.41	—	—	—	Whenever combustible burned
13	Total Refuse from Coal in Ash Pit.	1674	1282	1600	898	1335	1070	1342	1186	is mentioned, moisture
14	% " " " " "	13.42	13.26	13.81	11.04	13.09	13.22	8.68	8.39	as above noted has
15	Lbs. Dry Coal Burned.	12098	9395	11285	7852	14419	—	—	—	been deducted and also
16	Lbs Combustible Burned	10424	8113	9685	6954	12464	—	—	—	Refuse as taken from
17	Chemical Analysis of Coal % Moisture.	4.70	4.46	—	—	—	—	3.0	3.0	Ash Pit of Boiler (14)
18	" " " " % Ash.	13.48	12.23	—	—	—	—	5.6	5.6	
19	" " " " % Sulphur.	0.30	0.24	—	—	—	—	1.93	1.93	On Tests 9 & 10 Webster
20	" " " " % Carbon (Fixed)	56.10	57.30	—	—	—	—	43.4	43.0	Soft coal was used,
21	" " " " % Volatile Gases.	25.70	26.10	—	—	—	—	46.3	46.3	supplied by
	Total	100.28	100.27	—	—	—	—	100.03	100.03	Fairlie & Wilson.
22	% Coke obtained by Analysis	69.6	69.5	—	—	—	—	48.6	48.6	
23	Calorific Value of Coal from chemical Analysis (Approx)									
24	Analysis of Flue Gases % CO_2	8.54	3.74	7.73	10.22	7.41	11.21	—	—	
25	" " " " % O	11.79	10.10	12.0	10.47	12.64	8.79	—	—	
26	" " " " % CO	.14	.07	.18	.20	.20	.20	—	—	
27	Lbs of Air per Lb. Coal calculated from CO_2	26.60	23.30	29.37	22.21	30.51	20.25	—	—	
28	Lbs. of Water from Tanks on 32° Basis	104272	83707	101670	74923	130628	69771	158591	145967	
29	" " " " " Corrected for Temperature (36)	102333	82272	99911	73580	127604	68664	156165	143725	
30	Efficiency of Boiler (Dry Coal)									
31	Total Water evaporated from & at 212°	113606	91707	111302	81565	138997	76065	174782	160796	
32	Temperature of Flue Gases entering Economizer.	310.4	473.5	316.8	450.2	335.5	434.4	382.1	619.8	
33	" " " " leaving "	239.9	226.6	268.4	229.8	279.0	214.5	268.6	266.8	
34	" " Feed Water entering "	143.9	139.8	141.7	144.5	162.5	135.2	133.4	135.6	
35	" " " " " Boiler	273.0	231.3	268.1	233.1	293.2	242.4	234.0	233.1	
36	" " " " " in Tank	146.8	142.3	142.9	140.4	165.7	138.1	136.4	136.7	
37	" " Atmosphere	72.0	76.5	71.0	74.0	81.5	84.5	76.0	67.0	
38	Actual Evaporation per lb of Coal.	8.209	8.513	8.630	9.044	8.338	8.489	10.101	10.17	
39	" " " " " Dry Coal	8.453	8.853	8.856	9.364	8.839	—	—	—	
40	" " " " " Combustible Burned	9.820	10.269	10.318	10.513	10.225	—	—	—	
41	Equivalent Evaporation from & at 212° per lb Coal.	9.110	9.488	9.612	10.032	9.311	9.581	11.305	11.373	
42	" " " " " " Dry Coal.	9.390	9.867	9.864	10.375	9.640	—	—	—	
43	" " " " " " Combustible.	10.097	11.445	11.492	11.720	11.154	—	—	—	
44	Water evap^{n} from & at 212° per # H.S per 2 Boilers per hour.	4.63	3.73	4.53	3.32	5.66	3.13	7.12	6.93	
45	" " " " " " " Unit per hr. (Boilers & Econ^{r})	2.13	1.72	2.08	1.53	2.60	1.44	3.27	3.01	
46	Ratio of H.S. for 1 Unit to Grate Surface " "	74.08	74.08	74.08	74.08	74.08	74.08	74.08	74.08	
47	Actual Water from Tank evap^{n} to Steam per # B.H.S. per hour.	4.170	3.353	4.471	2.995	4.191	2.798	6.36	5.83	
48	% Total Heat in Steam due to Economizer	12.39	10.48	12.03	10.20	12.51	10.04	11.13	11.92	
49	Boiler Horse Power developed A.S.M.E. Rating.	329.5	266.	323.	236.5	403.	223	387	466.	
50	Ratio devel H.P to Rated H.P. (2045 B.H.P @ 12# H.S. per H.P	1.610	1.3	1.579	1.157	1.97	1.09	2.48	2.281	

SCHEDULE OF TEST.

and, indeed, must do so, and then add a properly designed economizer. The top blanket layers of fuel are then taken off by the economizer and the draft is eased wonderfully. So if, therefore, adequate draft has been provided, either natural or artificial, suitable for operation without economizers, then there will be no difficulty in keeping up steam with a less expense for coal.

"The speaker first described with the aid of illustrations the dependence of chimney costs upon their height and inside diameter, the relations between the chimney heights, the hourly consumption of fuel and the operating costs and temperature of the gases entering the chimney.

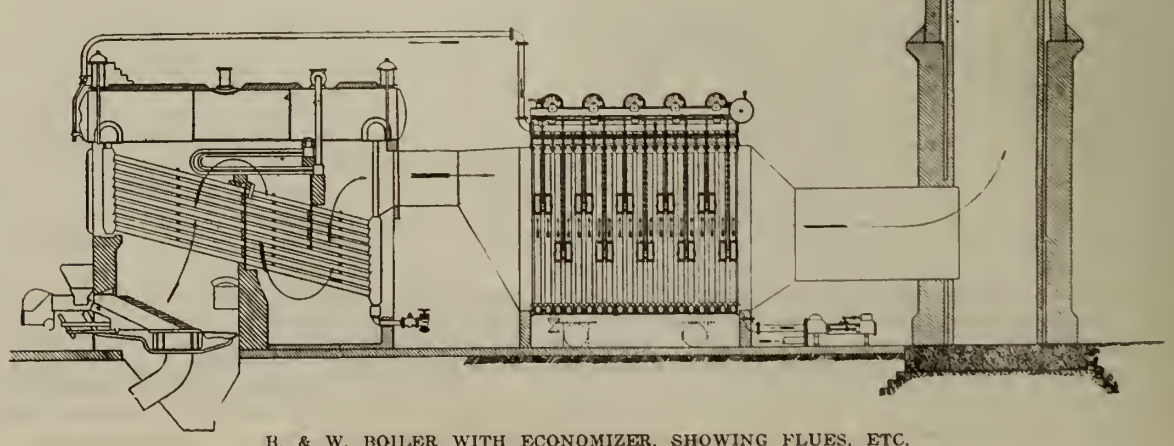
"Of great importance in determining the gross dimensions of the economizer, are the temperature of the entering water and the drop in temperature of the flue gases that are employed.

"The entire installation will be cheapest when the utilization of the flue gases in the economizer goes the farthest. How far the flue gas temperature is then econ-

Table No. 10 INFLUENCE OF FLUE HEATER ON THE DRAUGHT

1.	Number of boiler		33		46		59		68		...
2.	Height of chimney, ft.		110		80		80		80		140
3.	Conditions	Heater used	Heater not used	Heater used	Heater not used	Heater used	Heater not used	Heater used	Heater not used	Heater used	Heater not used
4.	Coal per hour, lbs.	491.7	547	752.7	875.6	683.1	984.1	760.3	843	2.952	3.282
5.	Temp. gases entering chimney, deg.	231.	399	254	342	365	645	279	452	373	575
6.	Average draught suction inside damper, inches	.....	.....	.17	.22	.09	Not taken	.25	.27	.64	.67
7.	Draught suction with damper wide open, inches	.40	.51	.25	.27	.32	.41	.26	.30	.69	.97

The following abstract of a report by Engineer Gleichman, presented at the Munich convention of the International Association of Steam Boiler Inspection Societies, and translated from "Gluckauf," is of interest to those having to do with economizers:



B. & W. BOILER WITH ECONOMIZER, SHOWING FLUES, ETC.

omically utilized depends upon the temperature of the feed water. If the service is variable it is proper to proportion the outfit for the average efficiency.

"The question whether, in large plants, one common economizer or separate equipments behind each boiler should be used cannot be settled by general principles since it depends upon working conditions. With very regular load a common economizer would be advantageous because of its cheaper first cost and smaller amount of outside radiating surface to the single chamber, while, where boilers are frequently cut off, as in electrical stations, individual economizers are preferable, there being danger that otherwise a too great cooling down of the flue gases may reduce the draft.

"Summing up, the question of employing economizers may be answered by saying that they are primarily of use in enabling the designer to lay down an economical plant, by most completely utilizing the flue gases and obtaining the best combustion. Their field of usefulness will widen the more that small boiler plants disappear and hand-stoking gives place to mechanical. The size of an economizer as compared with the boiler heating surface—which cannot be settled by a fixed ratio, since it depends upon the feed water temperature—should increase with the pressure and with increased attempt to employ in the boiler only heating surfaces of high value."

Note the attitude of Mr. Gleichmann upon the matter of draft. He treats it as a reasonable affair to be designed and laid out to requirements. Just as any practical man would give thought to provide the right air spacings of grates, determine the use of large or small tube areas and forethought to other resistances, to the draft for properly operating a boiler to suit conditions. No fear or special anxiety is given to such matters, although it is important that they should be taken into account.

An interesting test at the Clark thread mill, where boilers were intentionally put in, designed to run at over-rating, using an economizer with induced draft, producing a boiler horse power with less than half the usual rating of 10 sq. ft., is worthy of record.

The test was made under Mr. Abercrombie, the expert of the thread interests in Scotland and America, and shows definitely a less draft needed for over-rating conditions than other practicing engineers would require without economizers.

"Induced Draft," occasionally we find, is still regarded as "some bogey." The subject of Induced Draft is a broad one, but in general, I would say that these operate more satisfactorily than forced draft alone, which later produces arduous conditions to the maintenance of the stokers, furnace, boilers and a strain upon the labor. The forced draft stokers need to be watched for holes in the fire, which have to be hand-treated under extreme difficulty, with steam falling away until they are remedied. This is a frequent experience. Some forced draft stoker customers have considered it advisable to add to their retort capacity to cut down the blast effect, although they were developing nowhere near 200 per cent. of running. These owners had installed the size of their equipments as recommended by the stoker concern. Forced draft to hand-fired boilers after a five years' use produces a sad looking plant; while induced draft keeps operating indefinitely for years in smooth steady fashion.

This line of argument is not fair to either type of draft. Conditions must be maintained aright for any apparatus to keep performing its duty—the induced draft has a wider range of accomplishment to changed conditions and makes for more agreeable plant operation. This is due largely to its greater size to handle the same air weight as would be forced through the fire by the blast fan type.

In the great paper mills of S. D. Warren & Co., and Hollingsworth & Whitney, the induced draft is found dependable 144 hours every week, and in many public service stations they are found reliable for service every hour of the entire year.

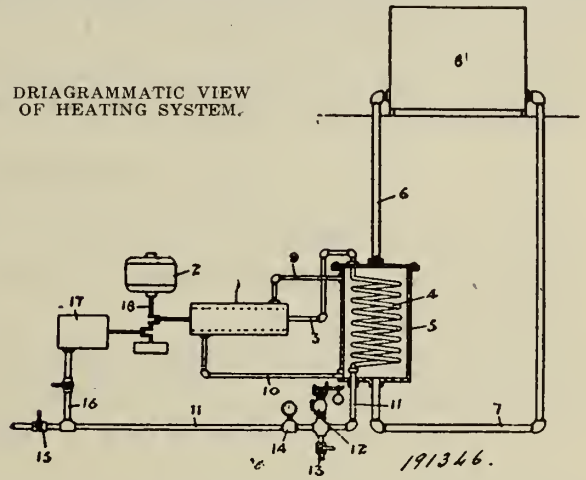
(To be concluded)

A New Heating System

A NEW heating system of considerable interest forms the basis of a recent patent issued to Robert Cairns, Chief Engineer of the Farmers Dairy, Toronto. The accompanying illustration shows in diagrammatic form the principle of the system as outlined in the patent specifications.

The principal feature of the invention consists in the novel method of heating a circulating medium by the compression of air by electrical means and the passing of the compressed air through suitable radiating coils to convey the temperature to the water of the circulating heating system, and to utilize the reduced temperature compression for other purposes, or to expand the air to relieve the consumption of electrical energy in initial compression.

The air compressor (1), which can be of any suitable type, is operated by an electric motor (2). The compressed air is carried from the outlet of the compressor by a pipe (3) to a radiating coil (4). This coil is enclosed within a tank (5), which is connected to a suitable water heating system of the circulating class by the pipes (6) and (7). The heat of the compressed air passing through the coil heats the water in the tank, which rises through to pipe 6 to the radiators and returns by pipe 7. The heat of this compressor is further utilized by the connection of the water jacket of the compressor to the tank (5) by means of the circulating pipes shown. A pipe (11) leading from



the coil (4) is provided with an adjustable safety valve (12), which may be regulated to relieve at different pressures, and below the safety valve a drain cock is provided which will allow condensation to be drawn off.

A suitable pressure gauge is arranged in the lengths of the pipe and cut-off cock cuts off the pipe (11) from an extension which may be connected to any suitable apparatus which it is desired to operate by compressed air.

A branch pipe (16) leads from the pipe (11) to a re-expanding cylinder (17), which is connected with the shaft (18) of the electric motor so that the pressure of the cooled compressed air remaining may be utilized to relieve to a certain extent the work of the motor. The safety valve is of the adjustable type so that it may be adjusted to relieve at various pressures. The adjustment may be regulated to increase or decrease the temperature of the circulating water through the heating system, for as the pressure increases the temperature rises.

It is stated that a system such as described has in experimental tests shown extremely satisfactory results, and when it is considered that the compression of air to 100 lbs. produces a temperature of approximately 450° Fah. with an intake temperature of 60° Fah., the heating of water can be accomplished to suit the requirements of very extreme weather, besides providing cold air for refrigerating or cooling purposes, and the inventor further states that the application of electric energy to the production of heat in the manner described is entirely novel, and it is further stated that many variations in the actual apparatus may be made without departing from the principles of the invention.

Application Forms for Graded Certificates

The Forms Given Below Are Those Which Will be Issued Shortly by the Board of Stationary Engineers for Both Engineers and Plants—Certificates Will be Graded on These

IN our Oct. 6 issue the regulations respecting the grading of stationary engineers were printed. Below we are giving the application forms which will be sent out in connection with this grading of both engineers and plants. It will be seen that two different forms are shown. The engineer himself has only to do with the first one, as it concerns him alone, while the other one has to do with the plant. The form which the engineer is required to fill out will be sent out shortly by the Board of Stationary Engineers to all those holding certificates at present. When filled out and returned by the engineer, the information given will serve to determine his status for the coming year, and whether a second or third-class certificate will be granted him.

For this reason it is earnestly requested by these who will have charge of the grading that all information asked for be given fully and as accurately as possible. This, it will be readily seen, is to the engineer's own advantage.

One thing more, the fee for renewal for the year 1920 will be only one dollar, and not the amount required under the regulations for an entirely new certificate.

A number of inquiries have already reached POWER HOUSE as to what steps an engineer should take for the obtaining of the new certificate. The answer is easy: do nothing but wait for the application blank to come to you, fill it in and return it. If by any chance you are overlooked, some time in the latter part of the year write the Board requesting one.

Engineers having no certificates at present and passing the present examinations up to the last day in December will be given one of the present certificates, and this will be exchanged at the proper time for the 1920 certificate, either second or third, corresponding to qualifications.

The second form will be filled out by the owner of the plant, or likely by the engineer for the owner. This form will be sent to the owner of the company direct at a later date than the engineer's application form. It asks for sufficient information for the plants to be graded properly.

Application For Renewal of Stationary Engineer's Certificate, 1920

I, ...
(Name in full, no initials)

of .....hereby make application for a graded certificate for the year
(Place)

1920, same to be granted to me in lieu of renewal of my present non-grade Stationary Engineer's Certificate. The sum of One Dollar is enclosed herewith.

AND I hereby affirm that I am a British subject, the holder of Stationary Engineer's Certificate No. ..... last issued to me in the year....., and that I have had experience with boilers and engines as follows:

State length of practical experience, giving dates to cover each period of your employment at separate plants:

....

....

State in what capacity you were employed:

.....

.....

State if you hold certificates from any other Boards; if so, submit same with this application for verification:

....

Give names of your previous employers:

....

Give name and address of your present employer:

....

Give length of time in his employ:

....

Give B.H.P. (Boiler horse power) capacity of plant or plants you have handled:

....

Give B.H.P. of plant where you are now employed .....: also steam pressure carried.....

State kind of boiler or boilers now under your care, whether return tubular, water tube, horizontal, locomotive, marine, etc. ....

.....

....

Give dimensions of boiler or boilers.....; length and diameter of same.....; number of tubes.....; diameter of same.....; area of grate surface.....

N.B.—No details of an applicant's experience should be omitted, as this information will be used in deciding the grade of certificate he will be granted.

I hereby make oath and say that the statements herein contained are to the best of my knowledge and belief true in substance and in fact.

Sworn before me at the.....
of..... in the.....
of .....this.....day of
.....19..
.....
A Commissioner, etc.

.....
Signature of Deponent.

NOTICE.—All questions on the application must be answered in detail, otherwise a Third-class Certificate only will be issued from same; pen and ink to be used.

Certificate No.....

Signature of applicant.....
(Write plainly)

Address .....
.....

Application For Registration Certificate, Province of Ontario

In compliance with section 7, sub-section 4, of the Act respecting Stationary and Hoisting Engineers,

I, ... of .....

hereby make application for a Registration Certificate for the Province of Ontario, which Certificate will permit me to have operated the stationary steam plant owned by me located at.....particulars of which are as follows:

B.H.P. .....

Steam pressure carried during the day..... night .....

State kind of boiler or boilers in your plant, whether return tubular, water tube, horizontal, locomotive, marine, etc.....
.....
.....

Give dimensions of boiler or boilers.....; length and diameter of same.....; number of tubes.....; diameter of same.....area of grate surface .....

I hereby make oath and say that the statements herein contained are to the best of my knowledge and belief true in substance and in fact.

Sworn before me at the .....
of..... in the.....
of..... this.....day of.....
.....19..
.....
A Commissioner, etc.

.....
Signature of Deponent.

KEEP TANK VENTS OPEN

THE attention of works engineers to the necessity of close inspection to see that tank vents are open and unclogged is emphasized by a writer in "Factory."

Every large oil tank has a vent. Tanks which hold other supplies besides oil must also be vented in a positive manner to prevent gases being confined. There is another function which the vent performs that is fully as important.

When a tank of liquid is being pumped down, the top will soon collapse if the vent pipe becomes closed. Such an accident is of frequent occurrence and the difficulty of bringing the tank crown back into its normal position is great.

The usual type of vent in an oil tank is a gooseneck of sufficient cross section. The gooseneck projects through the upper part of the tank and by means of a return vent terminates in an open-ended drop. On the open end is usually placed a fine copper or brass-mesh screen. The opening in this way has a chance to become stopped up by dirt sticking to this screen and forming a hard layer.

BELT SPEED AND LENGTH RULE

TO find the speed and length of belts "Belting" gives the following:

"To find the speed multiply the circumference of the driving pulley in feet by the revolution per minute. For example, a pulley 12 in. in diameter makes 150 r.p.m. What is the speed of a belt traveling over this pulley? The circumference in feet is equal to 3.1416 by 150, the number of revolutions per minute equals 471.24 ft. per minute, or nearly 471¼ ft. To find the circumference of the pulley, multiply the diameter by 3 1/7, which product multiplied by the revolutions per minute gives the speed of the belt per minute. To determine the length of the belt, add the diameters of the two pulleys, divide the result by 2 and multiply the quotient by 3 1/7. Add the product to twice the distance between the centres of the shafts and you have the length substantially."

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Fuel Economy is Still Desirable

FORGETFULNESS is a common failing and unless repeated to-day we are apt to forget the lesson of yesterday. During the period of war activity much was heard about the necessity for fuel economy. Governments, engineering organizations, and the press, technical and lay, laid stress on this feature of industrial conservation. This was as it should be, for the lessening of fuel consumption not only relieved the labor shortage but rendered available coal for essential industries.

While the war has been won, fuel conservation is still well worth considering as a factor in the winning for ourselves the fruits of the peace through which we have been struggling to a better civilization.

Many hare-brained theories are being advanced by half-baked economists and radicals of a less disinterested type for the remaking of the world, and for its betterment as a place to make a living in, but none of them has as much to commend it as the old-fashioned idea of hard work, greater production individually and in the mass.

Greater production is only one aspect of efficiency and includes not only increased production of material things but their wiser utilization. The personal inspection of possible sources of power waste, whether in the engine room, boiler room, or factory, will do much to lessen needless waste of coal, and this together with the proper training of operatives and investment of apparatus tending to economy will do much towards lessening the use of all Canada's fuel resources and the importation of coal from our neighbor to the south. Money in pocket will also result from this practice whether the power plant owner takes the more altruistic view or not.

Boiler room losses are easy to detect and are easily remedied. Air infiltration, leaky baffles and excessive heat radiation are only three of the possible sources, to mention nothing of improper methods of firing. Losses from bare steam pipes through condensation are rarely estimated at their true value and covering, which saves 70 to 90 per cent. of the radiation loss, is, in all cases, good investment. Insulation should cover not merely the pipe itself but also its flanges, fittings and the surface of any accessories with which live steam comes into contact.

A steam leak is small in itself but great in its appetite for coal. Three dollars a month is too much to pay for a one-sixteenth-inch hole in a steam line. It is better to have the leaky gasket, fitting or other cause replaced or repaired. Leakage of steam at stuffing boxes is too often prevented by an unwise tightening of the gland nuts. This is going to the other extreme and requiring more steam for work which doesn't appear at shaft. A pump may require as much as 30 per cent. more steam from this cause alone.

Steam traps are another potential source of loss through steam leakage and the best of traps is none too good. And these sources of loss are only a few of the many possible. On the other side of the ledger are the many power plant accessories made for the express purpose of securing economy in operation. The majority of these find their place in the boiler room and if wisely used fulfil expectations. Recording and indicating apparatus go hand in hand with means for securing better combustion with less labor.

Eventually, in every country, the burning of fuel will be an exact science carefully worked out even in the smaller plant and probably subject to some form of control. The coal resources of the world are not inexhaustible and their wise utilization is a matter of concern to everybody.

Man is optimistic by nature and readily makes himself believe that other sources of power will be found, possibly twelve-mile deep shafts into the earth's crust or interatomic energy will be available, but carbonaceous fuels are not replaceable in some industries.

Did You Ever Do This?

I MET my friend upon the street, his face was out of plumb; his countenance was far from bright, in fact 'twas sour and glum—he looked as though his wife had just begun to try on him, some sixteen kinds of fancy eats to stow beneath his skin.

He waddled 'cross the street, he did, with stride both poor and lame; you couldn't call it rheumatiz, nor was this fellow lame.

But I had known this chap for years, in seasons good and bad, nor had I seen his map before so wrinkled nor so sad. I thought some grief had come to him and smote him on the jaw, or else he'd been pulled into court for bustin' up the law.

So I drew nigh unto this prune, and sought to cheer this boy. I cracked ten jokes and cackled, too, to spray his soul with joy.

He never budged an inch, by heck, his sufferin' was intense; there camped upon his carcass now a spasm most immense.

"Come tell me now what's all about, this grief what's smote your life—be it an illness in the house, or have you canned your wife?"

He drew my head toward his chest, and bade me flop an ear, and meantime tried to choke a sob and boot away a tear—and then he lifted up his voice and told me of his woes—he had that day put on his hide his woollen underclothes!—ARK.

Appointment Made to Board of Examiners

In connection with the grading of certificates in Ontario, an appointment has been made to the Board of Examiners whose duty it will be to carry out the provisions of the Act. Chas. Mosely has assumed the duties of assistant to the chairman of the Board, Mr. W. C. McGhie. Mr. Mosely's duties will be those of a permanent examiner and will entail his travelling from centre to centre throughout the Province. Mr. Mosely was formerly in charge of the Power Plant at Toronto University, the supervision of which will be now under his son, Chas. S. Mosely, Junior.

An experience of forty-five years as operating engineer, 30 years of which were spent in charge of power plant operation will bear evidence to Mr. Mosely's capabilities in filling his new position.

A New Water Turbine

The need for bridging the gap between the higher speed of the Pelton wheel and lower speed of the Francis turbine has been recognized, and it is now reported that a Budapest engineer has succeeded in providing this intermediary machine. It is stated that the new turbine can be installed as simply as a water wheel, but presents the advantages as compared with water wheel working of higher efficiency, lower first cost, and reduced operating and repair cost. Essentially the wheel consists of two discs carrying a series of cylindrical blades, and tests with model wheels have indicated efficiencies of 87 to 89 per cent.

Readers—Notice!

ON January 1st the subscription price of POWER HOUSE will be two dollars per year. Last spring, in reply to a questionnaire we sent out to all subscribers, it appeared to be the universal opinion that for a semi-monthly journal like POWER HOUSE, two dollars per year would be a minimum subscription price. Now, we're here to help the engineer—we're doing so, constantly. We should get three dollars per year at least. But two dollars 'twill be—after January first next.

In the meantime subscriptions will be accepted (also renewals) at one dollar per year. Send in yours to-day.

Germany's Copper Shortage

ONE result of the Allied blockade of Germany was seen in the many expedients to which the Hun was forced in the obtaining of the 120,000 tons of copper necessary annually for military requirements. Home production was only about 23,000 tons per annum in pre-war days and this was reduced to about half owing to the mobilization of the miners.

The *Technical Review* in a translation of an article from *Technick und Wirtschaft* gives some further interesting data relative to the economies practised. During the first two years of the war the deficit was partially covered by booty from Belgium, France and Russia. Large quantities of scrap copper and brass were collected from munitions works and from fittings on naval and mercantile vessels, the scrap being smelted and refined.

Bronze scrap with about 90 per cent. copper and 10 per cent. zinc was successfully treated by electrolysis, the metal being formed into cathodes which were electrolyzed in copper sulphate, several weeks being required for the deposition of the copper. The dried sludge from the process contained up to about 60 per cent. of tin which was recovered as pure metal.

To minimize the consumption for army purposes all brass and copper uniform badges were abolished and zinc replaced brass in munitions. In spite of rigid economy the consumption remained enormous, and by the end of 1916 stocks had become exhausted. This necessitated the substitution of iron in cartridge cases, caps and driving bands, all tubes and wires in electrical plant, torpedo tubes and propellers on small war vessels. For medium shells, zinc driving bands were used, and electrolytic iron for those of large calibre.

In the navy, cast brass (55-60 per cent.) replaced Admiralty bronze, the tendency of the former alloy to pipe and froth in casting hollow articles being counteracted by making the gate of equal capacity with the mould, and allowing time for the included oxides to rise to the surface before actually running the metal into the mould. The risers were also plugged and the imprisoned air only released when the mould was nearly full. These alloys failed to withstand friction and, therefore, parts exposed to heavy wear had still to be made of Admiralty bronze.

Thomas in Detroit "News."

Why did they civilize us when we were happy?

Laying Out Boiler and Engine Foundations

Every Stationary Engineer Should be Able to Lay Out and Superintend Excavation Work, Mixing and Pouring of Concrete Foundations and the Erection of the Machinery on Them

By T. H. FENNER, Associate Editor

THOUGH many stationary engineers are never called upon to carry out installation work, everyone should know the methods to be employed in laying out foundations, supervising the building of concrete forms, and the proper mixture of concrete to be used in making the foundation. He should know something of the different kinds of earth and their bearing qualities, and the necessary safeguards to be employed where the land is of an unstable nature.

After the foundation is completed he should know how to proceed with the erection in the quickest and safest possible way. When it is necessary to employ an erecting engineer from the machinery contractor, the very cheapest he can be obtained will be around $10 per day exclusive of travelling and hotel expenses. The engineer in charge of the plant can thus save his employer a large amount of money if he can carry on this work, and incidentally show he is something more than an engine driver.

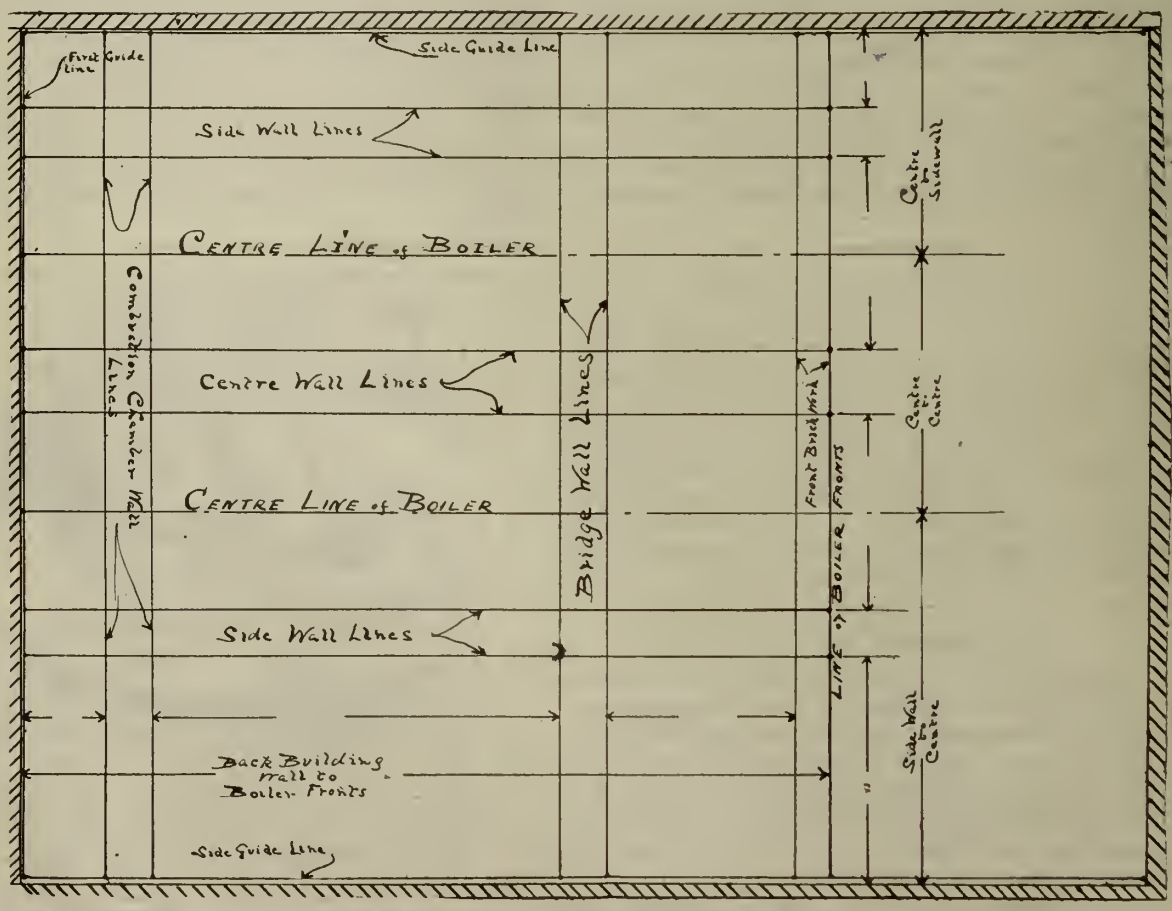
The Preliminary Steps

We will take for an example the installation of a new plant. Installing additional machinery in a plant already in operation has its difficulties, but on the other hand, it is somewhat simplified by the fact that there are well-defined leading marks such as lines of shafting, steam pipes, and so on, to aid in the location of the new foundations.

Let us assume that you have been called on to instal two horizontal return tube suspended boilers, 72 inches diameter by 18 feet long, and a cross-compound horizontal engine, with jet condenser, and the feed pumps, heater, etc., in connection therewith. Remember, the size of the installation really does not make any difference in the procedure, but only in the amount of labor. A 5 horsepower engine requires a boiler, steam pipe, feed arrangements, and a foundation to stand on; and a 5,000 horsepower engine requires the same things, but more of them. This much may be granted.

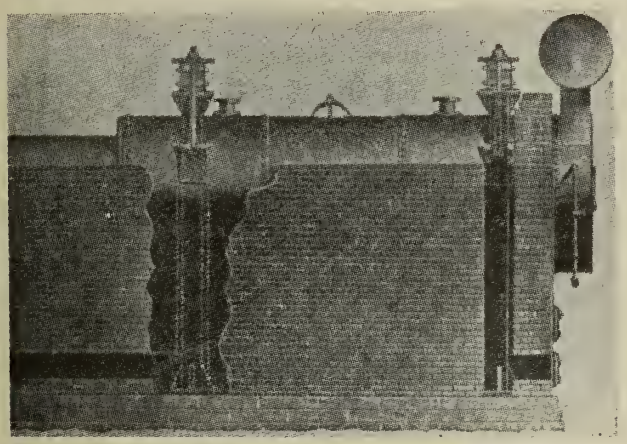
Now one advantage of the new installation is that in the majority of cases the layout, or the leading points of the layout, are determined before the first shovelful of earth is removed. Secondly, the field is clear, there being nothing in the way of bringing stuff in. In making additions to old plants, where very often adequate consideration has not been given to the possibilities of the future, many difficulties are encountered in handling heavy pieces of machinery in confined spaces. However, in this case these difficulties are not in evidence.

The first thing to be done is to procure blue prints of the general layout and detailed blue prints of the various foundations. Study these till the whole arrangement is thoroughly fixed in the mind's eye, and then make sure that the power house building has been completed in accordance with the plans. Look at the arrangements of doors, stairways, etc., and see if it is the best arrange-



LAYING OUT FLOOR FOR BOILER FOUNDATIONS.

ment in the light of operating problems. Right now is the time to observe one particular feature that will not only help you in erecting, but save time and money in future when repairs are necessary. I allude to means of handling heavy pieces, such as cylinder covers, flywheels, crank shafts, steam pipe, etc. If no crane is



SIDE ELEVATION OF SUSPENDED BOILER.

specified, then arrange to have eye-bolts secured to the roof, or an I-beam built into the walls on which you can put a small trolley to carry chain blocks or any other handy method which may suggest itself to your mind. It may cost a little at the time but it will save many times its cost.

For instance, the writer was in charge of a plant where the main header, 14 inches o.d. pipe, was supported on a frame about thirty feet above the boiler room floor. The roof beams were about the same height above the header. If an I-beam had been fitted longitudinally above the header at a reasonable height, taking a length down would have been governed by the time necessary to uncouple the flanges and lower away. Instead of this, hours were consumed in making a rigging to secure blocks to and the lowering and raising had to be done in several fleets, and on one occasion, at least, nearly resulted in a serious accident. In this plant an adequate travelling crane had been installed in the engine room, on the other side of the wall, and the installation of an I-beam trolley on the boiler room side would have been simple.

If the tour of inspection shows everything to be satisfactory, the next job will be to locate the foundations and get started on the job. Now, the foundation drawings from the makers of the boilers and engines will show the usual thickness of foundation that they put in, but remember, they probably know nothing of the nature of the ground that the foundation is to be put on. Different kinds of ground have different bearing powers, and whereas if you were erecting on rock you could build without any foundation; if the soil is soft blue clay, you must proportion the foundation to the bearing power. The following table shows the bearing power approximately of different kinds of ground:—

	Tons per square foot
Rock	200
Soft rock	18
Dry clay	4 to 6
Clay	2 to 4
Soft clay	1 to 2
Sand gravel	8 to 10
Sand	2 to 4
Alluvial	½ to 1

These values are not to be taken as exact, the value given for soft clay being on the high side. A good way to determine what the ground is like is to drive a pointed rod of iron down with a sledge, the resistance encountered in the driving giving a fair indication of the stability. Another point to be taken into account is that sometimes a foundation has to be made considerably deeper and heavier than the weight it has to support calls for. For instance, if an engine room floor is constructed with a basement 6 to 8 feet deep under it the foundation will have to extend from the basement floor to the engine room floor. Thus the weight thrown on the ground supporting the foundation is that much more than it would be if the engine room floor was laid on the ground.

However, as we are first concerned with the boiler foundations, there will be no necessity to figure on a floor level above ground. The maker will have given shipping weights or he may have given full information of weight of boiler bricked up, filled and all fittings on. If not, this weight must be determined. In the event of the ground being exceedingly soft, piling may be necessary, but this is a rare occurrence. Should it be so, it is better to call in outside help with the necessary equipment. In the case of blue clay, the best procedure is to make what architects call a raft, which is merely a large, solid slab of concrete. This concrete can be made of cheap material, using ashes instead of sand as a binder. It should be made of much larger area than the foundation and its purpose is to spread the weight over a large area to reduce the load per square foot to a minimum. For example, the writer had to make a foundation for a 50-ton railway track scale on this kind of soil. The scale manufacturer's erector was of the opinion that piling would be necessary. The bed of blue clay was of great depth, and piling would have been a very expensive proposition. Instead of this the excavation for the foundation was made 24 inches deeper than the plant called for. It was not practicable to make it wider on account of a shed covering the tracks. The form of the foundation was a number of piers supporting the bearing points of the scale, and these piers were joined together by a web 12 inches thick. The two feet deep excavation was filled with a mixture of broken brick, ashes and cement, on top of which the forms for the foundation itself were laid. The result was entirely successful, the scale erectors being very much pleased with the dry condition of the foundation through a prolonged spell of wet weather. However, suppose that the ground we have to deal with in the hypothetical case we are handling is of dry clay or sand gravel, with a bearing strength of four tons to the square foot. Let us first find out what weight we have to support.

The weight of a boiler 72 inches diameter by 18 feet long, complete with front and fittings but without water, is 25,000 lbs. roughly. The water capacity will be the volume of the boiler less the volume of the tubes. The boiler will never be full when working, but will be filled on many occasions for testing, etc. There are 72 4-inch diameter tubes in a 72-inch boiler. Their volume will be $4 \div 12 \times 4 \div 12 \times .7854 \times 72 \times 18$ and this subtracted from the volume of the boiler and multiplied by 62½ will give the weight of water in pounds. We have, then

$\{(6 \times 6 \times .7854 \times 18) - (4 \div 12 \times 4 \div 12 \times .7854 \times 18 \times 72)\} 62.5 =$ 24,812.5 pounds approximately.

The weight of boiler fittings and contents will therefore be 25,000+24,812=49,812, say 50,000 pounds. This is a suspended boiler so that this is the weight to be borne by the steel supporting columns. The walls for the setting will be with this size of boiler 18 inches wide and the foundation will be at least 2 inches wider.

We will have two brick walls 18 inches wide by about 22 feet long, and anywhere from eight to ten feet high, according to the height the boiler is set above the grate bars. The centre wall between the boilers may be wider on account of having the two supporting columns set in it, or perhaps the supporting columns in the centre will be heavy enough to carry the weight of the two halves, and the dividing wall remain the same. With suspended boilers the wall has no weight to support, and is there purely as an airtight casing. Supposing we allow a two-foot wall in between. Now, the back wall will stretch

right across the rear of the boilers, and be the same thickness and height as the side walls, so its length will be 1.5+6+2+6+1.5=17 feet. The bridge wall has to carry half the weight of the fire bars, the other half being carried on the two side walls or by brickwork across the front. The weight of a brick wall will be roughly about 125 lbs. to the cubic foot. Take a side wall first, we will have 1.5×22×10=330 cubic feet. 330×125=41,250 lbs. Our foundation is 20 inches wide and 20 feet long, that gives 1.66×20=33 square feet. That gives a pressure of only 1,250 lbs. per square foot, and the ground is good for four tons at least. Now the weight of the boilers is to be concentrated on six points, or if separate supporting columns are used in the centre, eight points. However, the columns in the centre will be adjacent to one another, so that the weight will really be concentrated at one point on the ground. We have, therefore, on each of the outside columns, 50,000÷4=12,500 lbs., the remaining 50,000 lbs. being supported on the two or four inside columns as the case may be.

That is, on each supporting point in the outside foundation the weight would be 12,500 lbs., while the two inside points would be supporting 25,000 lbs. each. These columns will be fitted with a foot of cast iron or steel with an area of 1½ to 2 square feet for the outer columns, while the inner ones, if designed as single columns, will have a proportionately larger shoe, or if each boiler has its own columns, the two shoes can be made to cover the width of the centre foundation.

The depth of the foundation will be governed by the probable depth of the frost line and will vary with locality. However, about three feet is a usual allowance. The crushing strength of good concrete is about 600 lbs. per square inch. On the outside columns we have a weight of 12,500 lbs. Dividing 600 into 12,500 gives a little over 20 square inches as being the necessary area of concrete. This is well within the proportions we have, so there is no need to bother as to concrete strength immediately under the column, and this weight will be distributed over a much larger area of ground by the concrete foundation. The same applies to the inside supporting columns so we are now in a position to lay out the ground and get the forms fixed up.

Locating Foundations

The first thing you require is a definite line to work from. You will have four bare walls and a rough, uneven floor. You want to determine the ground level, and for this you must turn to your building plans. This will show you the depth of foundation of the building and the relation of the top of foundation to the level of the ground. Therefore you take the foundation top as a point to measure from and it will usually be found to correspond with the ground level. Drive a stake into the ground or a nail into the foundation at the required level and attach one end of a line to this stake or nail. Now run this line along the wall parallel to the foundation to a second stake or nail and you have a base line established to work from. Take your subsequent distances from this line, and not from walls which may be two to six inches off the straight if of any great length. From this line run a second line at right angles, (squaring it off with a three-foot steel square), along the corresponding wall, and then you have the lines necessary for cross measurements. Run both these lines at a definite distance from the wall, and do not neglect to allow for this distance when making measurements.

The foundation plan will show the centre lines of the two boilers, their distance from each other, and the distance from the wall to the first centre line, and the second centre line to the other wall; the distance from the wall to the back boiler wall face, thickness of wall, combustion chamber space, length of boiler, and an overall dimension from the building wall to the boiler front. With these you can proceed to mark out the excavations for the foundation forms.

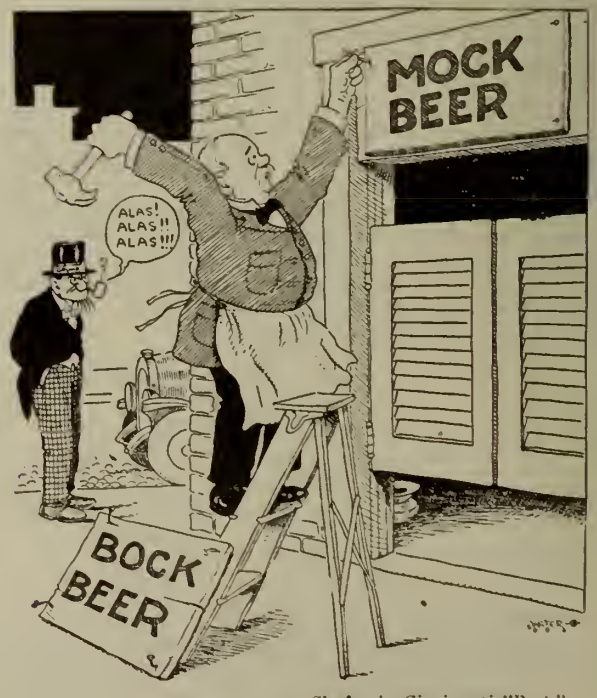
A word about measuring. Where the distances to be measured exceed fifteen feet use a steel tape, long enough to obtain the whole measurement in one reading. Measure along lines that have been squared off, and are straight, because if the tape is not held in a straight line, the measurement will be incorrect. The error will vary according to the length. Measurements taken with a short tape or a straightedge, that has to be moved along in stages, are almost sure to be out. Of course, for preliminary measurements to determine the excavation lines, accuracy is not essential, that is extreme accuracy.

First of all measure from your side line, along the back wall line the distance to the first boiler centre line. Drive a stake or nail here. Measure from that to centre line of second boiler. Then measure along the side line the overall dimension from back wall to boiler front, and mark it. Now measure from the other end of your back line along the opposite side of the building the overall dimension again, taking care that your tape is at right angles to the back line. The best way to be sure of this is to run a line first and square it off. Having got the two points on each side, stretch a line between them, and that is the line of your boiler fronts. Measure off on this line your two centre line points, and run lines from them to join the centre line marks on the back line. You now have your boiler front, and boiler centre lines accurately located.

From the front line of measure back along the centre lines to locate the front side of the bridge walls, thickness of walls, from back of bridge wall to front of back wall and thickness of wall. Place stakes at these points, and then measure on your front and back lines from the centre lines to the faces of the side and centre walls, and run lines from the front boiler line to back wall line to locate these. On the outside wall lines locate again the bridge and back wall lines, and run cross lines joining them. You now have your foundation completely laid out.

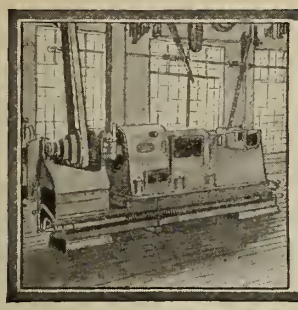
THE Mueller Co., of Port Huron and Sarnia, get out a house organ entitled "Mueller International News." Some of the items seem to indicate that the editor has a regular "stay for supper" acquaintance with his readers, to wit:

> "Hank Robertson was seen with a girl at the Free Methodist Church recently. It is claimed that he knocked three milk bottles over as he left her front porch that night."

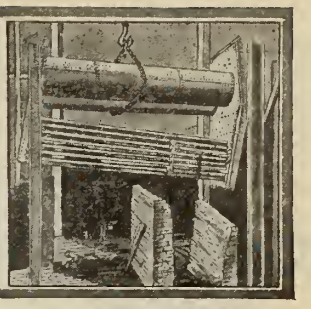


Shafer in Cincinnati "Post."

Signs of the Times.



NEW POWER PLANT EQUIPMENT

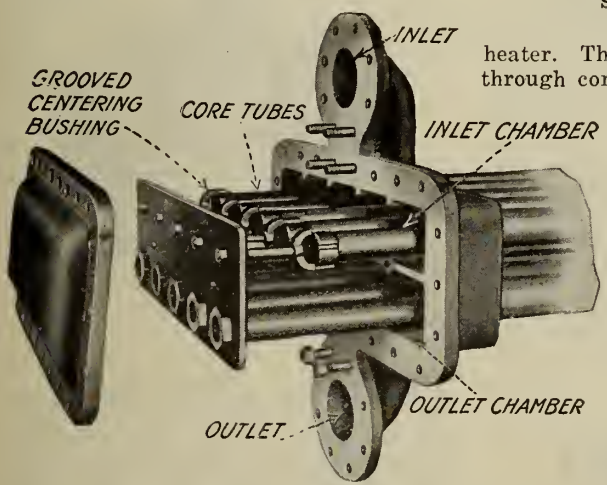


THE DRAVO SUPERHEATER

In designing apparatus to superheat steam, the main objects are: simplicity, efficiency and ruggedness. It should also be readily accessible for inspection and cleaning.

These objects have all been carefully considered by the Superheater and Engineering Co., of New York, in the Dravo superheaters, the headers of which are always outside the gases of combustion and are generously dimensioned steel castings or else extra heavy pipe, as is dictated by conditions.

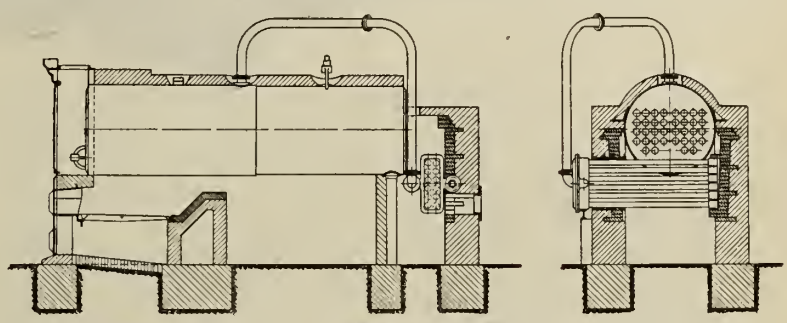
The tubing is seamless drawn steel tubes of suitable gauge which are expanded and flared into the headers. The openings in the headers required for expanding the tubes, are closed by means of closures made of machine steel with bolts threaded clear through and peened over. These are secured by tripod crabs and points made airtight by asbestos gaskets woven over copper netting, the gasket being placed in a pocket where it cannot blow out.



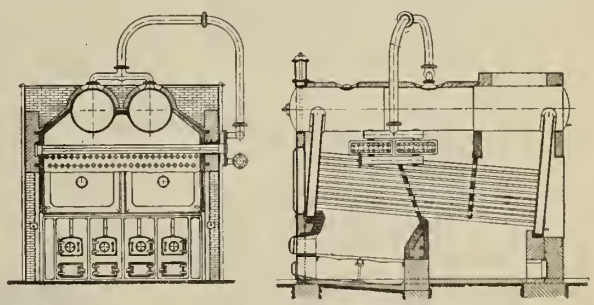
MAIN HEADER WITH COVER REMOVED AND CORE TUBES DRAWN.

The opposite ends of each two tubes are expanded and flared into cast steel connecting pieces or return bends. The openings in these castings are closed by key caps, which make a taper metal to metal joint and which the steam pressure tends to make tighter.

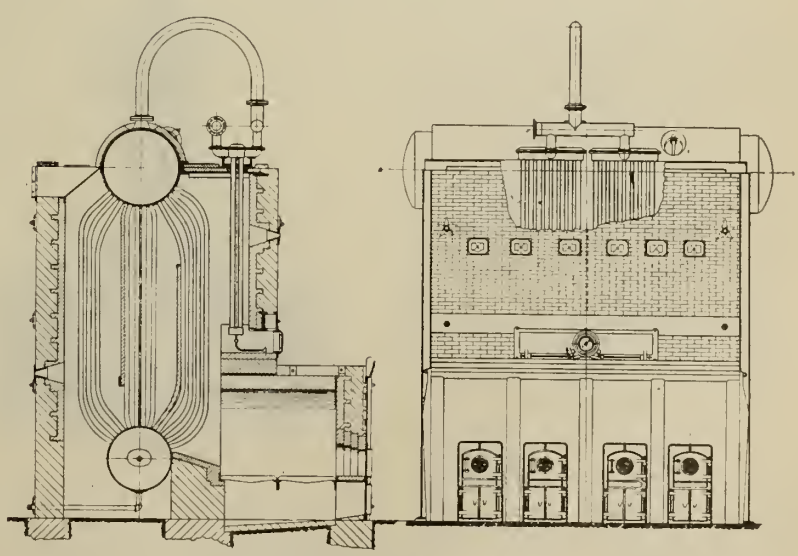
In order to efficiently heat a poor conducting medium like steam, and to do it quickly, for it is in the superheater but a short time, the steam must be brought intimately into contact with the tubes either by subdividing, filming or agitating it. Subdividing is usually done by using a number of small tubes, while filming is accomplished by means of a core within each tube, the steam passing through a comparatively small annular space. Agitating the steam as it passes through the superheater is the method employed in the Dravo superheater. The steam enters the apparatus through core pipes and through grooved bushings, which are used to secure and centre said core pipes. The core pipes are perforated and the steam which enters them is jetted through the perforations against the hot tube surfaces. It thus enters the annular space formed by the core pipes and tubes, in increasing quantity and the core pipes are decreased in size in the direction of the steam flow so that the resulting annular space is



SUPERHEATER APPLIED TO HORIZONTAL RETURN TUBULAR BOILER.



SUPERHEATER APPLIED TO WATER TUBE BOILER WITH THREE-PASS BAFFLING.

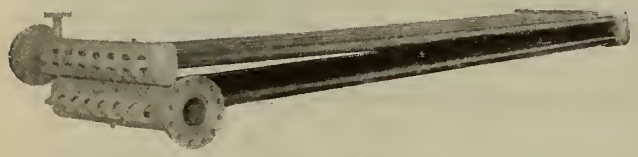


SUPERHEATER APPLIED TO ERIE CITY WATER TUBE BOILER.

increased, thereby lessening the friction in the superheater.

The method of agitating the steam has been found to be most efficient, and the lessening of friction has made the drop in pressure very small.

The comparatively few tubes in the



SINGLE SECTION OF SUPERHEATER.

TWO-SECTION SUPERHEATER SHOWING ARRANGEMENT.

Dravo superheater and their spacing offer little resistance to the passage of the gases through the boiler or its setting, thus making a drop in draft pressure due to installing the superheater almost negligible.

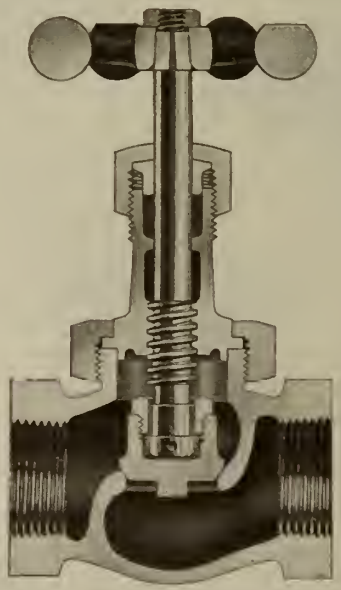
With the efficiency obtained by the agitating principle, the accessibility of parts, the simplicity of arrangement, the ease of cleaning, both inside and outside, and the materials used, make good the claims of the Dravo superheater to being efficient, accessible, simple and rugged. This equipment is adapted for installation in any type of boiler setting. The illustrations show several different types of boiler settings all fitted with the superheater.

JENKINS' NEW REGRINDING VALVES

The attention of the trade is called to two new types of high duty valves that have recently been designed and placed on the market by Jenkins Bros., of Montreal. This addition to the Jenkins line has resulted from the demand in certain quarters—particularly marine and shipbuilding—for an efficient regrinding valve. Both of these valves are designed to meet all the exacting requirements of the engineering trades and are being manufactured in various styles of globe, angle, horizontal and check.

The "Reliance" has been designed for a working steam pressure of 200 pounds per square inch. The body and bonnet are made of the very best naval bronze, assuring satisfactory service under severe working conditions. The naval bronze spindle is accurately machined to limit gauges, insuring perfect fit, ease of operation, and interchangeability. The lower end of the spindle is provided with an extra heavy collar that facilitates the regrinding of the valve seat. The disc is of substantial dimensions, having a radial face where it fits the seat in the body. The stuffing box is designed for high efficiency; it is fitted with a metal gland or follower and packed with special asbestos rings of such durability that they will not require renewing for several years. Packing may be renewed while the valve is under pressure and wide open. This is accomplished by the lock nut forming a seat against the lower side of the bonnet, thus shutting off the steam or water from the stuffing box. This feature also prevents the rattling of the disc. Ends of the valves are tapped with standard pipe threads.

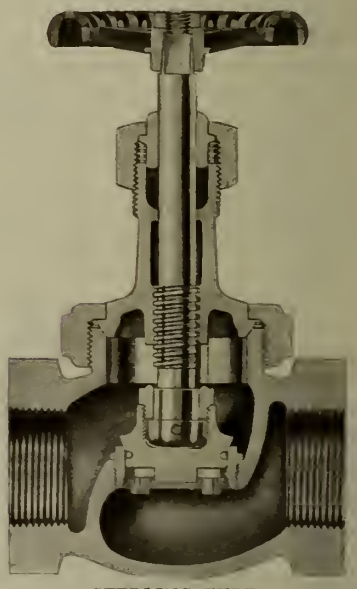
The "Sterling" type is of extra heavy design and suitable for a working pressure of 300 pounds per sq. in. These valves are subjected to a 800 pound hydraulic test before leaving the factory. They are similar in outward appearance to the "Reliance" valve, but the interior construction is varied to meet the added requirements of the higher pressure. The bonnet is fitted to the body by means of a ball joint. The slotted union nut permits the joint to be tightened by means of a spanner wrench, or a hardwood block and hammer. The disc in this valve is designed to minimize the cutting of the valve seat from the wire drawing of the steam. The extension below the main valve fits loosely in the valve port and holds back the steam and particles of scale until the valve is partly open, thereby preventing cutting action. The stuffing box is on the same lines as that of the "Reliance," but with a slight change in the shape of the gland or follower.



RELIANCE TYPE OF VALVE

NEW CONTRACT

The D. W. Griffith Company of New York city has recently given a contract to the Talbot Engineering Corporation of New York, for a complete plant for the operation of their motion picture studios. Owing to the immediate requirements it will be necessary to install a temporary plant while the permanent units are being built. It is interesting to note that the shop tests of the temporary boilers were made under the supervision of Roderick MacLeay, steam engineer of the Montreal General Tool Company, the Canadian company which is associated with the Talbot Engineering Corporation. The temporary installation will consist of two 100-horsepower type "T" Talbot boilers, one 11 x 25 x 14 Cross Compound Ball engine, one 14 x 16 Simple Straightline engine, and one 12 x 15 Ames Vim Horizontal Automatic engine. The temporary plant will operate non-condenser. Both the oil and feed pumps will be felt-driven triplex pumps. The temporary installation will be operated in a temporary building until the complete Talbot power plant is installed in the permanent power house. The permanent Talbot plant will consist of four 150 H.P. type "I" boilers, two 200 H.P. type "K" Uniflow engines direct connected to two Western Electric Co. direct current 150 K.W. generators, and one 100 H.P. Talbot type "G" engine direct connected to a 60 K.W. alternating current generator operating at 400 R.P.M. The engines are all of the four cylinder marine type mounted on cast iron frames or bed plates, which will carry both the engine and the generator. The engines will be connected to the generators with a flexible coupling. The plant will be condensing, using two 300-H.P. Talbot steel condensers. Storage batteries of large capacity will be comfined with the electric generators to steady the intermittent load required in the motion picture business.



STERLING TYPE.

The Operators' Point of View

RE GRADED CERTIFICATES

The Editor,—Referring to the Act, grading certificates, it seems to me that the statement in heavy type, page 435, gives very little encouragement to engineers not in charge to try and improve themselves, or obtain a higher position or certificate.

Any engineer in charge of a plant of 150 B.h.p. or over is entitled, if he holds a 1919 certificate, to continue until he changes his position.

This means that all engineers who are graded 2nd or 3rd class for 1920 who are not in charge, will never get in charge of a plant of over 150 B.h.p. unless some charge hand dies, quits his job, or a new plant starts up.

If this ruling is correct, it simply makes the Act a farce. On page 432 it states that any person who is in charge of a plant of unlimited capacity (i.e., 300 B.h.p. and over I suppose) must hold a first-class certificate. It also states in Section 15a that every person who operates as an engineer in charge without the certificate required by this Act, etc., is guilty of a contravention, etc., yet those who happen to be in charge for 1919 are permitted to continue, and some of our best engineers who have not been fortunate enough to get a charge job can remain just where they are to-day. Otherwise I think the Act is splendid, but let the best men have the charge jobs.

If a person takes an interest in the profession, studies hard, improves his knowledge and obtains a first-class certificate of competency, then for the sake of efficiency let him have a chance at a good job.

I would suggest that all engineers in charge who receive a grade lower than what the Act calls for should be given a provisional certificate to continue not more than one year, sit for an examination, and if they fail let a qualified man have the job.

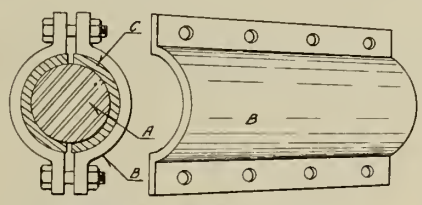
I would like to hear other readers' views on this matter.

JUSTICE.

EMERGENCY SHAFT COUPLING

Some time ago in fitting up a cheese factory some miles from any city, the discovery was made, somewhat late along on the job, that two 2-inch shaft couplings had not been sent along with the other material. The machines were all set and the hangers up ready for the shafting. There was a fairly good blacksmith in the village near the factory, so the erectors got him to split two pieces of 2-inch pipe, cutting a strip ¾ inch wide out of the length of the pipes. The pipe was 10 inches long. He also made two clamps for each pipe from heavy iron 10 inches long and big enough to fit over the pipe. He was just a little over three hours in cutting the pipes and making the clamps.

In Fig. 1, A is the shaft, B the clamps, and C the cut pipe. Fig. 2 shows one of the clamps. The whole outfit was put together as in Fig. 1, the



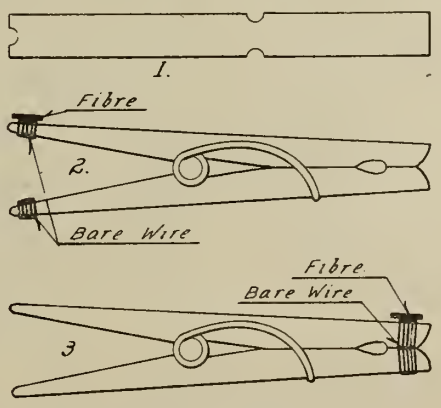
EMERGENCY SHAFT COUPLING

bolts in the clamps being drawn up tight, the shaft was lined and the outfit started. The couplings held on fine and ran for some months before the regular ones were put on. After the couplings had been tried out, strips of old canvas were wrapped around them and wired on to prevent the possibility of any oiler being caught by the bolt heads or ends, or cut by the corners of the clamps.

JOHN JAMES.

CONTACT CLIPS

For making either self-opening or self-closing electric contacts for use in wiring or testing, a dozen spring clothes



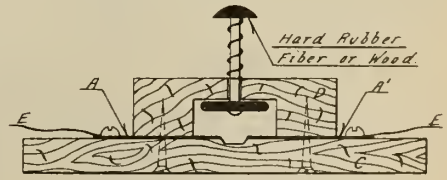
CONTACT CLIPS

pins with a little sheet rubber or sheet fibre and some bare wire will make a dozen contacts. Remove one of the wooden pieces from the pin, and around one end of the other wooden piece wind some bare copper wire to provide a contact surface. Then cut a piece of the sheet rubber or fibre to fit behind this bare wire to insulate it from the wall. And fasten to the wall this wooden piece, together with its wire spring and the piece of rubber or fibre. The fastening may be done by using two styles (or even one can be made to do) preferably just a little narrower than the wood of the pin, so that shallow notches are required in the edge of the pin and these will prevent end movement. If screws are used do not bore the pins for them as the wood may split. Fig. 1 shows the wood notched for three screws, one at the thin end and one at each side toward the other end. Having these in place wind bare wire onto the other wooden piece and to correspond with that wound on the first piece, then insert it into its place in the wire spring. Fig. 2 shows a self-opening contact. Fig. 3 shows a self-closing contact. In making Fig. 3 it sometimes may be necessary to trim a little wood off the humps to give the wire a hold, or if this will not let the wires come together when wound, place some sheet fibre into the hollows and then wind the wire on.

If the bare wire used consist of some of the end of the piece of bell wire being used in the circuit itself, but from which the insulation has been removed just there, this method of winding will avoid the necessity of making two wire joints later to connect the contacts with the circuit wire.—J. E. M.

QUICK-ACTING SWITCH

The home-made quick-acting electric switch shown may interest a number of readers. The face C is made from a piece of wood 6 inches long and 3 inches wide and ⅞ of an inch thick. The block D is 4 inches long, 3 inches wide, and



ELECTRIC CONTACT SWITCH

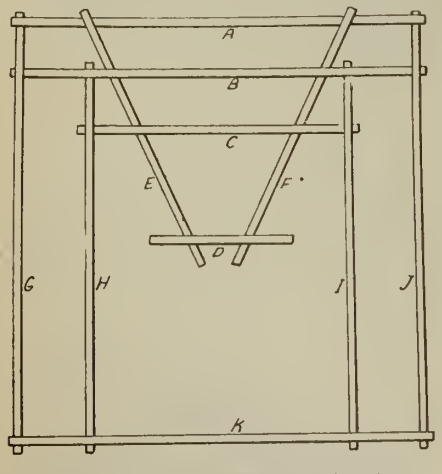
1½ inches thick. The blocks are planed, sandpapered, and given two coats of shellac. The terminals AA' are strips of copper, to which are attached the light wires E. A piece of copper is rounded at the ends and a piece of heavy

wire is riveted into it; on the other end of the wire a push piece can be riveted, as at B. A light piece of wire spring is used to hold the switch open; the blocks are fastened together as shown. A push down on the knob B completes the circuit on this single-pole switch; this switch is instantaneous. It is not difficult to make, and a locking clip can be added, if desired, to hold the circuit closed with another few minutes' work.

J. E. M.

REMOVING REFUSE AROUND THE POWER PLANT

Wheelbarrows, such as are used for wheeling coal in or those used by contractors for wheeling heavy material in, are a slow rig to wheel light bulky stuff on, for one cannot pile on nearly so much stuff as he could wheel away at a time. The sketch I enclose rudely shows how I made a rack for a wheelbarrow to be used in wheeling light refuse material which, by the way, was coarse enough to not fall through. No dimensions are given as these would differ with different makes of barrows and also the outside dimensions of the rack are a matter of choice and in consideration of the class of material proposed to be wheeled. Pieces E and F are laid into the front corners of the barrow and extend forward diagonally. If necessary they are weighted down on the inner ends to hold them in place until other parts are attached. D is fastened to them and is just long enough that its ends brace against the sides of the barrow. K lies across the handles but not close enough to be uncomfortably in the way. A, G and J are then attached as shown, A passing under E and F. B is placed under G and J and above E and F and shoved up tight to E and F and fastened there. H and I are then placed below B and K, and C is placed under them and above E and F, and shoved up tight to E and F. C should be left plenty long and can be shortened later



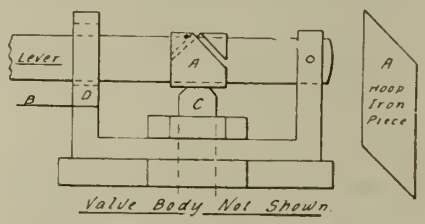
FRAME FOR WHEELBARROW

if desired. C, H and I are then adjusted to what appears to be the best position and fastened there, and C trimmed if desired. This completes the rack, which may be lifted off at any time. To hold it in position when in use, it depends on the fit of E F into the corners of the barrow and on the fit of D against the barrow sides. The weight of itself and its load holds it down. I used wooden slots 1 by 1½. Other material could be used. More pieces could be put in if required. The manner in which A, B and C are put in maintains the slope of E and F.

J. E. McCORMACK

REPAIRS TO SAFETY VALVE

Owing to the effective length of the combined valve-head and valve-stem having become reduced by wear and by regrinding the lever arm of a ball and lever safety valve sloped downwards towards it outer end until the ball was inclined to keep slipping along the arm, thus increasing the pressure at which the valve would lift to let the steam escape. At first I wired X each side of the staple in the ball to a side of the guide (D) through which the arm passes. These wires (B) were always taut, and I thought they interfered with the free action of the valve. As a remedy I took a piece of hoop iron, 1-16th inch thick or more; heated it to redness and allowed it to cool slowly, thus rendering it less brittle; then cut a piece (A), with oblique ends and the length of each side nearly equal to the distance

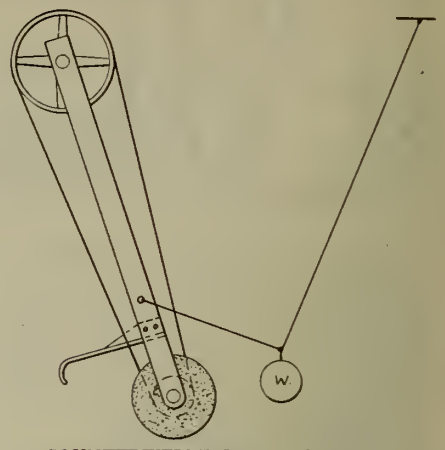


SAFETY VALVE REPAIR

around the lever arm at a point just above the valve-stem, and wrapped this around the arm as indicated in the sketch. I left the aforementioned wires (B) on as they had been, but they now remained slack. Had there been more slope to the arm it would have been necessary to use thicker iron or else slip a narrow strip, not wider than the arm was thick, through underneath the arm and between it and the hoop iron piece, but as it was this one piece of hoop iron did the trick alone. A little care should be taken to see that the hoop iron does not be uneven enough to bring the pressure to bear toward one or the other side of the valve-stem instead of over the centre, and when next firing up one should watch both the valve and the steam gauge to see that they correspond as before. In making the repair care should be taken to see that no chips or filing attach themselves to the valve-stem or get a chance to work into any part of the valve mechanism.—J. E. M.

COUNTERWEIGHING SWING FRAME

In some factories and mills swing machines resembling that in the sketch are in use and it is desirable to have them held back out of the way when out of the work. A weight attached to the frame by a rope running over a pulley is common practice, but possesses no buffer effect at the end of the return stroke. It rather stops with a jerk. An operator here rigged the device in the sketch and it was soon copied in another



COUNTERWEIGHTING A GRINDER

plant by another operator. The weight W, hangs on a rope attached to the frame and to hook behind and higher up. The rope must be slack enough to let the machine swing well ahead without the rope pulling into near a straight line. The principle is that the full of W varies with the size of the angles assumed by the rope. The pounds weight required in W, the slack in the rope and the distance of W from the frame must be determined experimentally in individual cases. The first two factors may vary within rather wide limits, the location of W on the rope being determined later by experiment as it is in this adjustment that the chief virtue exists.—J. E. M.

COMMERCIAL AVIATION

With the prospect of peace-time conditions, aeronautical engineers are devoting their time and energies to perfecting forms of aircraft that will be reasonably safe, and pilots are being more carefully trained in managing airships of various kinds. The British Government has recently decided to offer prizes in a competition to develop safer airplanes. An appropriation of $320,000 has been made for this purpose, and the prizes will be distributed among producers of large airplanes, small airplanes, and sea planes.

Regular trips are made from Milan to Rome, from Milan to Padua, and from Rome to Naples. The Rome-Milan trip occupies three and one-half hours by airplane, whereas the same journey by train takes about eighteen hours. For this service an eight-passenger airplane is used, fitted with an inclosed cabin, electrically heated and lighted and provided with arm chairs. Five hundred pounds of mail are carried on these machines in addition to the passengers. Daily trips are made across the English Channel, and during the Peace Conference Mr. Bonar Law traveled regularly from London to Paris by airplane. In Paris, regular ascents are made daily, carrying passengers, and in London during three days of Easter week the Handley-Page Company carried 827 sightseers over the city.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread. 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, olass A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	15%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.....	....	7 80

PROOF COIL CHAIN B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ i.n	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....$2	20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, bright....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon....	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1'' rd..	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper $22 00		$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	65 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

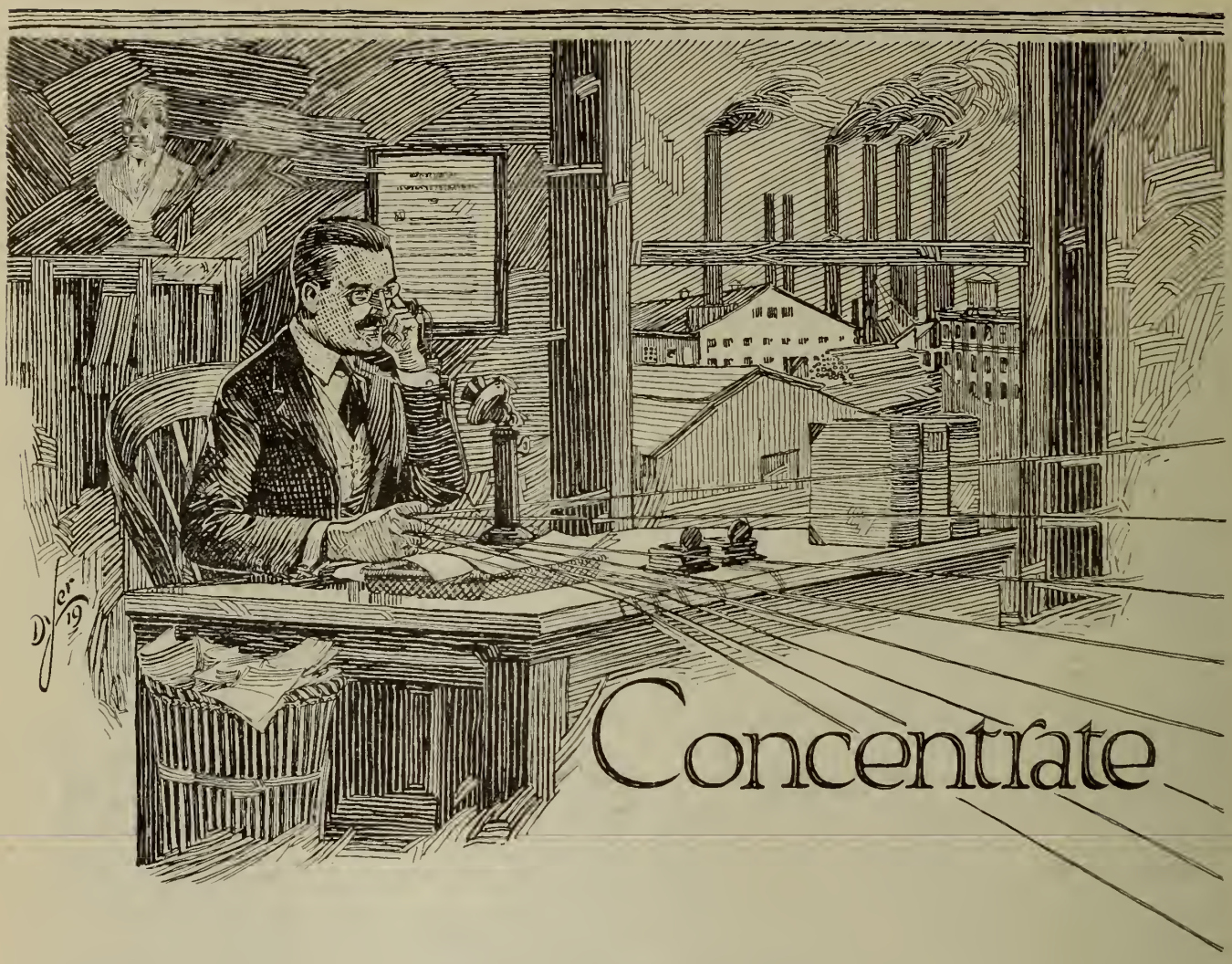
ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12 00		$13 25
Sheets, 3½ lbs.....	12 00	13 25
Sheets, 4 to 6 lbs....	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.



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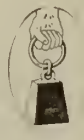

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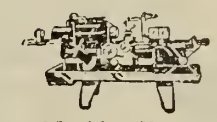
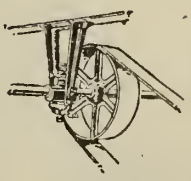
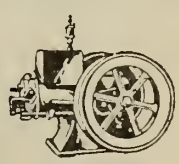
Trucks and Wheelbarrows

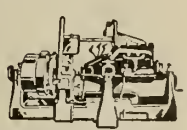

Machine Tools

Scales

Valves


Power Transmission


Engines and Pumps


Automobile and Service Station Equipment

The Canadian Fairbanks-Morse Co., Limited

Halifax St. John Quebec Montreal Ottawa
Toronto Hamilton Windsor Winnipeg
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ENGINEERS WANTED

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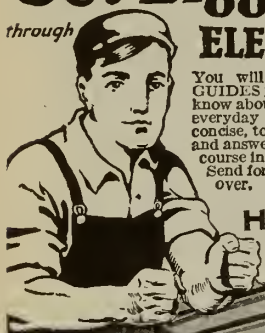

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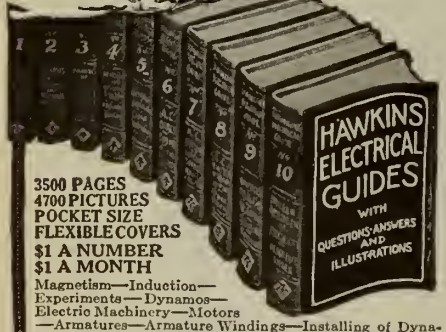

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THE VALVE ENGINEERING CO.

A recent development in the power plant supply field is seen in the Valve Engineering Co., which has opened offices at 160 King Street W. for the sale of valves of all kinds. Mr. M. J. Keane, the proprietor, is well known in the steam specialty business, having been for seven years manager of the valve and steam goods department of the Canadian Fairbanks-Morse Co., Toronto. Before his connection with the above firm, Mr. Keane was with the Walworth Mfg. Co., Boston, as salesman, and also with the Pratt & Coady Calve Co., Hartford, Conn. Experience of this nature has well qualified him for the giving of

M. J. KEANE
Who has started the Valve Engineering Co., King St. W., Toronto.

engineering service in connection with the specialties he is handling, a long felt want in the power plant field.

Agencies for a number of very good lines have been secured. Penberthy valves and other apparatus will be handled; Witwyte high pressure packing and jointing and Pennsylvania flexible metallic tubing will also be a special line. Witwyte high pressure jointing is used for steam, hydraulic, gas engine, motor car and other joints, and is intended for superheated steam of all pressures. The Pennsylvania line of metal hose is well known, and in demand wherever metal hose which will stand severe usage is necessary.

In keeping with the idea of service to the engineering public, all lines handled by Mr. Keane will be kept in stock at all times, ensuring prompt delivery, instead of delay, while woods are being sent or made at the factory.

NEW FACTORY OF YATES REFRACTORIES

In order to supply the constantly-increasing demand for furnace fire brick, the Gates Refractories, Ltd., have recently acquired a plant and property in Montreal East, and are now operating on a scale that will gradually meet the requirements of the trade. Until a few months ago J. W. Gates, the patentee of the bricks that are now being manufactured by this company, obtained his supply from old-established fire brick firms, but the growth of the business during the past year necessitated considerable more brick than could be furnished by outside companies. In view of this the original company was reorganized and additional capital secured for the further extension of their activities, and likewise the acquisition or construction of a plant for the production of bricks for their own special requirements. They will likewise be in a position to supply all special shaped high-grade fire brick for every industrial purpose. The plant acquired is located about seven miles from the centre of the city, and was formerly occupied by the Art Furniture Company.

The buildings are of two-storey brick construction, with about 12,000 feet of floor space. Two large crushers, one dry and one wet, have been installed with the necessary conveyors fer carrying the crushed and ground clay from the dry to the wet machine. The storage of the materials and the molding operations are carried out in this department, and to the rear of this building a drying room, 60 by 60 feet, has been erected and fully equipped. The floor of this section is of tile, under which the steam piping is located for the drying of the bricks after they come from the molds. To one side of this addition are located the baking and burning kilns. At present there are two in operation, one of 50 tons and one of 60 tons capacity. Two others of 60 tons capacity each will be completed and in operation before the close of the year. Eventually the kilns and the drying department will be under the one roof. The present output of the factory is about 300 tons per month, but this will probably be doubled within the next few months. Efficiency tests have been made at the McGill University on these bricks, and the fusing point has been determined, officially, at approximately 1750 degrees C., or 3200 degrees F.

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one side of the plant and there are also docking facilities a short distance from the works for the shipment of materials or product by lake or ocean vessels. The aims of this company are to specialize in contracting for power plant brickwork, also manufacture all kinds of special shapes of fire brick for boiler settings and all types of furnaces.

CATALOGUES

The Sanford-Riley Stoker Co. announces the appointment of Mr. M. G. Brennan as district engineer in the Western territory and Mr. W. Mather as district engineer in the East.

The International Chemical Co., Toronto, Ont., have issued three pamphlets descriptive of "Protecto" for boilers, International Gear Coating for all forms of gear drives, and International Soluble Cutting Oil for machine shop use.

Clinkers Conquered is the title of a booklet recently issued by Ernest Bernitz, Inc., Boston, Mass. Its purpose is to acquaint the engineering public with the Bernitz method of furnace construction.

The Sarco Company, Inc., New York, have issued a new bulletin on their steam traps. It is descriptive of this now well-known power plant accessory.

The Esterline Co., Indianapolis, have issued a publication entitled, Typical Graphic Records. As the title indicates, this publication gives a large number of typical charts taken by Esterline graphic meters on various industrial operations. The machine shop rolling mill and other steel working industries are particularly prominent in the number of charts displayed. In the eighteen years in which the company has been engaged in the graphic recording instrument business they have collected quite an interesting series of characteristic curves, and many of them are reproduced in the publication under review.

The Bailey Meter Co., Cleveland, Ohio, have recently issued Bulletin No. 30, entitled, "Fluid Meters For Low Pressure Gas and Air." The meter described in this publication is ideal for the measurement of the flow of gases and air under low pressure, recording and integrating the rate of flow of gas and recording gas pressure.

The Canadian SKF Co., Ltd., Toronto, have issued Talk No. 4 on countershafts. The subject matter describes the advantages of self-aligning ball bearings for this class of work.

Getting New Plant.—The Acme Roofing Co., Walkerville, Ont., have sold their factory, and it is their intention to erect a new plant and install the most up-to-date roofing machinery and equipment. They are now receiving tenders on new machinery. Information as to the location of the new factory will be given out later.

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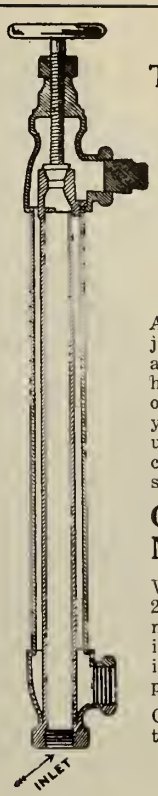

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There are many points on your line where you should have a steam trap, but where there isn't room for a cumbersome bucket or float trap.

Leaving these points go untrapped is costing you money! For when live steam is carried through long lines of untrapped piping, there is useless radiation and waste of steam.

Stop that loss by installing the Steam Trap Sarco.

It is so small, so compact, that it can be installed without change of piping.

The Sarco requires no floor space because it becomes practically integral with the pipe system.

It requires no building up or pit digging. It can be installed at any angle. And you can install three Sarcos for the price of one float or bucket type.

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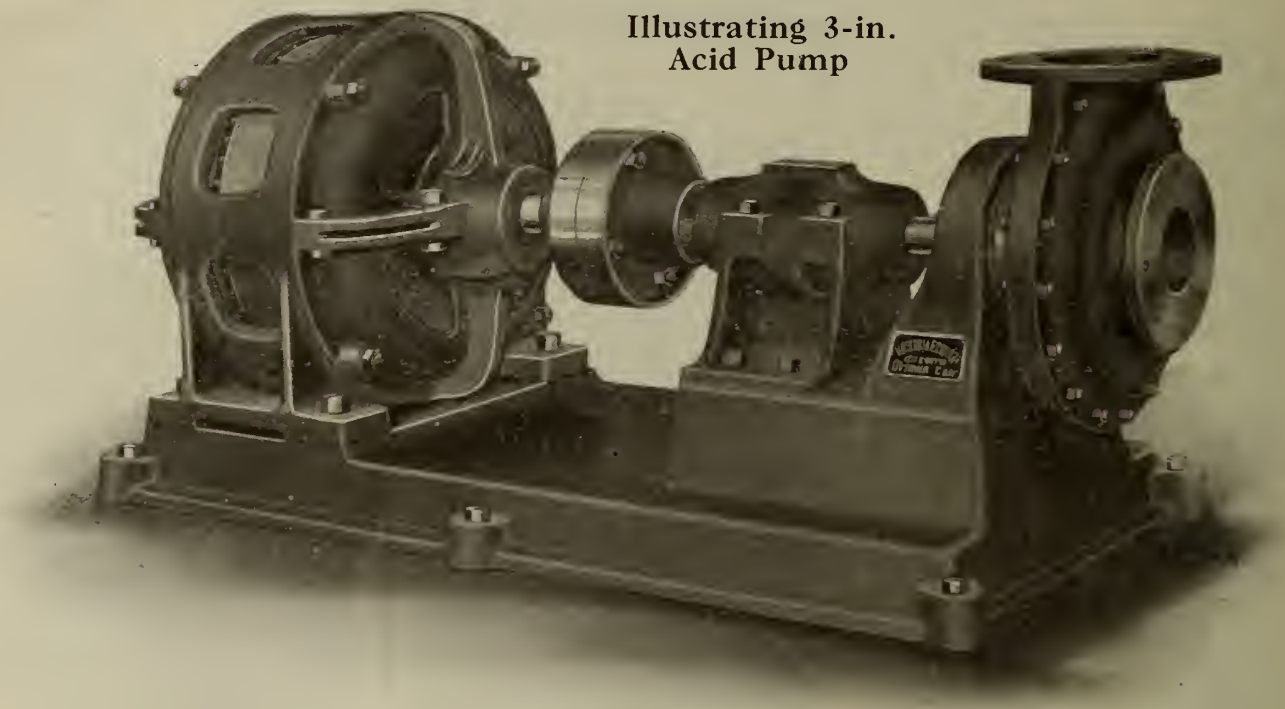

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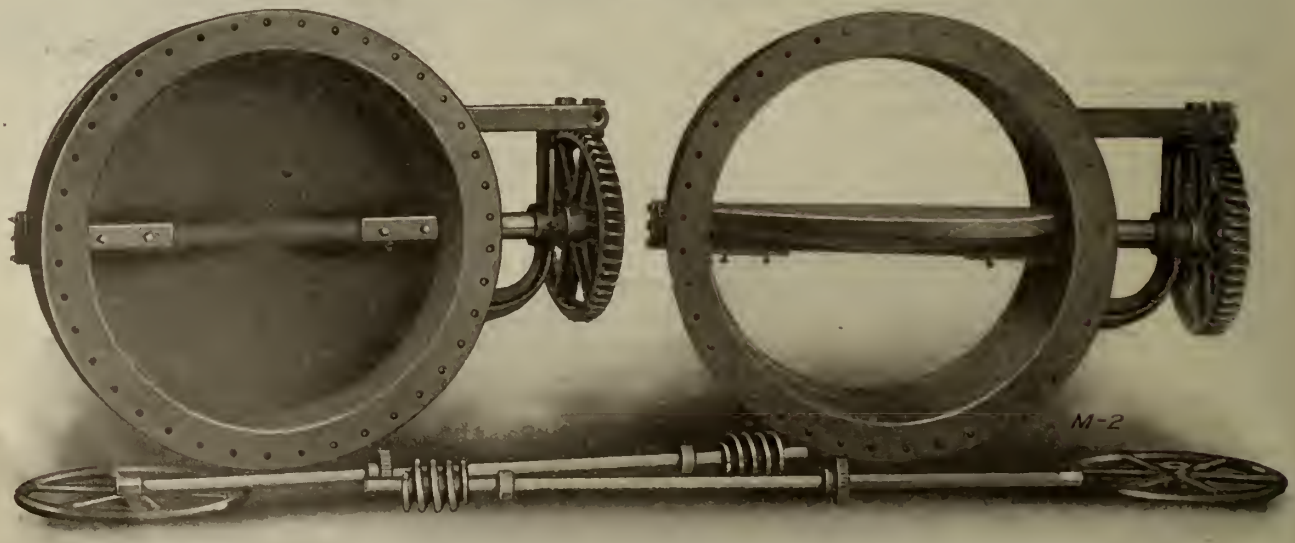

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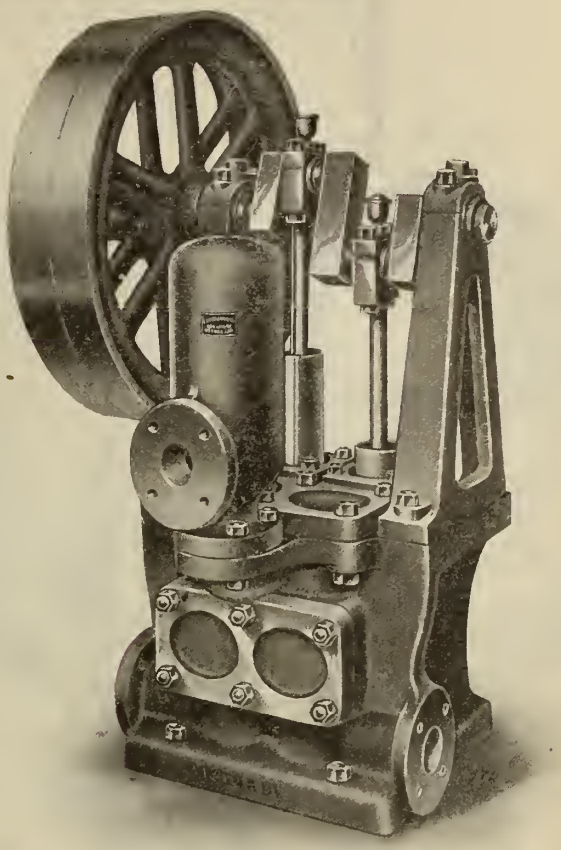

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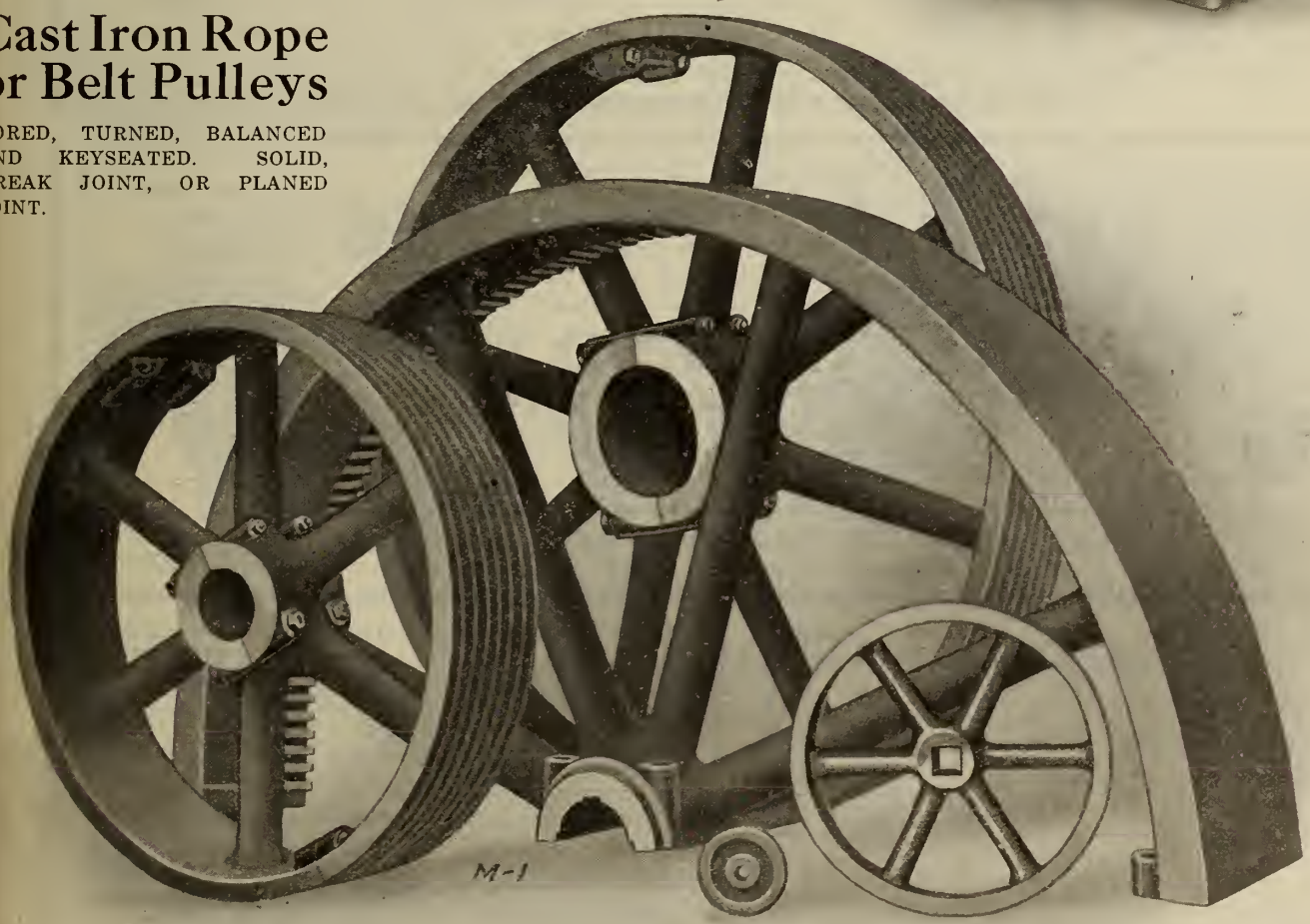

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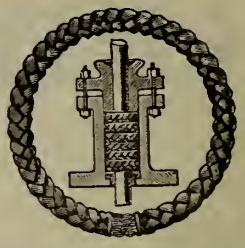

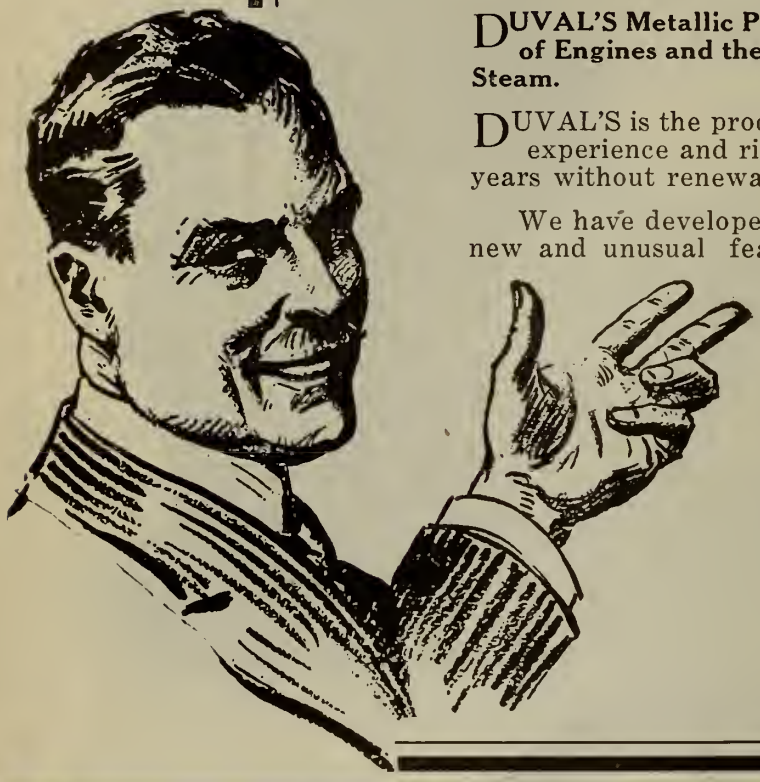

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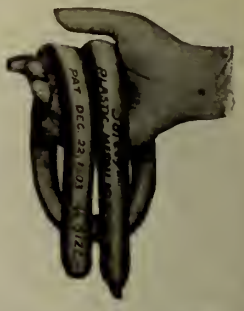

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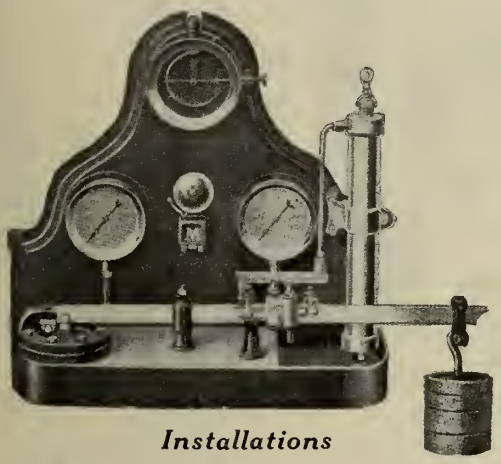

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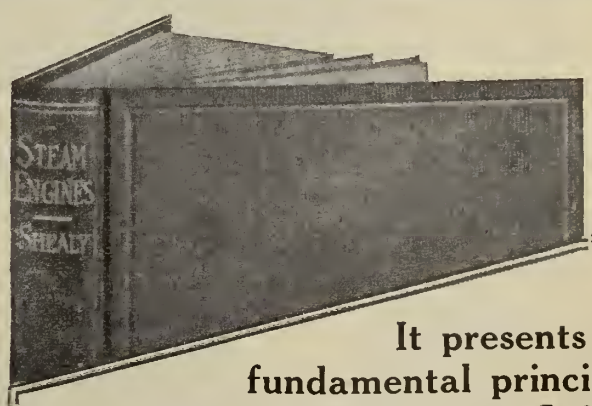

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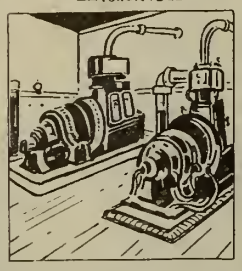

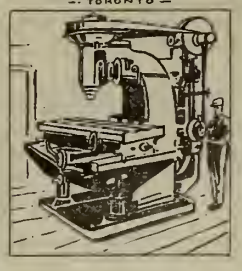

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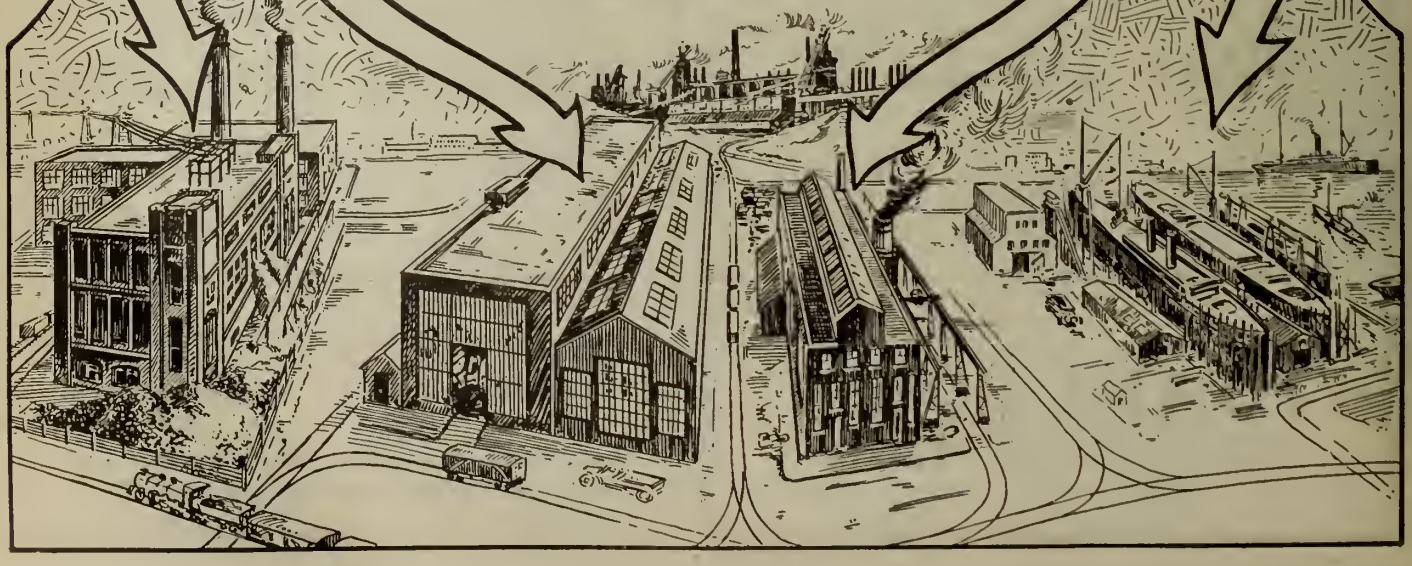

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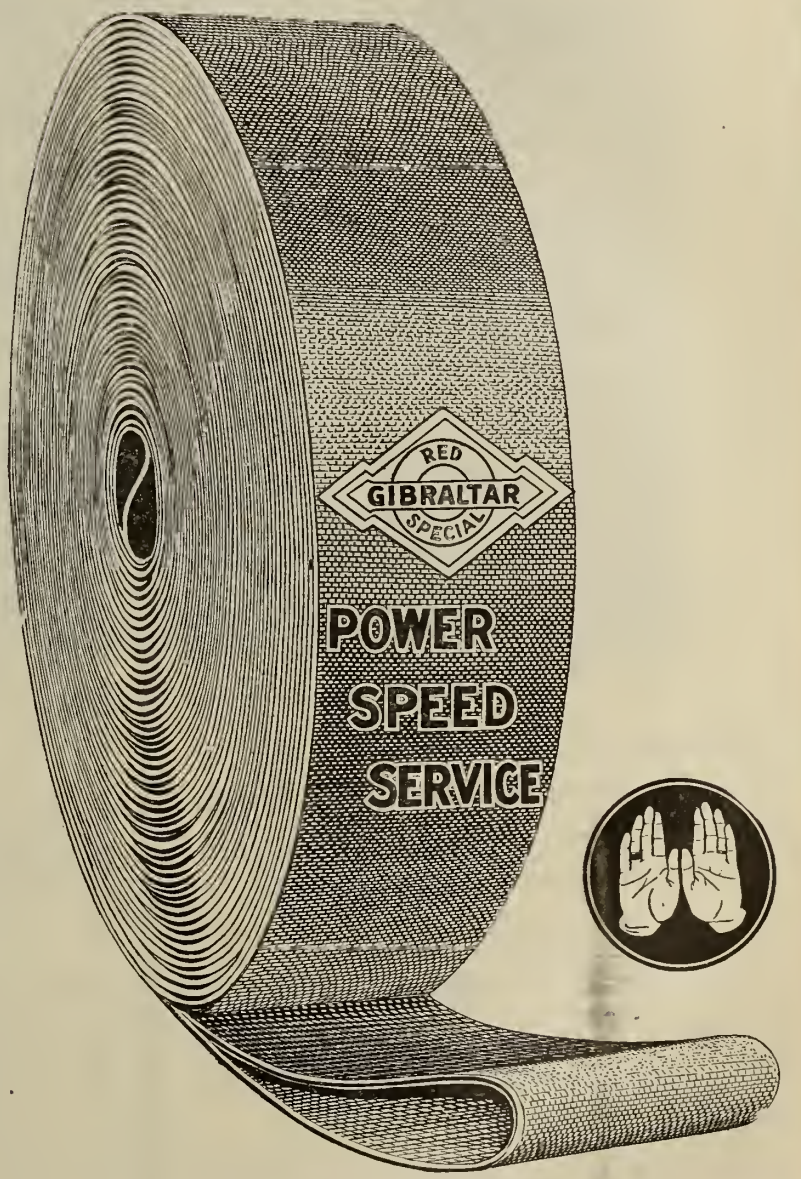

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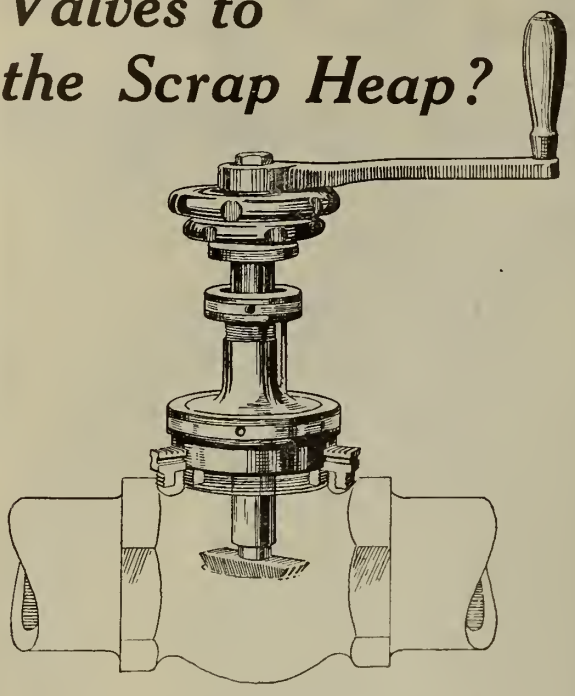

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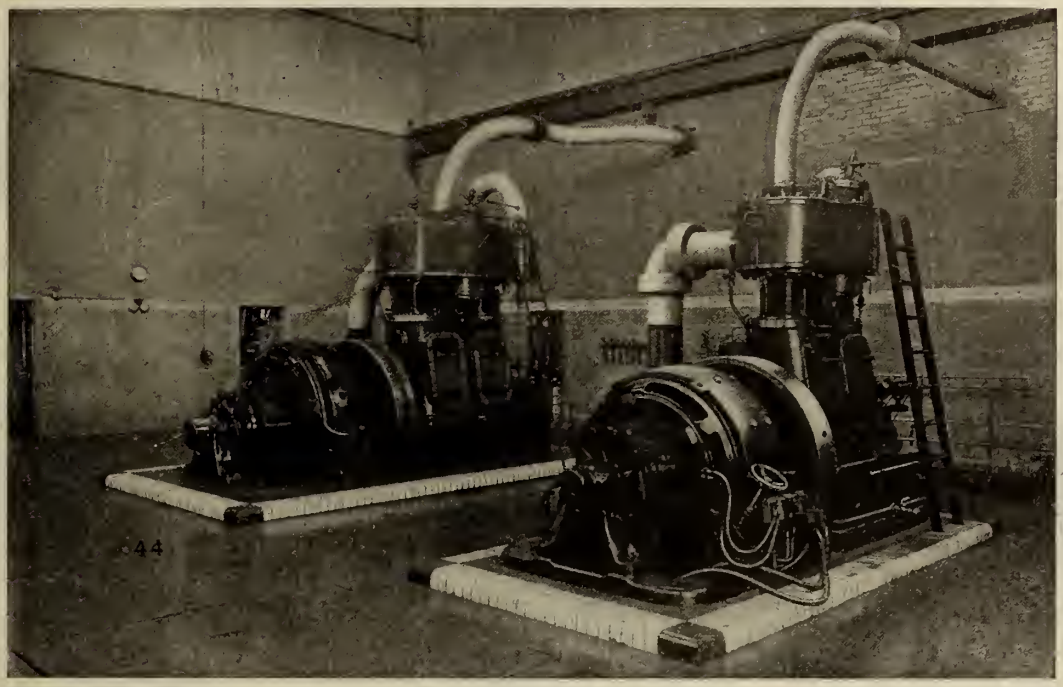

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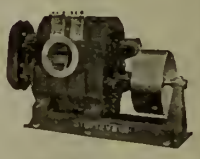

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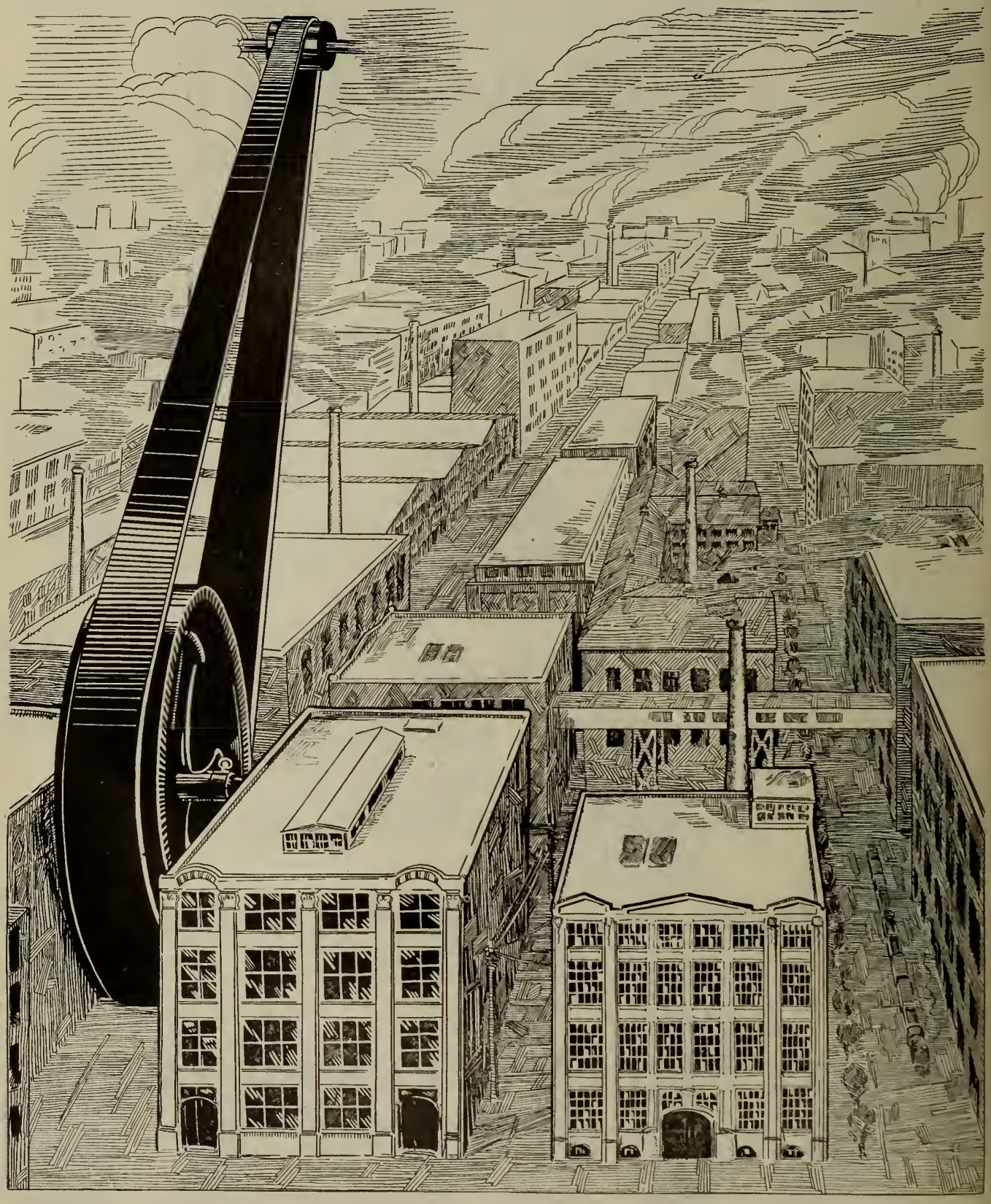

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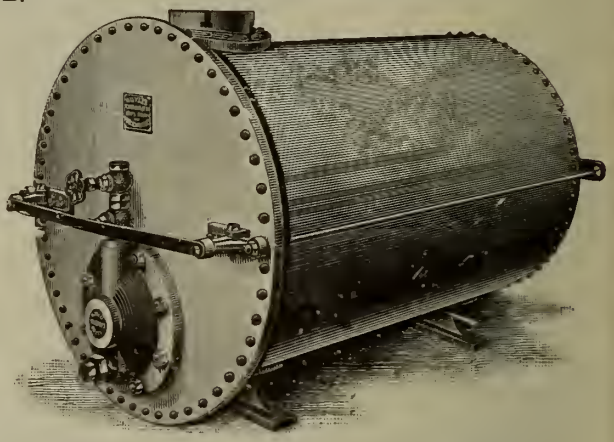
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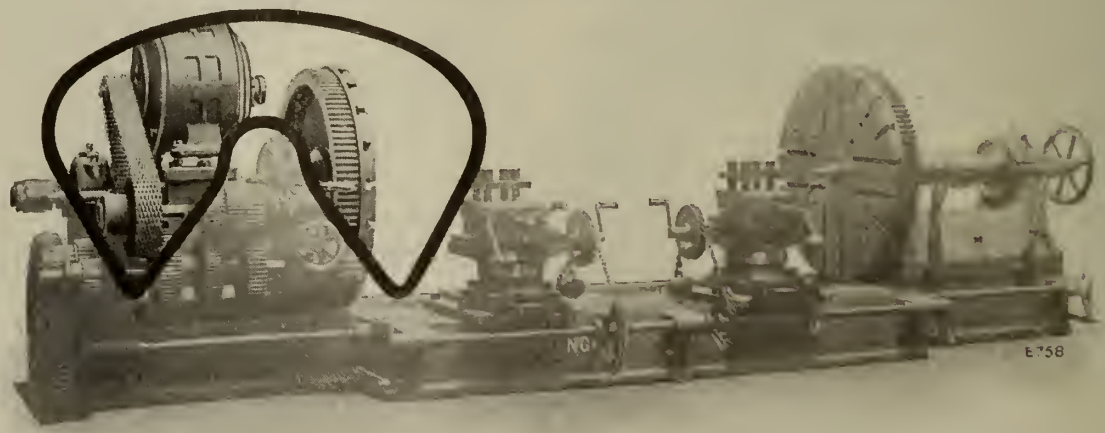

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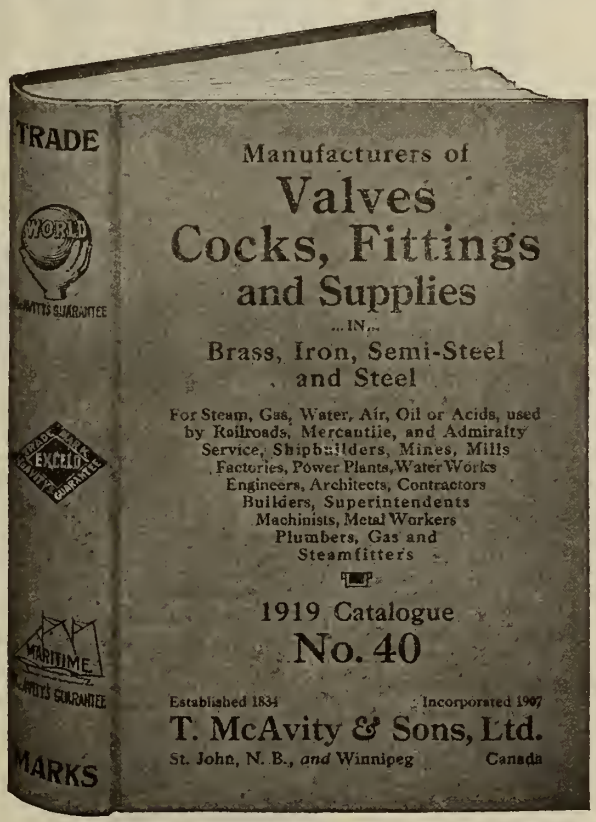

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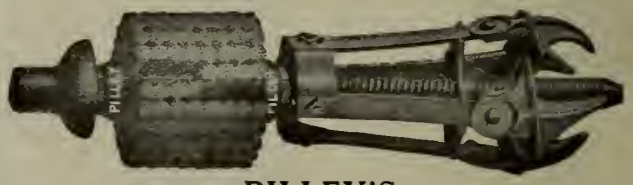

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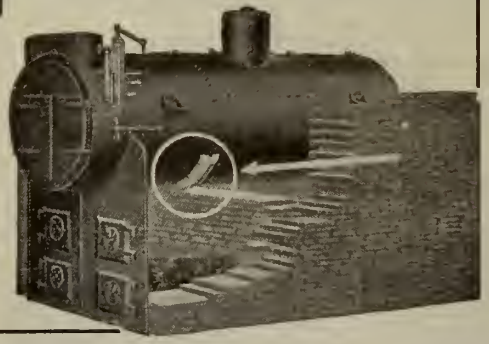

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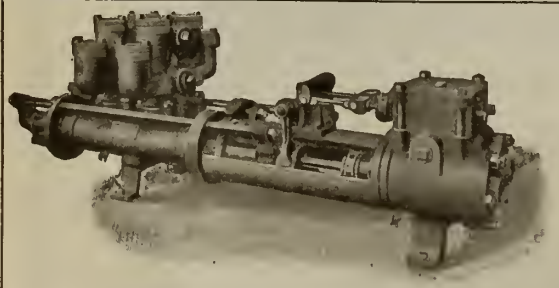

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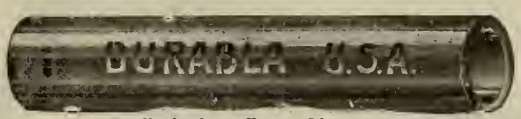

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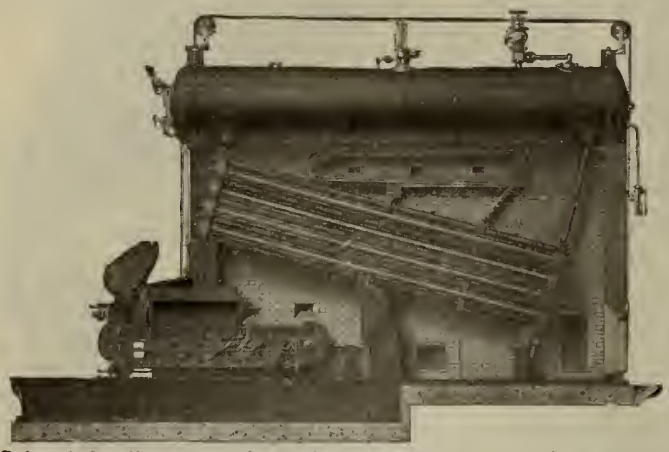

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MacKinnon Steel Co., Sherbrooke, Que.
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Defender Automatic Regulator Co., St. Louis, Mo.
Canadian Fairbanks-Morse Co., Ltd., Montreal
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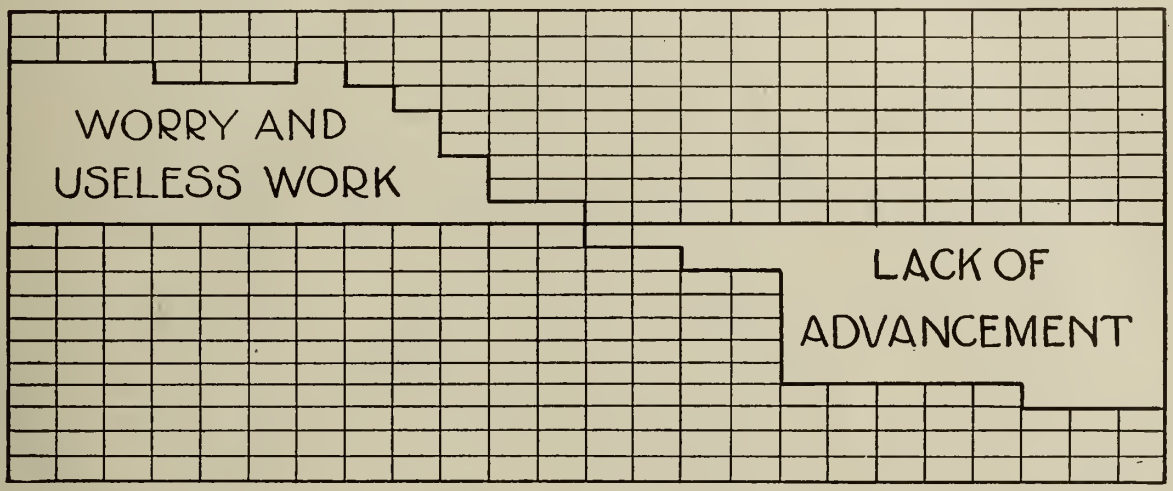

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J. H. HALE, General Secretary,

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Republic Flow Meters Co., Toronto.

METERS, GAS.
E. J. Philip & Sons, Toronto, Ont.

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Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto.

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Green's Economiser, Ltd., Toronto, Ont.
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Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
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Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

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Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

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Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

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Graton & Knight Mfg. Co., Montreal.
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PACKING PISTON
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Shell Bar Boico Supply, Ltd., Toronto.

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Johns-Pratt Co., The, Hartford, Conn.

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PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GAS
Norwalk Iron Works, South Norwalk, Conn.
PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich
F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City., Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York, N.Y.
RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.
RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RECORDERS, DRAFT
Jas W. Hays Corp., Michigan City, Ind.
RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
RAGS
Shell Bar Bolco Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Limited, Toronto, Ont.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
REGISTERING MEASURES
S. F. Bowser Company, Limited, Toronto, Ont.
RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
RECORDING INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City., Ind.
REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal
Norwalk Iron Works, South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Laurie & Lamb, Montreal
REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.
REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
ROOFINGS—RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.
ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.
SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.
SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.
SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Bolco Supply, Ltd., Toronto.
SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.
SMELTER LININGS
Beveridge Paper Co., Montreal, Que.
SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.
SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.
SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass
SPROCKETS, COMPENSATING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SPRING
Morse Chain Co., Ithica, N.Y.
SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.
SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Hamilton Co., Wm., Peterboro, Ont.
STAND PIPES, STEEL
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal
Cole, Ltd., Geo. W., Toronto
Williams Machinery Co., A. R., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que
Mason Regulator & Engineering Co., Montreal.

JEFFERSON

Underground

Take a trip underground—listen to the music of the pumps—"CHUG, CHUG, CHUG" — twenty-four hours a day, and you'll realize the importance of dependable unions. The failure of a single union might cause serious consequences involving loss of life and heavy damages.

JEFFERSON UNIONS will render perfect service as long as the pipe line holds out. Once you put a JEFFERSON on the line, you can say "Good-bye" forever to pipe line troubles.

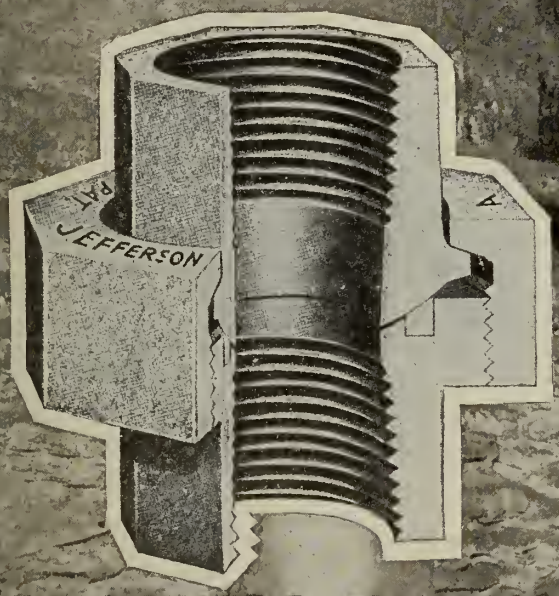
Insist on genuine JEFFERSON Unions—the name on the nut protects you from the "Just-as-good" variety.

Talk over unions with your jobber. He has JEFFERSONS in stock and can tell you why JEFFERSONS always make good.

Write for our catalog "UNIONS"

Jefferson Union Co.

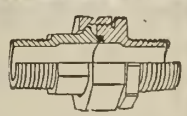
Lexington, Mass.



"LOOK FOR THE NAME ON THE NUT"

Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.

Union Elbow, all female. Takes the place of a straight union, nipple and an elbow. Also made male and female.



All Male Union. Saves two pipe joints between two female threaded parts.

Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. H. W. Johns-Manville Co., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Mfg. Co., York, Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
S. F. Bowser Company, Limited, Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS (UNDERGROUND STORAGE)
S. F. Bowser Company, Limited, Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

TRAPS, STEAM AND WATER-LINE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Montreal.
Victoria Foundry Co, Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (Vacuum and Gas Filled Types)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg. Co., Belleville, Ont.

TURBINES, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal,
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Engr. & Equip. Co., Worcester, Mass.
Escher Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Canadian Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNDERGROUND TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VACUUM GOVERNORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Canadian Steam Boiler Equipment Co., Toronto
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

VACUUM REGULATING VALVES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VACUUM TRAPS
Darling Brothers, Ltd., Montreal, Que.
Cole Ltd., Geo. W., Toronto.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Empire Mfg. Co., Ltd., London, Ont.
Darling Brothers, Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Victoria Foundry Co, Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Mfg. Co., York, Pa.

AIR VALVES
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Engineering Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
York Mfg. Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, BRASS
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa

VALVE CHAIN WHEEL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

VALVES, FOOT
Shell Bar Boico Supply, Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
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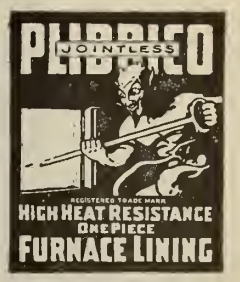

TRADE MARK

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID.
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
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D. M. MEDCALF,
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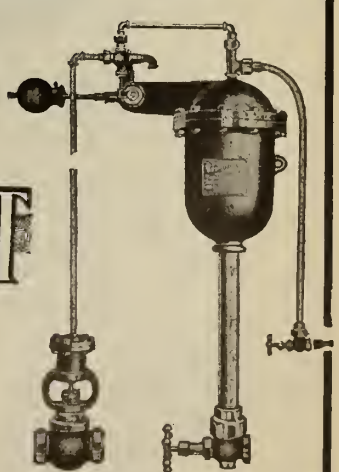

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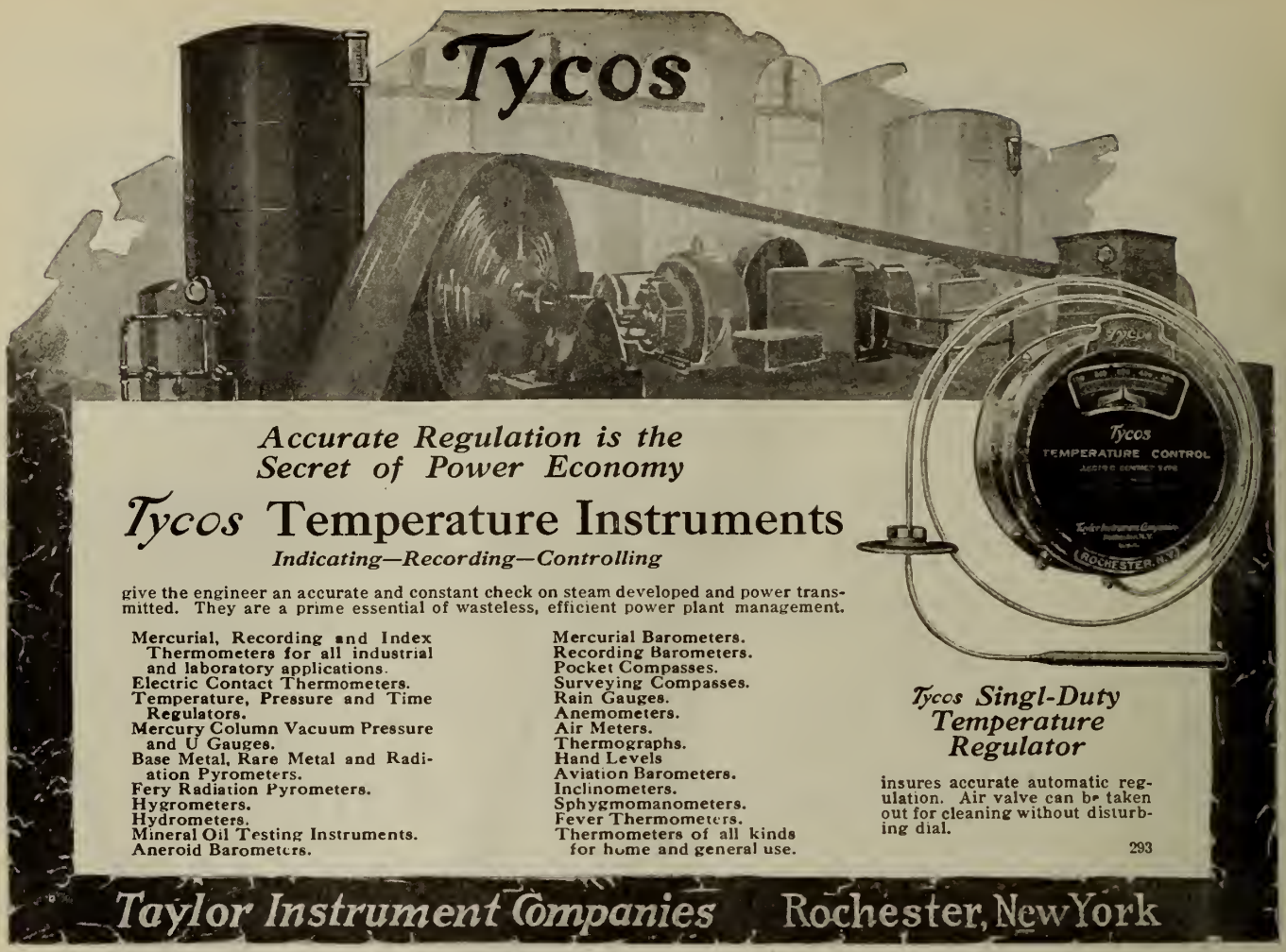

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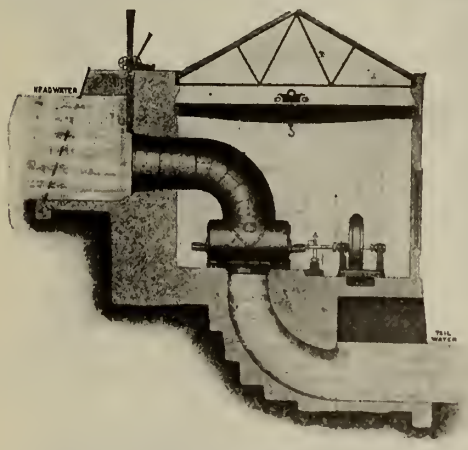

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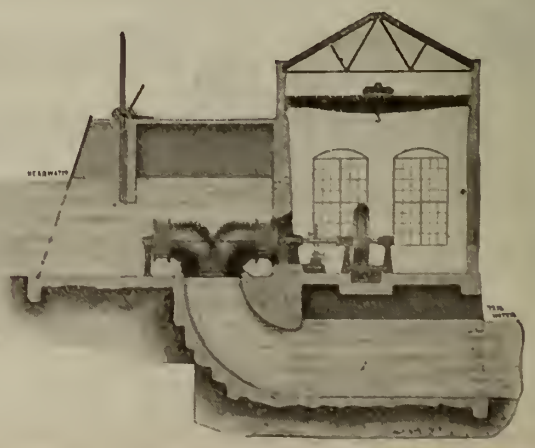

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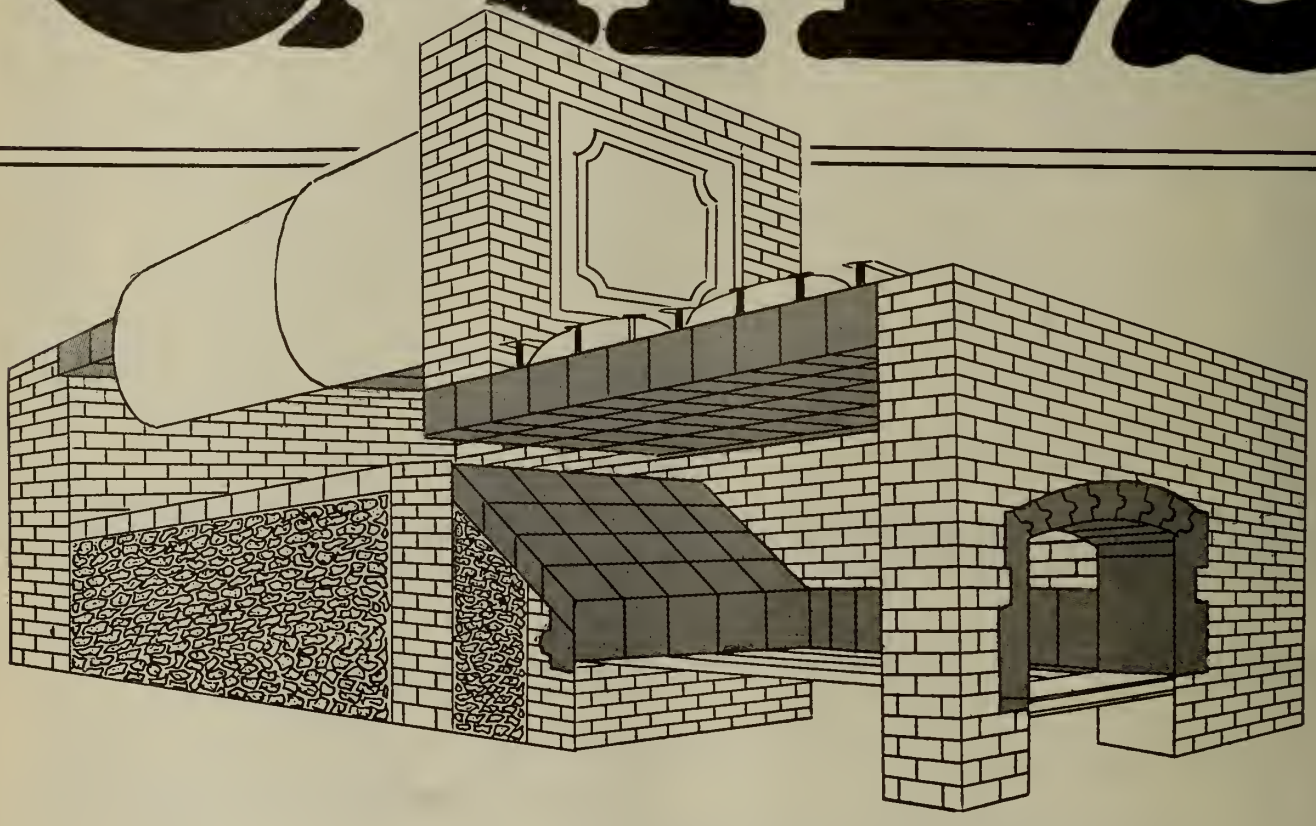

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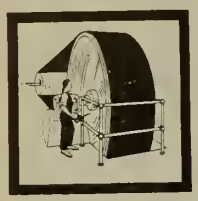
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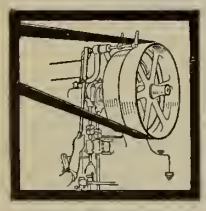
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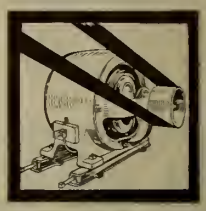
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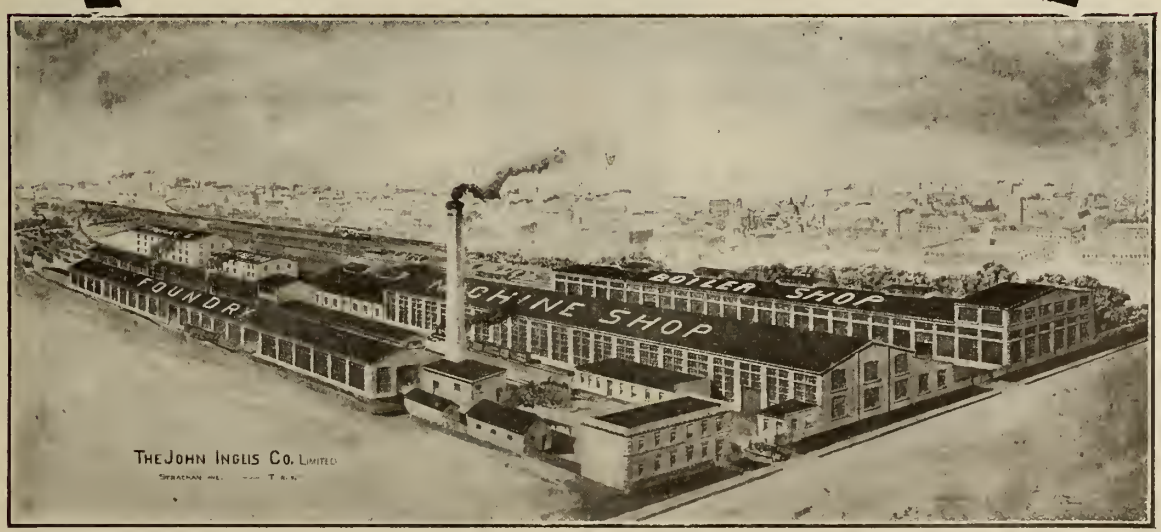

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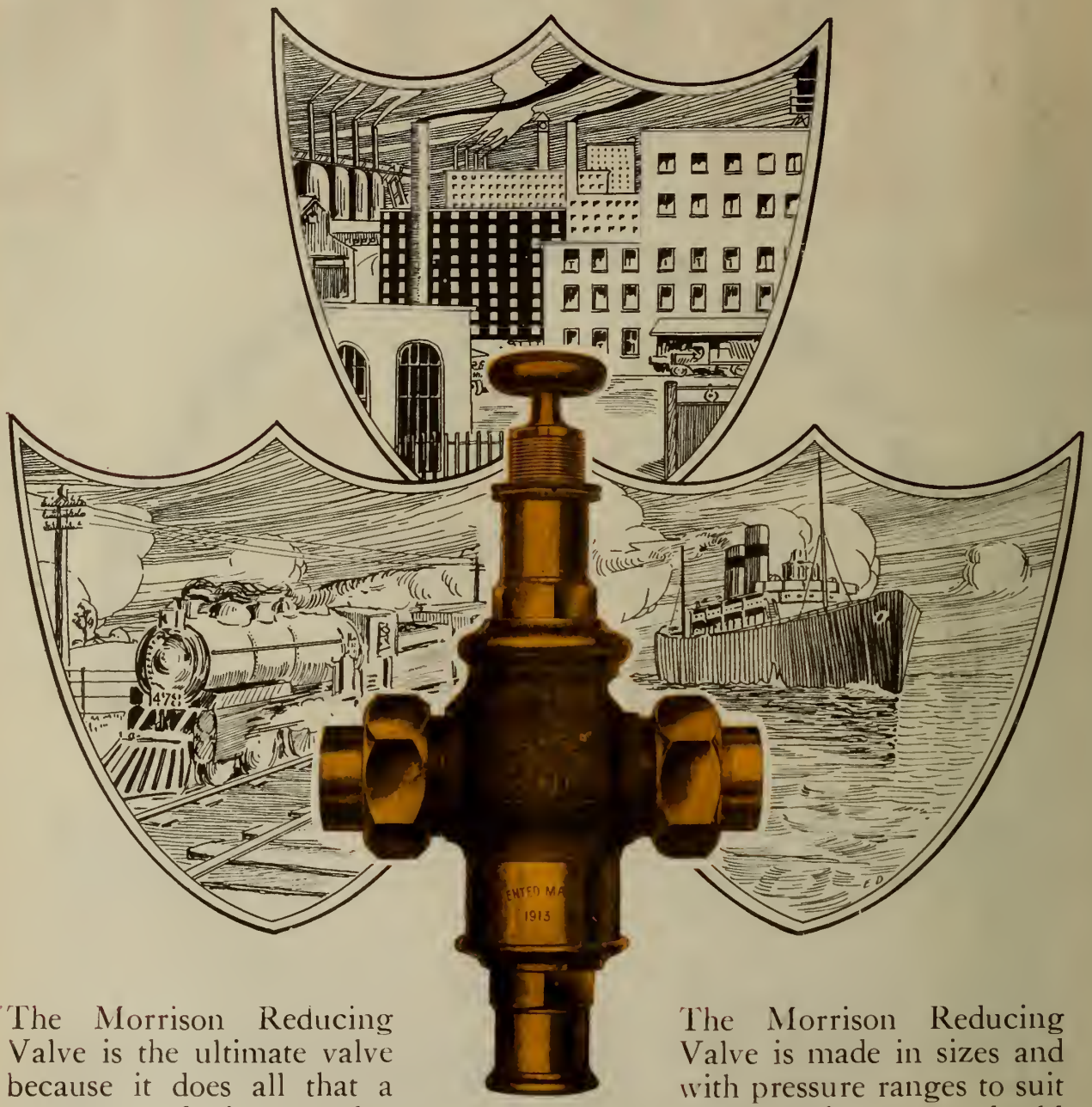

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Vol. XII.—No. 18. Publication Office, Toronto—November 5, 1919 Published Semi-Monthly $1.00 per Year

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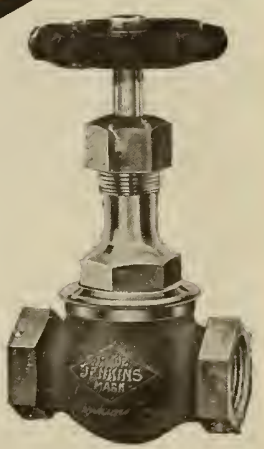

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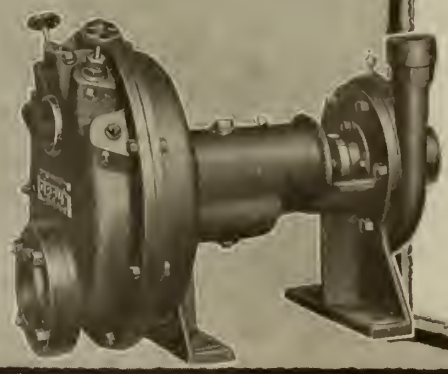

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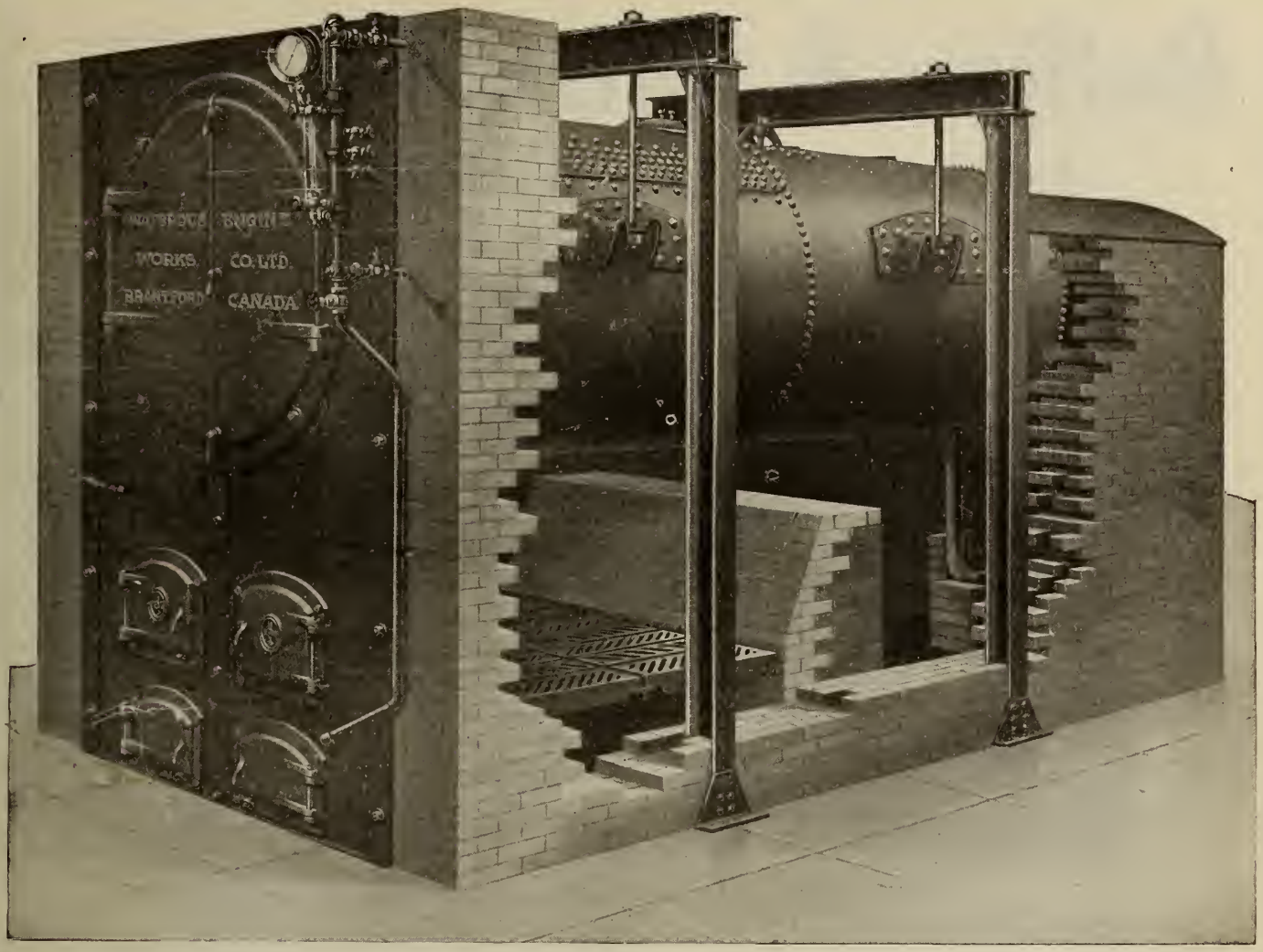

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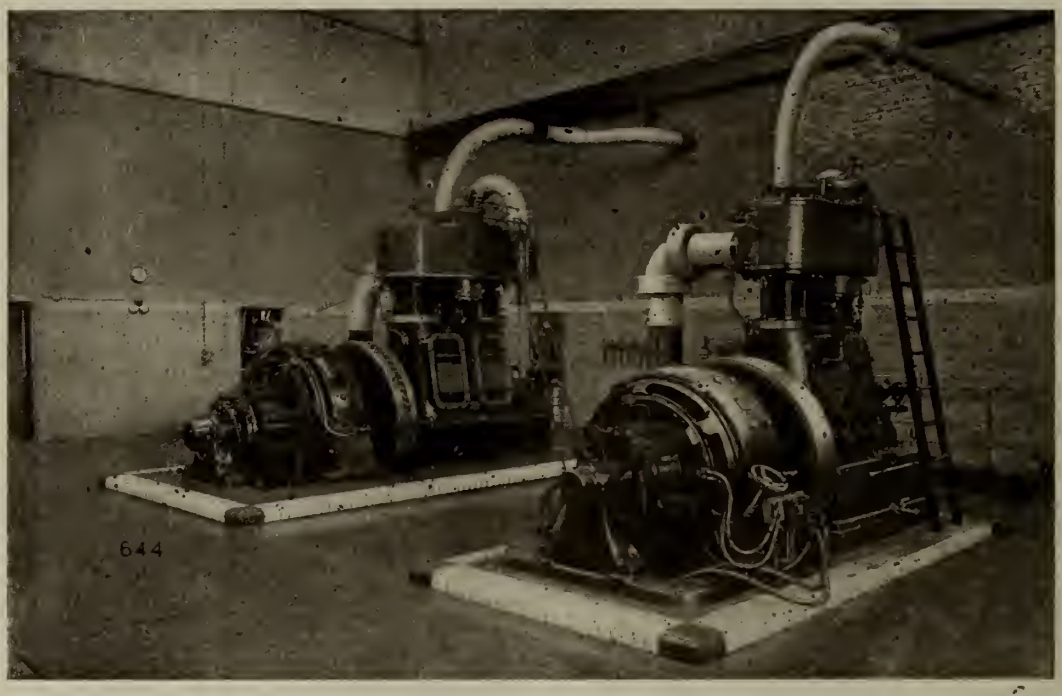

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"Action D," and 2" white pyralin coated offset connection.

The scores of householders who have enjoyed the freedom from embarrassment, that the "Silentic" makes possible, are our best advertisement.

But silence is not the only selling point of the "Silentic." Note its handsome snow-white appearance——no nickel to tarnish and spoil its appearance. Like all our lines of plumbing, the "Silentic" meets every requirement. All our sanitary fixtures must be absolutely efficient, non-corrosive, durable, Sanitary or they do not leave our factory.

Empire Manufacturing Co., Limited

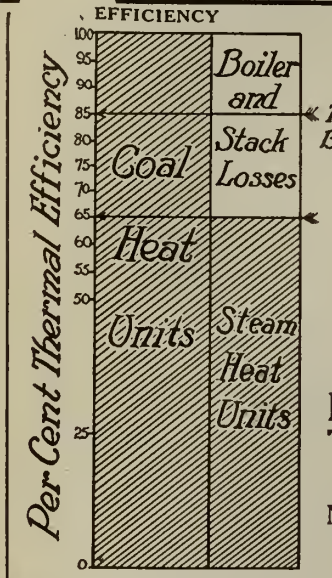
London and Toronto, Canada

Little Pointers that mean LARGE SAVINGS

to the ENGINEER and MANAGER who READS, REMEMBERS and ACTS on STEAM, STEAM-GENERATION and STEAM-GENERATORS (boilers) by

MOGENTOL

TRADE MARK



Under ordinary conditions The thermal efficiency Of the best boilers Of the conventional types Is 60% to 72%.

Contra-flow boilers have a thermal efficiency of 85%. Get the actual facts by test of your own particular boiler efficiency, then figure out how much money you are blowing ut the stack that could be put in your pocket by installing Talbot boilers.

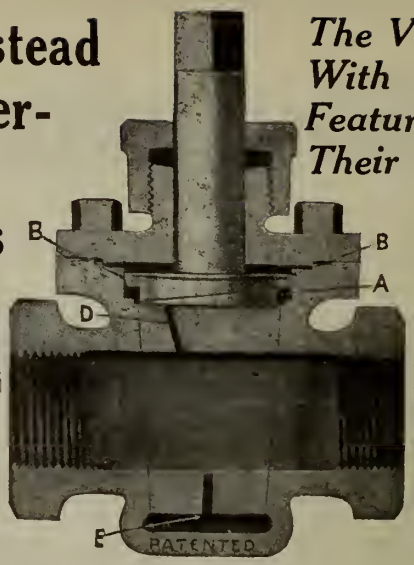
Let our Engineering Department show you how.

Montreal General Tool Co., Limited
673-5 Notre Dame St.
MAISONNEUVE, MONTREAL
Suite 512, 66 Broadway, N.Y.

TALBOT (with the stroke above) *Watch Our Next*

Homestead Quarter-Turn Valves

The Valves With Features All Their Own



USE HOMESTEAD VALVES

If you want a quick-opening Valve.
If you want a quick-closing Valve.
If you want a tight-closing Valve.
If you want a leak-proof Valve.
If you want an "Unobstructed Flow" Valve.

Homestead Valves save time, trouble and expense when used in place of "globes" and "angles."

Homestead Valve Mfg. Company
Pittsburgh, Pa. : : Works: Homestead

UEHLING WASTE METER

COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO_2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

CO2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

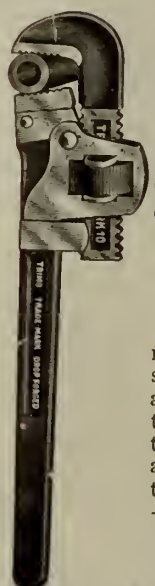
Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company
2008 Empire Building New York City

TRIMO

THE WORD TRIMO



Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company
Roxbury (Boston), Mass.

You can patch up holes in your Boiler Furnace Lining

in a Jiffy

with

PYRO PUTTY

TRADE MARK REG U.S. PAT OFF

FIRE BRICK IN PUTTY FORM

The World's Best Furnace Lining Material

PYRO-PUTTY comes to you in a stiff, moist, pliable, "ready to use" condition. PYRO-PUTTY enables unskilled labor to make furnace lining repairs in less time and at less expense than would be possible with standard fire bricks. Simply clean out the breaks in the walls, pound in PYRO-PUTTY with a mallet, smooth it off with a trowel and you'll have a patch that will outwear the rest of the furnace lining.

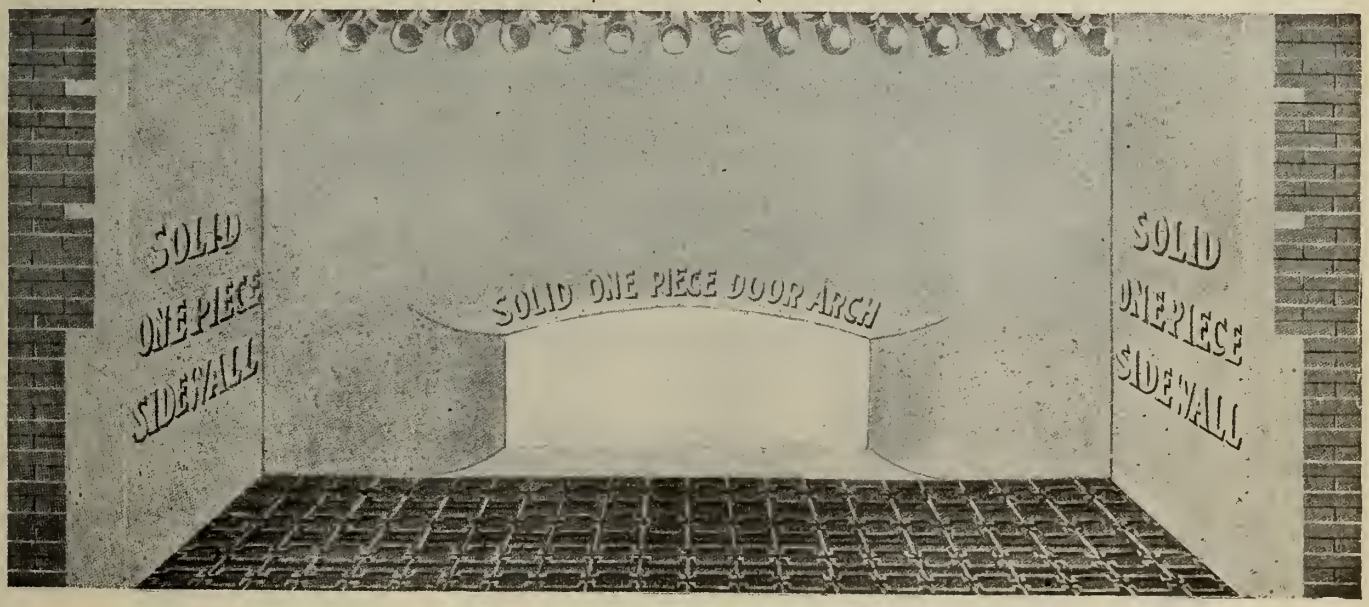
Pyro-Putty is far more durable than standard Fire Bricks for making New Furnace Linings

PYRO-PUTTY should be used, in preference to standard fire bricks, for making complete furnace linings because it is far more durable. And furnaces lined with PYRO-PUTTY are both efficient and economical because there are no joints to let the hot air out or the cold air in.

PYRO-PUTTY is put up in 700-lb. barrels, a barrel being equivalent to 100 standard fire brick. Sketch below represents the fire box of a water tube boiler lined with PYRO PUTTY. Compare it with your own fire box linings—then

ORDER A FEW BARRELS OF PYRO-PUTTY NOW!

"A few barrels of Pyro-Putty should be part of the emergency equipment of every steam power plant"

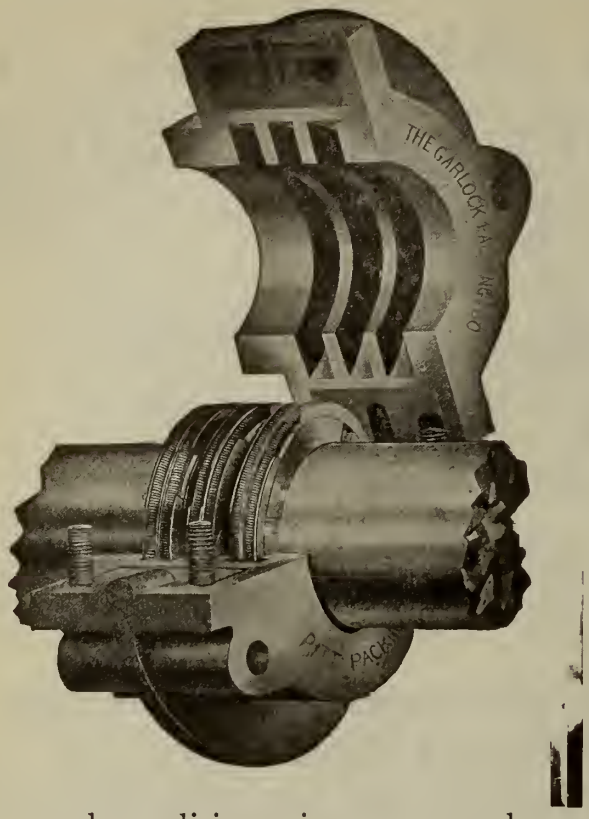


Sketch above represents the fire box of a water tube boiler lined with PYRO PUTTY.

Write to-day for further information and prices

PYRO PRODUCTS COMPANY

P.O. Box 685, Toronto, Ontario



GARLOCK Metal Packing

OUR position in the metal packing field is based on the principle that "No one style of metal packing can be made to meet all conditions." Working on this basis our experts study carefully the conditions surrounding each case, and with strict regard for mechanical principles, determine which type of packing is best suited to the conditions.

¶ The accompanying illustration shows our Flexible Packing, with split case, which is the most popular style and best all-round packing for stationary work, and when recommended by us to meet stated conditions, is guaranteed to give satisfactory service. This style is also made with solid or split-case to fit inside of stuffing-box, when packing space is sufficient to permit inside application of case and segments. All of our metal packings are so designed that the piston rod has absolute freedom of lateral movement without affecting the efficiency or increasing the friction of the packing.

¶ Next to correct mechanical design the most important feature of metal packing is the material used in the bearing rings. Our materials are made from formulas which long experience has shown to give the best results. A special grade of cast iron is generally used for bearing segments, in order to secure minimum wear and friction, but under unusual conditions, or when considerable condensation enters stuffing-box, bronze rings or segments of softer metal have to be used in the wearing parts.

¶ We can solve your metal packing problems, and we will give the usual Garlock guarantee of satisfactory service, if conditions are such as will admit of the successful use of any metal packing.

Write for catalog describing our many styles of metal and fibrous packing.

The Garlock Packing Company, - Hamilton, Ontario

BRANCHES:

Montreal, Quebec - 409 Shaughnessy Bldg.
Toronto, Ontario - Continental Life Bldg.
Winnipeg, Manitoba - - Galt Building
Calgary, Alberta - - 211 8th Ave. West

Do you know that—

a hot surface of this measured area wastes 127½ pounds of coal each year?

Few people realize that this condition exists if the temperature within a pipe, for example, is 230° Fahrenheit (the temperature of steam at 5 lbs. pressure) and the temperature of the air surrounding the pipe is 70° Fahrenheit—a very moderate condition.

If it is steam heat—

Size of steam pipe.	
2"	$ .95
3"	1.40
4"	1.80
5"	2.20
6"	2.65

The waste in dollars per year per linear foot of pipe, coal at $10.00 per ton, 1 lb. steam pressure—temperature of air around pipe 70° Fahrenheit.

Read the remedy to the right.

If it is hot-air heat—

Size of hot-air pipe.	
8"	$1.00
9"	1.10
10"	1.25
12"	1.50

The waste in dollars per year per linear foot of pipe, coal at $10.00 per ton. Air in pipe 150° Fahrenheit—air around pipe 70°.

Read the remedy to the right.

If it is hot-water heat—

Size of hot-water pipe.	
2"	$ .67
3"	1.00
4"	1.25
5"	1.55
6"	1.85

The loss in dollars per year per linear foot of pipe, coal at $10.00 per ton. Water in pipe 180° Fahrenheit. Air around pipe 70° Fahrenheit.

Read the remedy to the right.

EVERY hot surface radiates heat. If this heat goes where it is not required, it is wasted and so is the coal that was burned to produce it. Opposite are some actual figures on such wastes—based on average conditions in American homes like yours.

The Remedy

Insulation correctly designed, manufactured and applied will reduce heat loss from hot surfaces as much as 90%. Efficient insulation must be made of material that does not conduct heat and that combines with this property the necessary strength and durability.

Johns-Manville Asbestocel Insulation has all these desirable characteristics. It is made for application to steam, hot-air and hot-water systems. Other Johns-Manville Materials: Sponge felt and 85% Magnesia for high pressure steam, Anti-Sweat and Zero for cold water, Combination Built-Up for Brine and Ammonia.

Inspect your heating plant for exposed hot surfaces on pipes, boilers and heaters, and for sections not *properly* insulated.

Have your steamfitter apply Asbestocel to pipes, boilers or heaters, sealing all cracks and joints, finishing boiler and heater surfaces with Johns-Manville Insulating Cement. In this way you will save the added coal that must be burned when there is waste.

CANADIAN JOHNS-MANVILLE CO., LIMITED

Montreal Toronto Vancouver Winnipeg Hamilton London Ottawa

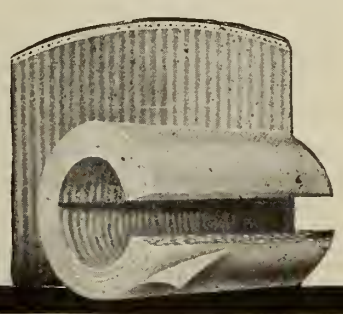
Unfortunately many materials used for "covering" pipes are not efficient heat insulations — not only because their constituent materials are inferior, but because their construction is incorrect or faulty.

To aid you in buying, Asbestocel is shown here in two forms:

In sectional form for fitting around steam and hot-water pipes.

In flexible roll form, for fitting around hot-air pipes, heaters, etc.

We recommend Asbestocel rather than air cell because of its construction, viz: the cells run around the pipe—not lengthwise, thus preventing circulation of air.



JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

INSULATION *that keeps the heat where it belongs*

CEMENTS *that make boiler walls leak-proof*

ROOFINGS *that cut down fire risks*

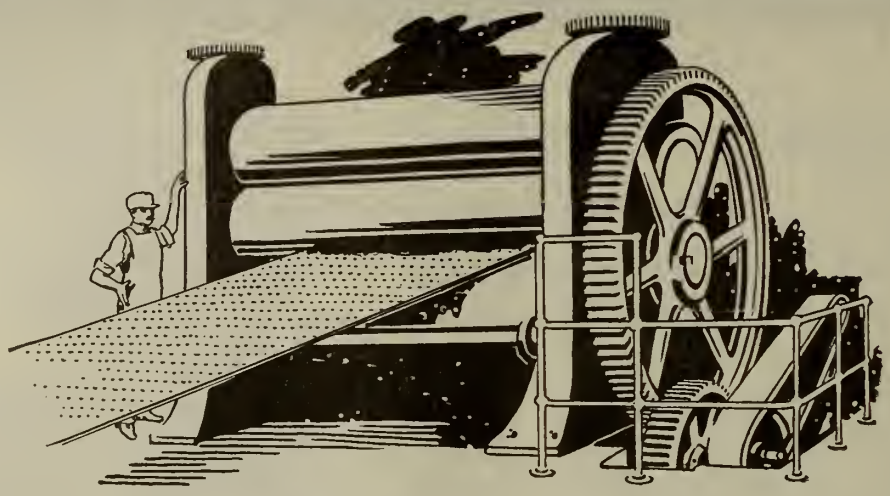
PACKINGS *that save power waste*

LININGS *that make brakes safe*

FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE

Serves in Conservation



Friction Surfacing Cuts Power Bills

Here is a statement that you can prove to your satisfaction and profit.

Take the meanest drives in your plant—the ones you know are wasting power in slippage on pulleys — ask our belting engineers to specify the correct size of

Dominion Friction Surface Belting

Keep a careful record of those belts for one or two months, or even a year, and compare it with the previous performance of those same drives—then compare *your* power bills for the two periods.

Dominion Friction Surface Belting will prove, in service, every claim we make for it, because the rubber with which it is saturated is a special friction compound that prevents practically all slippage and pays for itself in the power saved.

Our engineers are ready to help you, without charge, increase *your* production and lower *your* cost by making *your* transmission more efficient.

Phone or wire our nearest Service Branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

Makers of Dominion Hose, Packing and Industrial Rubber Goods and Dominion Tires, the GOOD Tires for every purpose.

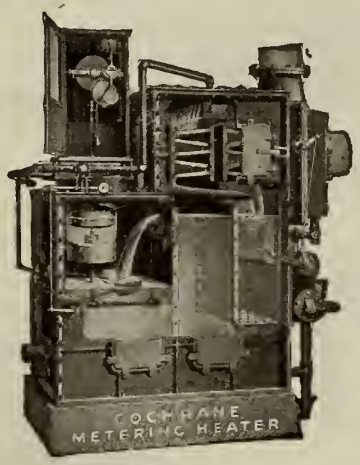
Service Branches:

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Kitchener, North Bay, Fort William, Winnipeg, Brandon, Regina, Saskatoon, Edmonton, Calgary, Lethbridge, Vancouver, Victoria

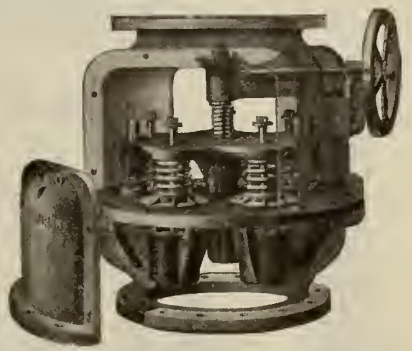
56

COCHRANE
COAL SAVERS

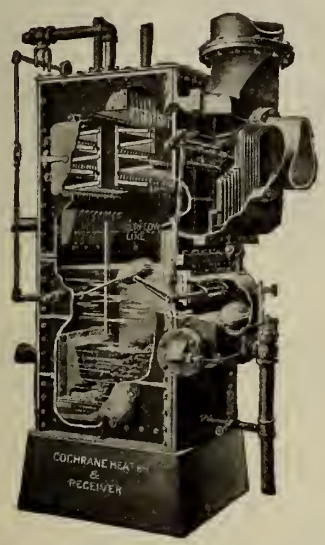
The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Metering Heater saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.



The Cochrane Multiport Back Pressure Valve saves coal by preventing leakage of exhaust steam and by making it easy to adjust the back pressure whenever desired. The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Open Feed Water Heater saves coal by utilizing exhaust steam to heat the feed water; 1% saving for each 11° F. rise.

Canada is Saving Many Thousand Tons
of Coal Per Year by Using Cochrane Heaters

Here are the figures:

The **horsepower** of Cochrane Heaters in use is about 10,000,000 boiler horsepower.

The corresponding amount of **coal burned** is 35,000,000 lb. per hour.

Considering an average of 10 hours' operation per day, 300 days per year (many heaters run 24 hours per day, 365 days per year), this amounts to 105,000,000,000 lb. of coal per year, or 50,000,000 tons, worth at $5.00 per ton, **$250,000,000.**

The saving due to the use **of Cochrane Heaters** is 1% to each 11° F. rise in temperature. On the average, the water is raised from 100° F. to 210° F. using steam at atmospheric pressure, 10% or a saving of 10%. Cochrane Heaters are thus **saving about $25,000,000** per year, which is vastly more than the heaters cost.

In addition, Cochrane Oil Separators are saving millions of tons of coal by **purifying exhaust steam** so that it can take the place of live steam in heating and drying coils, low pressure turbines and industrial processes.

Sorge-Cochrane Hot Process Water Softeners are saving millions by **keeping scale and corrosive substances out of boilers** and thus saving expense and labor in cleaning boilers, and for new tubes and other boiler repairs.

Cochrane Metering Heaters are also telling hundreds of **steam-plant owners**, managers and operators how much **they are gaining in economy** by using different coals, different methods of firing, different methods of controlling the draft, stopping up air leaks in boiler settings, cleaning soot and scale from heating surface, etc. The total gains realized in this manner often amount to 25% or more.

Our engineering department has given hard study to fuel economy for over 25 years. It will be glad to aid you with suggestions if you will describe your present boiler feed water heating, softening, or metering arrangements, the amount of exhaust steam you have available and what you are using it for.

Ask for a book on "The Profitable Utilization of Exhaust Steam."

CANADIAN-ALLIS CHALMERS
HEAD OFFICE: TORONTO LIMITED

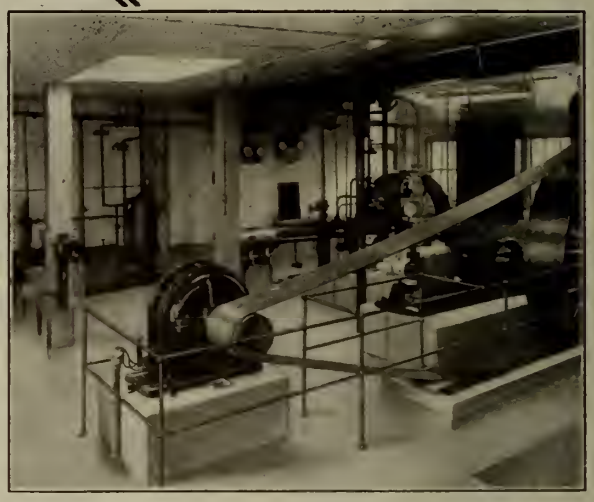
Branch Offices: MONTREAL, QUEBEC, HALIFAX, SYDNEY, ST. JOHN, OTTAWA, HAMILTON, LONDON, WINDSOR, COBALT, SOUTH PORCUPINE, WINNIPEG, CALGARY, EDMONTON, NELSON, VANCOUVER and VICTORIA

LINDE

REFRIGERATING AND
ICE MAKING MACHINERY

LINDE machines represent Quality and Service!

100-ton plant in operation.



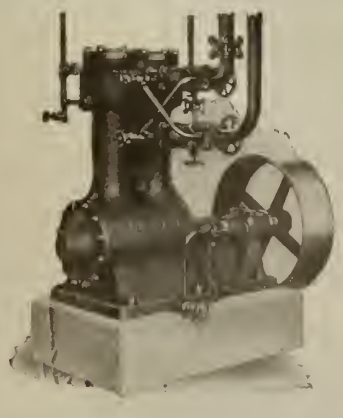
Everything for Refrigerating and Ice Plants, large or small

Mechanical refrigeration scientifically applied means increased returns to the user. Increase your profits by installing LINDE system in place of unsanitary methods. LINDE (New) Vertical Enclosed Type Machines offer the most modern improvement and convenience for small plants from 1 to 30 tons. The large horizontal frame type guarantees unequalled service to users whose heavy demands calls for loads up to 300 tons.

Our engineering staff is at your service. Designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Limited
37 St. Peter Street, Montreal, Que.
Toronto Winnipeg Vancouver

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin

Every Part of Every FRICK INSTALLATION Must Be Perfect in order to maintain

FRICK SUPERIORITY

That is why Frick Refrigerating and Ice Making Equipment proves a profitable investment wherever installed.

The entire Frick line, from the smallest to the largest plant, from the smallest part to the largest part in each plant, is designed to meet our strict standard of Durability—Efficiency—Economy. Every part must be perfect in order to maintain the well-known FRICK Superiority.

Therefore, when you purchase FRICK Equipment you are assured of perfect service regardless of the unforeseen overload demand that might be placed on it sometime—assured of continued operation without danger of breakdowns in the midst of a busy season—assured of economical operation at all times—and a long life. Frick Equipment has been standing up under the above conditions for nearly a half-century, day after day, year after year, under the most severe conditions.

You can't go wrong when you specify "Frick Equipment." **Catalog on request.**

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

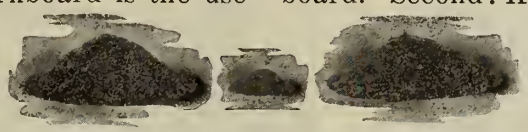
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Corkboard that Is *All* Cork

One important thing to be observed in the manufacture of superior corkboard is the use of **clean cork only.** Nonpareil Corkboard, known to refrigerating men everywhere for its unique service records, is made of the best cork waste available, practically all of which is obtained from the plants operated by the Armstrong Cork Company in this country and abroad. By thus going back to the sources of supply, control over the quality of the raw material is assured.



Pile to the left, cork before being cleaned. Centre pile, screenings removed in the cleaning process. Pile to the right, clean cork—the only kind used in Nonpareil Corkboard.

There are two reasons why dirt should be scrupulously guarded against in the manufacture of corkboard. First: Foreign matter reduces the insulating efficiency of the finished board. Second: If the natural gum binder gets impregnated with dirt, it cannot perform its function properly, and the result is impaired durability.

Examine a sample of Nonpareil Corkboard critically. Break it in two and look at the fractured surface. You will find it to be clean and of uniform quality throughout. For all dirt, dust and fine particles were removed from the raw material before it was baked.

If you want corkboard that is **all cork** and **good cork,** insist on "Nonpareil."

Nonpareil Corkboard Insulation

For Cold Storage Rooms

Many owners, managers and superintendents of refrigerating plants have found answers to difficult questions in the 152-page book "Nonpareil Corkboard Insulation." Do you own a copy? If not, let us send you one. There is no charge for it.

Armstrong Cork & Insulation Company, 504 McGill Building, Montreal, Quebec, Canada

York Refrigerating Machinery

QUALITY—SERVICE

From the very beginning we have been building **quality** and **service** into our Refrigerating Machines. This has resulted in increasing sales of our products and increasing satisfaction on the part of our customers.

With a York Refrigerating Plant you can improve the quality of **your** product as well as the measure of service **you** render to your trade.

Any firm that installs a Refrigerating Plant is looked upon by the trade it serves as a progressive firm. Give MECHANICAL REFRIGERATION a chance. In these days of keen competition it is the progressive owner who survives and profits.

Write us for information and prices.

York Manufacturing Company

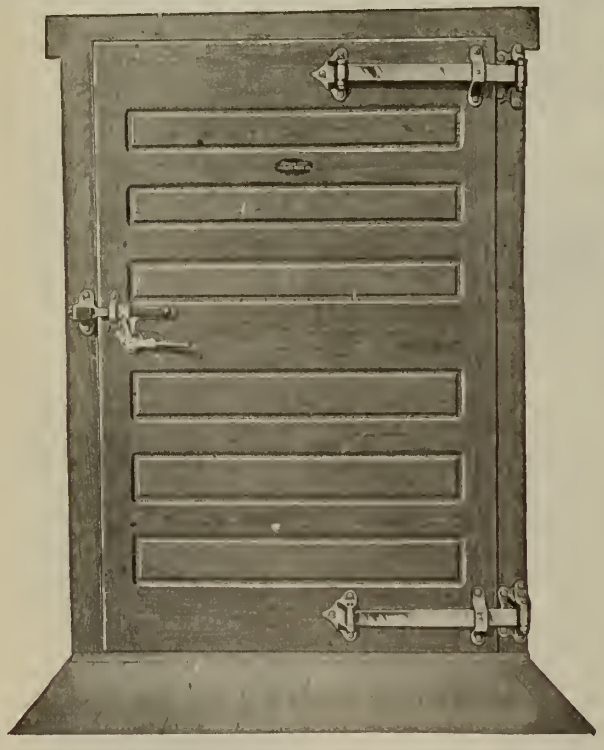
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY

YORK, PA.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard S TORONTO, 82 Chestnut St. MONTREAL, 324 Craig St. West CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:—

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as *Standard throughout our plant*, as we find *them substantially made* and the *insulation perfect*. We also find the *Hardware stands up better than on any other door* we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are *equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant*. We would not be warranted in throwing out the doors but would like the type hardware you supply."

THE WASHINGTON MARKET, Washington, D.C.

"The *doors supplied by you*, in use at both plants, *have been in every way satisfactory*, and we think the *Jamison door is the best on the market*."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

A Simple Design That Means Years of Reliable Service

The Yarway (formerly the Simplex) Seatless Blow-Off Valve is the last word in simplicity.

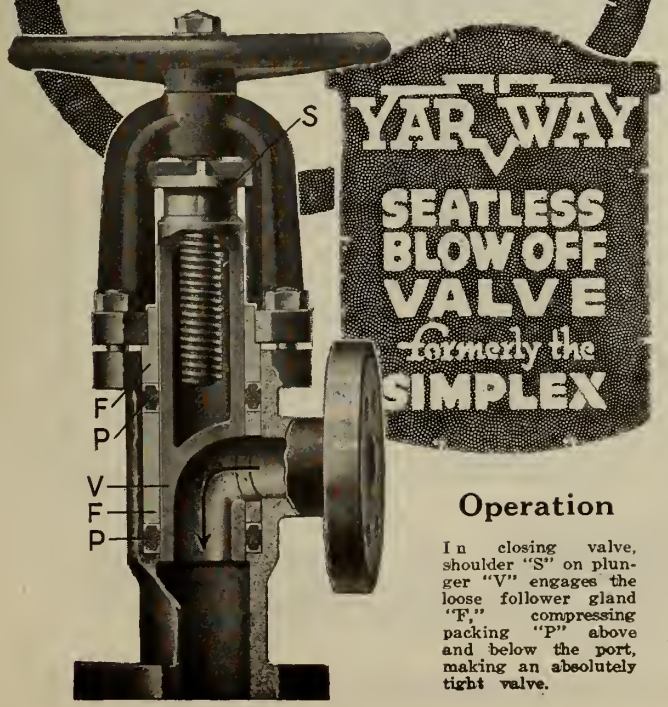
It consists of a hollow piston that is raised and lowered within the valve body. Study the illustration and description. Note especially how packing is automatically compressed when valve is closed, a feature that makes the Yarway leakproof. The protected position of packing prolongs its life to such an extent that renewal is necessary only at intervals of several years.

The large unobstructed port allows free uninterrupted passage to the blow down.

Try one for 60 days, subject to return. Write to-day, stating size of line and whether screw or flange, and angle or straightway.

YARNALL-WARING CO.
7604-20 Queen Street
Chestnut Hill, Philadelphia

A. McLELLAN
103 St. Francis Xavier St.
MONTREAL, QUE., CANADA

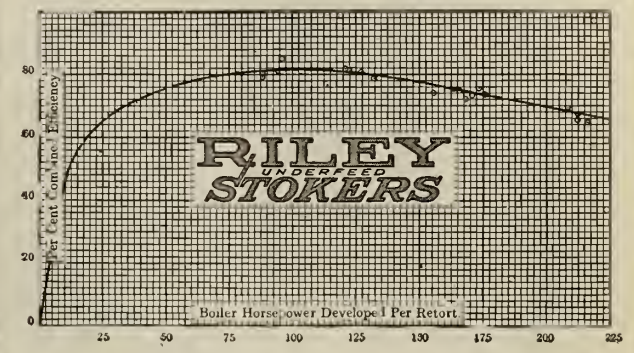


YARWAY
SEATLESS BLOW OFF VALVE
formerly the SIMPLEX

Operation

In closing valve, shoulder "S" on plunger "V" engages the loose follower gland "F," compressing packing "P" above and below the port, making an absolutely tight valve.

ARE YOU WASTING COAL?



If your boilers are operating at 65% efficiency, whereas you ought to be getting 75% or 80%, then you should investigate to-day the possibilities of RILEY UNDERFEED STOKERS.

The first year after installing Riley Stokers, the Haverhill Boxboard Company saved ten tons of coal a day, and reduced their operating force by thirty-six men—a total saving of $52,000.00.

Our catalog shows a cut of an evaporation curve. From it you can figure just what you can actually save in dollars and cents by increasing your efficiency.

Catalog HR-11 sent on request.

For information on Murphy Automatic Furnaces for small boilers, see Oct. 20 advertisement or send for Murphy Furnace Catalog H M-11.

Sanford Riley Stoker Co.
WORCESTER, MASS.

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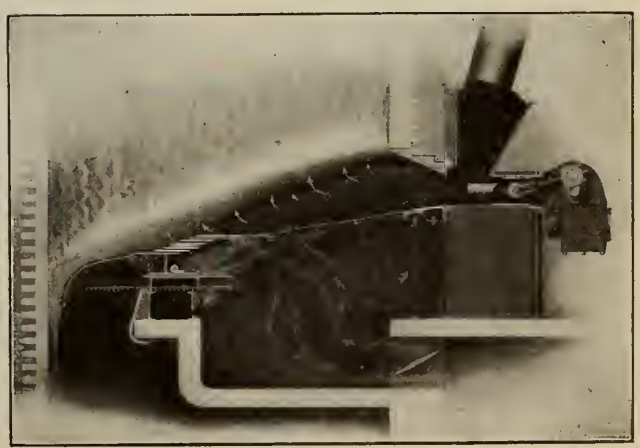

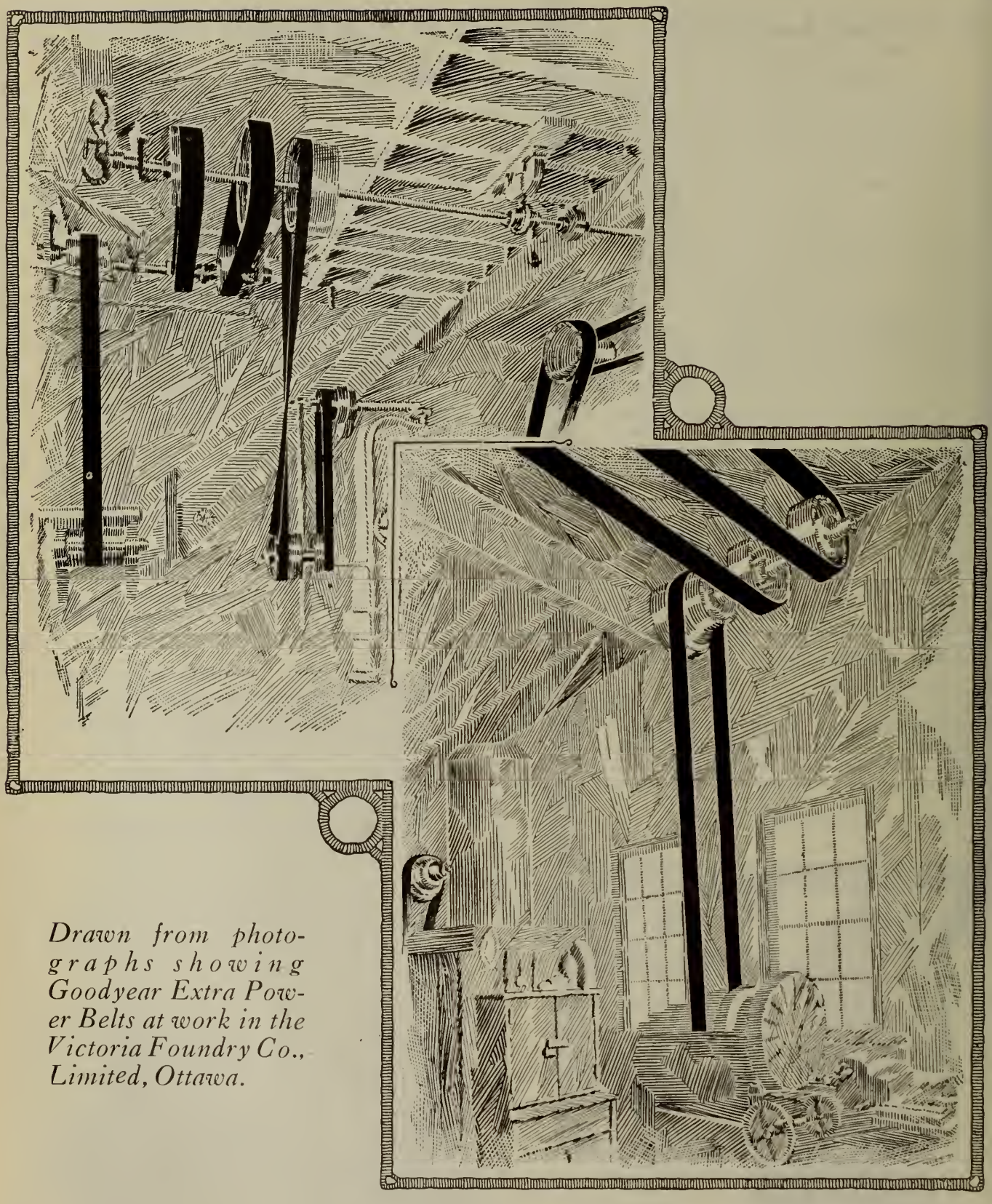

Drawn from photographs showing Goodyear Extra Power Belts at work in the Victoria Foundry Co., Limited, Ottawa.

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Changing belts costs money.

Belts which wear out quickly must be replaced frequently.

This costs money for belting.

Costs money for idle machinery.

Costs money for idle hands.

Costs money because piece-workers become dissatisfied.

Goodyear Extra Power Belting reduces belting costs.

It wears long, and so makes the belting itself cost less.

It keeps machinery and men busy, and enables everyone to produce at greatest efficiency.

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For example, here is what the Victoria Foundry Company, of Ottawa, say about their Extra Power:

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Gentlemen:

We have certainly had great satisfaction from your "Extra Power" Belting.

We have used it on all kinds of machines. It has been in service a surprising length of time—and is still in service.

For instance—

16 months on the cone of a 30-inch Lodge & Shipley lathe.
18 months on the cone of a 24-inch lathe.
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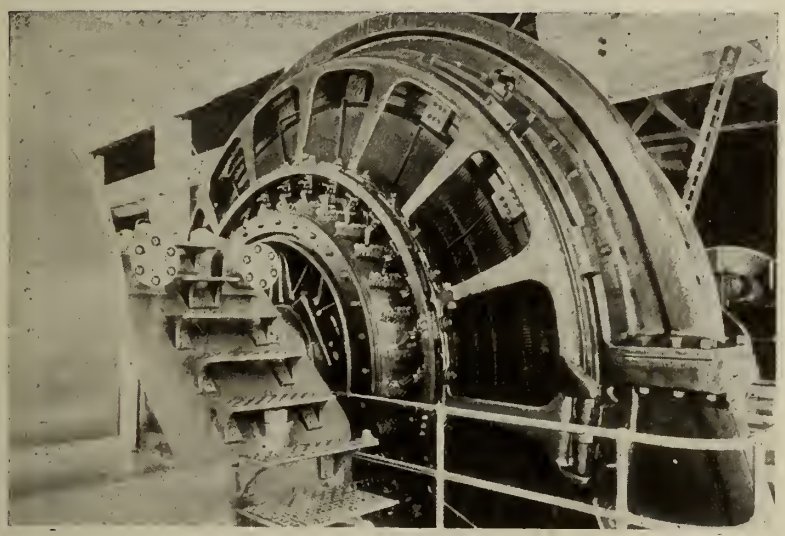


The Trueing of Commutators

The Second of Several Articles Descriptive of Commutators and Their Troubles. This Article Deals With Various Methods of Dressing and Trueing Up.

By W. F. SUTHERLAND

COMMUTATORS, like everything else, need care and attention, and at times, repairs of various sorts. Brush wear will often develop irregularities causing unevenness. A loose bar may creep out beyond the general surface of the commutator or the commutator may become excessively out of round or eccentric. Eccentricity in itself is not objectionable in slow speed machines, if present in small amounts. Many commutators operate when in this condition and give perfect satisfaction. In some cases it is only possible to correct this fault by trueing the commutator up when the armature is in its own bearings.

The above faults may be termed mechanical ones and other troubles of an electrical nature may necessitate corrective measures. Excessive sparking due to many causes will very quickly destroy the smooth polished surface which ensures sweet running. The causes of sparking in its many forms will be taken up in a later article, the present one being a resume of the various methods in current use for the restoring of a satisfactory surface when necessary from any cause.

For the above troubles a number of remedies may be used. Sanding may suffice when slight pitting has occurred, but when high bars are present, when the commutator is out of round, or when pitting is present in large amounts and of a severe character, it will usually be found necessary to resort to grinding or turning.

Turning Commutators

In turning commutators, the allowable peripheral speed will depend in large measure upon the condition of the commutator itself. If high bars are present the first cut should be made at a speed of about 100 ft. per minute. The finishing cut may be made at as high a speed as the tool will permit, up to 200 ft. per minute, with moderate and large size commutators. Speeds of 400 ft. per minute are sometimes reached in the turning of small commutators.

A high cutting speed and a sharp and carefully ground tool give the best results in machinery copper. The tool should be of the diamond shape and should be set as high above the centre as possible and yet cut with a clearance below the point.

The maximum speed used should be about one-thirty-second of an inch. Fig. 1 shows one of the best tools used for turning commutators, that recommended by the Westinghouse Co. This is a side-cutting tool with the point ground to about 1/16 in. radius. The cutting side and point should be given considerably more rake than is customary for use in working steel or iron.

Care should be taken to see that the tool is sharp enough to make a clean, smooth cut without dragging copper over the mica. The ends of the bars should be rounded off with a file while the commutator is in the lathe or after turning in its own bearings and while rotating at

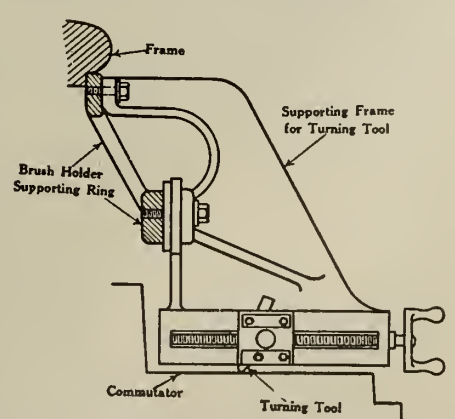


FIG. 1—ATTACHMENT FOR TURNING COMMUTATORS IN SITU.
—Courtesy Westirghouse Co.

the cutting speed. This rounding off should be done until the bars have a rounded corner of about 1/16 in. radius. The inner corner should also be rounded likewise as shown in Fig. 3. This is important, for if the commutator is

left with sharp corners at the ends of the bars, the mica is easily broken out and short circuits established by oil and dust at these points. After turning the commutator should be examined carefully to see that there are no small particles of copper bridging adjacent bars.

Before turning a commutator, a suitable head or cover should be made to prevent chips and dust from working into the armature. This head is best applied by taking a strip of cotton several inches wider than the length of the end connection and long enough to encircle the commutator, wrapping it around the commutator and binding the inside edge with cord as closely to the end connections as possible. The cord should then be turned up over the end connections and bound with cord to the outside of the armature.

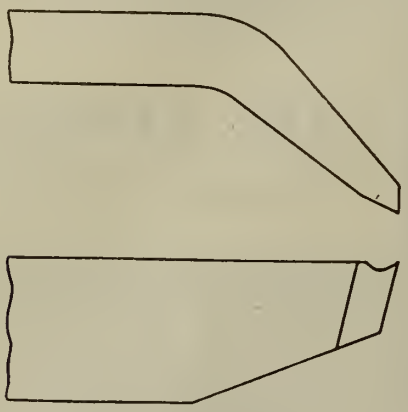


FIG. 2—TOOL RECOMMENDED FOR TURNING COMMUTATORS.

When turning a commutator with the armature in its own bearings some outside source of motive power is required if it is a motor that is being repaired. The power can most easily be obtained from a smaller motor conveniently placed and belted to the machine being worked upon. When turning the commutator of a generator, the engine can usually be speeded down to the proper number of revolutions per minute. Fig. 2 shows a turning device recommended by the Westinghouse Company and it will be seen that it is nothing more nor less than the familiar slide rest. A convenient lathe in the plant or in the engineer's own workshop can often be robbed of its slide rest and an attachment made for its support on the machine being worked upon. It must be kept in mind, however, that any support for the tool holder must be absolutely rigid and strong, for if the tool should dig in serious damage to the commutator will necessarilly result. The ways of the turning device should be set so that they are absolutely parallel with the commutator and securely fastened and braced.

It should hardly be necessary to reiterate the oft repeated advice—"Never lift the armature by slings around the commutator." This repetition may serve some useful purpose, for nothing will injure a commutator more; even if the surface be not marred, it will probably be forced out of round.

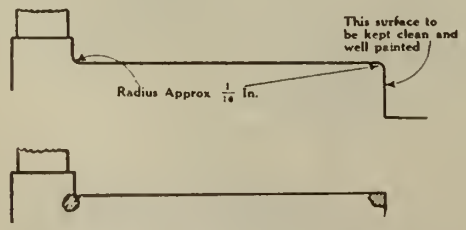


FIG. 3—SHOWING WHY CORNERS SHOULD ALWAYS BE ROUNDED AFTER GRINDING

Sanding

A commutator after having been freshly turned, is not in a fit condition to carry loads and it is necessary, in most cases, to sandpaper it before being put into service.

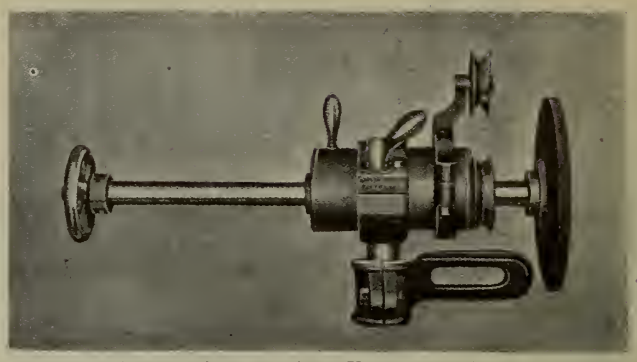


FIG. 4—JORDAN COMMUTATOR GRINDER.

The following hints re sandpapering also apply when it is desired to smooth the surface and thus remove any slight irregularities, such as pitting, etc.

If the surface is rough, No. 1½ paper should be used, followed by No. 1, and later by No. 00. Sandpaper should not be forced against the commutator by a lever, unless care is taken to distribute the pressure evenly over the whole of the paper. Many descriptions have appeared in the technical press of various sanding devices, but any engineer can make them to suit himself. One thing should be guarded against; the block should never be wedge-shaped so that it can be drawn into a brush holder bracket. If this occurs, a hurry-up repair job will be necessary and fireworks, of a verbal variety at any rate, will ensue. It it customary to mount the paper on a block, 15 or 20 sheets being screwed on to begin with, to give flexibility and an even distribution of pressure.

When the armature has been removed and placed in a lathe, the correct speed for sanding can easily be secured, and when it has been freshly turned in its own bearings, the same motive power used for turning will be available. Rotary convertor commutators are often sanded, brushes being of course removed, by starting upon the a.c. side and allowing the machine to run down to practically zero speed while sanding.

In finishing, one sheet of No. 00 paper should be used backed by felting or other suitable padding and the paper should be oiled with machine oil on the back. This oil will work through and will tend to catch the copper fragments and particles of sand, preventing them from being embedded in the mica. The surface of the commutator may then be polished with the back of the sandpaper or a strip of canvas.

It should hardly be necessary to repeat the warning often given: never use emery cloth or paper on commutators. Nothing will cause more trouble than this in operation, for the grains of emery will embed themselves in the copper with disastrous results.

Large machines are often shipped with the commutators freshly turned and after a commutator has been re-surfaced, it is also in a similar raw state. This condition and the fact that the brushes are either new or have been adjusted by sanding should be taken into consideration when putting the machine into service. If the machine is re-

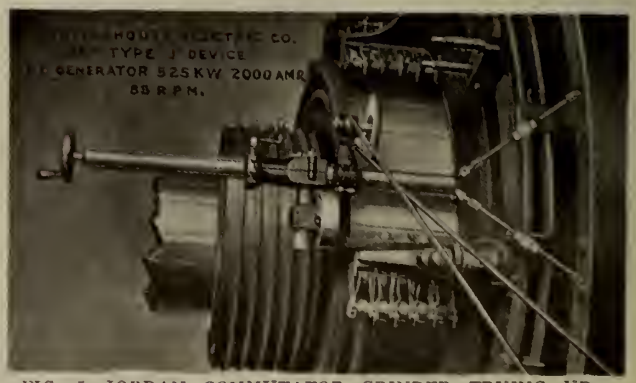


FIG. 5—JORDAN COMMUTATOR GRINDER TRUING UP COMMUTATOR ON WESTINGHOUSE MACHINES.

ceived with the commutator freshly turned, or if it has been refinished, it is advisable to run the machine light for some time, (one maker advising 24 hours), then at a load of about one-half full load for an equal length of time. This will polish the commutator.

A properly polished commutator will show a very high polish and will vary in color from a light straw to a dark brown, or even a blue gray, the actual color being of no importance. In the polishing of a commutator, no lubricant should be used.

Commutator Grinding

The turning of commutators has largely been superseded by grinding. This latter practice has much to commend it, for commutators can be trued up without removing the armature from its bearings and the machine can be run at its regular speed and can go on delivering power at the same time.

When turning up a commutator in the lathe, the motor or generator has to be shut down and the armature removed, possibly at the expense of some damage to itself. Copper may drag across the mica insulation and a considerable amount of material is removed. Turning with a portable slide rest suffers from the disadvantage of shutting down the generator or motor and running it at a reduced speed by some outside source of motive power. Difficulty is often encountered in securing a rigid support for the slide rest, failing which the tool is apt to dig

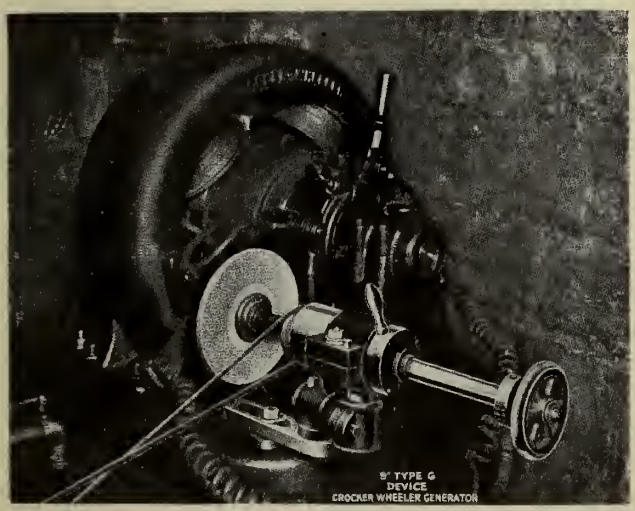


FIG. 6—SHOWING METHOD OF MOUNTING JORDAN COMMUTATOR GRINDER ON BED-PLATE.

into the commutator with disastrous results. End play of the armature in its bearings also has to be provided against.

By grinding a commutator it will last anywhere from two to three times as long, owing to the smaller amount of metal removed at each refinishing and sanding is unnecessary. The illustrations, Figs. 4, 5 and 6 show grinding attachments made by Jordan Brothers, New York, for the refinishing of commutators on all classes of direct current machinery.

Various types of this machine are in use, some belt driven, and some direct connected to a motor through a flexible shaft. The arrangement is simple, consisting in its essentials of a grinding wheel supported on a shaft running in ball bearings and with provision for adjustment radially to the commutator and lengthwise along the commutator face.

Special wheels are recommended by the makers of this device. Emery wheels won't do, owing to the conducting nature of the abrasive and to its tendency to embed itself in the copper surface. Wheels too hard or too soft are also unsuitable for the work.

In turning a commutator, the device is fastened in position so that its shaft is parallel to the generator or motor shaft, and the grinding wheel just clears the commutator. A round belt passes around a driving pulley

FIG. 7—USING THE IDEAL COMMUTATOR RESURFACER ON A SMALL MACHINE.

on the grinding wheel shaft and from there to a grooved pulley on a one h.p. motor. The grinding wheel is moveable parallel to the commutator and has sufficient range so that it can be fed across the entire width of the commutator face. The shaft in several of the various types of this machine is set in an eccentric barrel and by the manipulation of the handle controlling this eccentric barrel the wheel can be approached nearer the centre of the commutator, thereby taking off as light a cut as may be desired.

Re-surfacing by Abrasive Blocks

Another method for re-surfacing commutators has recently been developed. Blocks of abrasive materials of

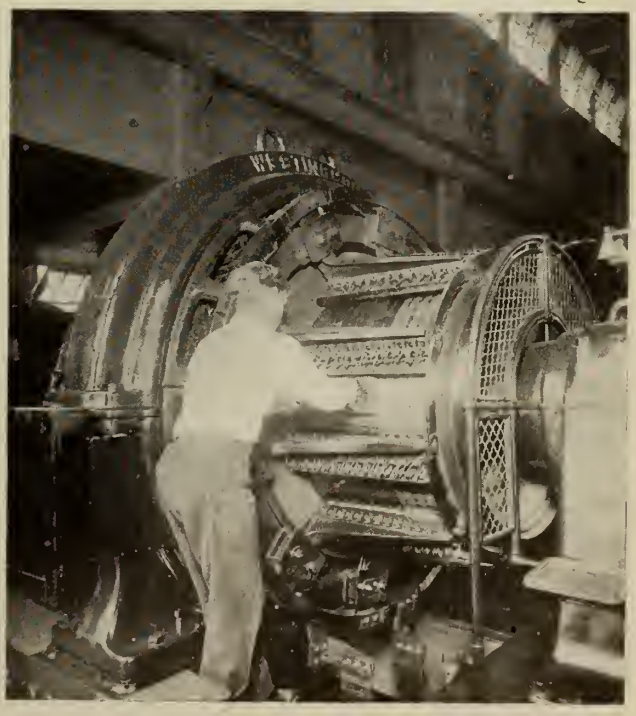


FIG. 8—RESURFACING ROTARY CONVERTOR COMMUTATOR.

FIG. 9—SLIP RINGS ARE EASILY TUNED UP.

the proper composition texture are used, fitted with suitable handles for convenient handling. Figs. 7, 8 and 9 show these re-surfacers, made by the Ideal Commutator Dresser Co., Chicago, in use. Fig. 7 shows one in use re-surfacing a small commutator, Fig. 8 shows a rotary convertor commutator being re-surfaced under load, and Fig. 8 shows its application to the a.c. collector rings of the same machine. The large re-surfacers for heavy work have double U handles, so that both hands can be used in controlling and supporting them.

As in the machine grinding of commutators, not every abrasive is suitable for use in these blocks, but artificial abrasives are used which are selected for characteristics suitable for the work.

Three grades are used, coarse for the removal of large amounts of copper, fine for the removal of high mica and small amounts of copper and extra fine for finishing purposes.

Many of the advantages which are inherent in the grinding of commutators by means of abrasive wheels are found in the use of these blocks. High mica, ridges and high bars are cut down, grooves and low spots smoothed out.

Making the Boiler Room a Safe Place to Work

The National Safety Council, Chicago, Issues Valuable Literature on Safety Practices in General. The following Article is Based on Their "Safe Practices for Boiler Rooms"

MANY potential causes of accidents exist in and around the power plant and particularly the boiler room. In carelessly kept boiler rooms the stumbling hazard is present in aggravated form. Loose coal is a prolific cause of accidents. If firing tools are carelessly placed one is almost certain to find in the same room, steam hose carelessly thrown down, wheelbarrows left projecting from dark corners, skids or planks behind the doors and scores of other hazards inviting accident.

Many boiler rooms suffer from lack of space. Space from the furnace door to the wall of the room, boiler settings, coal pile or other obstructions should be sufficient to permit the withdrawal of the longest firing tool without hazard or inconvenience. If there is sufficient space beside the boiler, racks for tools should be provided on the boiler setting. Other suitable places may be found in front of the setting, the wall of the room in front of the boiler or the back of the boiler setting. Tool racks must be substantially built. They must prevent the falling of tools and must not be in the way. The practice of allowing the tools to lie on the floor is inexcusable.

Exits

Two or more ways of exit should be provided from boiler rooms. The exits should be plainly marked and illustrated and the exit doors should be hinged to swing outward from the boiler room.

Boiler rooms are often slighted as regards both lighting and ventilation. Coal seems to suggest dirt, darkness, and disorder to the unthinking, but the visitor to this department is often impressed by the painstaking efforts of the grimy firemen in their attempts to secure order and safety.

Light (preferably sunlight, either from skylight or windows) should be provided in sufficient quantity to enable the reading of a newspaper to be carried out in any part of the room.

Elevated Runways

Elevated runways should be strongly constructed and adequately railed and protected. Entrance should be by metal or concrete stairs. Flooring of runways should be of grating type rather than of solid construction—the likelihood of accumulating coal dust on closed runways influencing the choice.

Several levels of runways may be found in the properly equipped and up-to-date boiler room, whereas in the older construction ladders are depended upon to reach the several points necessary in the course of a day's work. In addition to stairs and runways, chain or indirect control of several of the vital valves and safety appliances will be found most advisable.

Flooring

Brick flooring is sometimes recommended in handbooks dealing with subject. While it is a non-conductor of heat it lacks smoothness and does not lend itself to efficient operation.

Types of floors may be different around boiler settings and under coal piles. Floors immediately around boilers should be of metal plate with abrasive surface or of concrete. Under the coal pile, concrete will afford a suitable footing and will not interfere with the use of the shovel.

Storage of Fuel

If coal is dumped from railroad cars into a hopper a metal grating should be used near the top of the hopper to prevent a man falling into it. The grating should be of such a type as to permit of the efficient handling of the coal and at the same time to afford maximum protection to the workman.

A workman entering a bin should wear a safety belt and life line. The upper end of the life line should be attached firmly to some stationary object and a companion workman should keep the line adjusted short enough to prevent the man in the bin from being drawn under material.

Hot Wells

Hot wells should be fenced in or otherwise protected. If the well is less than fifteen feet in diameter the entire surface may be covered with metal plate or grating one foot or more above water level. If the hot well is more than fifteen feet in diameter or grating extending out

six feet or more from the side of the well may be installed with an appreciable slope toward the curb of the well and safety. Closed hot wells should, of course, be provided with a pipe at least ten feet in diameter and of sufficient size to permit of the escape of vapors.

In the economizer the temperature of the water is frequently raised to nearly that of the boiler. As the economizer is under the same pressure as the boiler, precaution should be taken to maintain and operate them with equal care. The water should enter the boiler after passing through a check valve. A safety valve should be provided for each economizer.

Many engineers recommend that the tops of boiler settings be made flat so that repairmen and others are provided with a rapid means of escape from the tops of the boilers in an emergency, and with a safe route to travel in their work. This may be done by filling around the drums or shells with an insulating compound, with four or five inches of concrete on top.

If flat top settings are impracticable a continuous walkway (with standard railings and toeboards) should be provided over each bank of boilers. The walkways should be arranged so that steam valves and safety valves are accessible from them.

Safety valves should not discharge across the tops of boilers. Direct the discharges upward and have them above the heads of workmen who may be working around them. When discharge pipes are carried through the roof they should be at least seven feet above the roof level.

At least one recording gauge should be connected to each steam system so that should an accident occur there will always be available a record of the steam pressure at that time. All steam gauges should be kept in good condition so that the pressure indicated will be approximately correct. For testing gauges a dead weight testing machine should be used.

Each boiler will be equipped, of course, with a water column and fittings. This should be located so that a view of the gauge glass from the boiler room floor is not interrupted by stairways, platforms, etc. Where it is necessary to provide a special platform for the water tender, this platform should not interfere with a view of the gauge glass from a position on the boiler room floor because it may be necessary to verify the water level from this point.

Drain connections from the water column should have an open end into a drain and be of sufficient size to permit any foreign matter that may enter the columns to be blown out. The drain connection should not be led into the ash pit, however; water striking hot coals will form carbon monoxide gas, a deadly gas, also explosive if mixed with air.

Guards are usually desirable where glasses are less than fifteen feet from the floor or water tender's platform. Glasses above this height may be obscured by some kinds of guards. Therefore, nothing is recommended except where men work near the glasses.

There are a number of glasses on the market which employ the principle of refraction to show the water level. These glasses usually have flat fronts and ribbed backs. They show a steel gray color above the water line. Disadvantages are that the water level can be observed from only one position and grease and dust collect in the grooves so that the glass has to be removed and cleaned. This glass is safer than the ordinary unguarded cylindrical glass. Wired glass guards surrounding the gauge glasses are very good where the location of the gauge exposes the workman to danger. They are objectionable when the gauges are some distance from the firemen or are poorly lighted, because glasses cannot easily be seen through them. They should be used on locomotive boilers where glasses are close to firemen.

Enamelled plates with vertical red and white stripes are sometimes placed behind gauge glasses to illuminate them.

All gauge cocks should be arranged to operate from the floor. Instead of having rods or drains attached to them it is often possible to arrange cocks with levers having holes in them so that they may be operated by means of a rod with a hook on the end. When not in use such a rod should hang at a given place conveniently located. Such an arrangement prevents the accidental movement of cocks.

Gauge Glass Breakages

Gauge glasses break from many causes. Brittle and unproperly cooled glasses break easily. Only the best glass should be purchased. Long glasses break easily; glasses not longer than 12 inches should be used.

Ends should be fused when cut as glasses are materially weakened by the broken surfaces. Impurities in the feedwater attack and wear glasses. If glasses wear rapidly experiments should be conducted to find a glass better suited to the water.

Glasses may be worn somewhat by the action of the steam and water passing through them. When the wear becomes perceptible glasses should be renewed.

Glasses should be protected from drafts or sudden chills. Sudden cooling of glasses places great strains upon them and will break any but the very best.

The expansion of the plates and the pressure in the boiler are apt to cause connections to move and break the glasses when they are mounted directly on the heads of boilers especially when mounted on bent plates. Eliminate this by the use of water columns.

Care should be taken to have the connections in perfect alignment and to place glasses in connections so that there is no strain on them.

Gauge glasses are very susceptible to mechanical injury, and if only slightly scratched are easily broken. Exercise great care in storing.

Gauge glasses should be protected from accidental blows. Breakage often occurs when gauge glasses are struck by the elbow or with a tool.

Many glasses are broken by turning the water into them carelessly when they are first put in. After renewing the glass proceed in the following manner:—

1. Replace guard and move as far away as possible.
2. Open gauge glass; blow down.
3. Open steam cock at top of glass slightly.
4. Leave in this position until glass is hot.
5. Close blow-down.
6. Open upper cock wide.
7. Open lower cock wide.

(Open and close all cocks slowly)

OPERATING RULES FOR BOILERS

Starting Fires in Boilers

If a boiler in a battery that is in service has been out of use for a time sufficient to permit all parts of the setting to become cold, or if it is a new boiler, the following method of starting up is advised:—

The stop valve between the "goose-neck" and the header should be tight; the drain pipes in the goose-neck and the drain valve underneath the non-return stop valve should be open; and the connection to the steam gauge should be open and in good condition.

Open the feed valve and fill the boiler gradually until the water level stands between the first and second gauges of the boiler.

Start a very light wood fire in the furnace and have the damper in the stack practically closed. The escape of smoke from the setting will indicate any air leaks, unclosed doors or other defects which are undesirable when the boilers are in service. If any such leaks are observed they should be corrected before going further; in the case of a new boiler or a boiler with new brickwork in the furnace, this preliminary heating should be continued for a day or two if possible before going further.

Continue firing with gradual additions of coal, the damper adjusted to the requirements until all the air is driven from the boiler and steam is escaping from the proper channel.

A period of at least two hours should be occupied in

bringing the steam pressure in the boiler up to the pressure in the header, as stated above; if the boilers are new a much longer time should be taken.

While steam pressure is rising in the boiler the gate valves between the boiler and the steam main should be slowly opened. This leaves the boiler still shut off from the main by the non-return valve. When the pressure on the boiler has reached the required amount the non-return valve will open automatically, placing the boiler in connection with the main steam system.

Before commencing heavy firing, corresponding to the service in the remainder of the battery, lift the lever on the safety valve to see if it is free to act, and observe at the earliest opportunity whether this valve lifts at the allowed pressure of the boiler or under it.

At this time the stop valve in the boiler feed pipe near the feed main of the boiler house should be wide open, also the stop valve between the check valve and the boiler; the feed-controlling valve should be adjusted by the water tender to an opening such as will provide the required water delivery.

Checking Fires

The practice of checking fires by opening fire doors so as to permit an inrush of great quantities of cold air into the boiler setting and to the stack is bad from an economic point of view and subjects the boiler and setting to an undesirably rapid change of temperature. Instead of this it is much better to close the ash doors or other sources of draft supply and if further checking is desired dampers should be closed. Finally if necessary fire doors should be opened gradually.

Blowing Out Boilers

The bottom blow-off should be used at least once every twelve hours, the valves in the blow-off connections being left open for a period of one-half minute or longer depending upon the character of the feed supply. A boiler should not be emptied before the setting has cooled.

Laying Up Boilers

If for any reason a boiler is to be taken out of service for cleaning, etc., the following procedure should be observed:—

(a) Check the dampers and allow the fires to burn out, at which time the non-return valve will be sealed; also close the gate valve in the branch next the header and open the drain pipes in the goose-neck or bend.

(b) Shut the stop valves in the feed pipe.

(c) Rapid cooling sets up undesirable strains in the equipment. Cool as slowly as time available will permit. A small amount of air may be passed through the furnace to assist in the cooling. To do this open the doors and dampers slightly.

(d) After the boiler is cool the blow-off valves may be opened and the boiler drained.

(e) If for any reason the boilers are to be laid up indefinitely the following precautions should be taken to provide for safe conditions when boilers are again put in service:—

Thoroughly drain the drums and tubes and clean them inside and out. Then completely fill the boilers and replace covers which have been removed. This method is not practicable when boilers would freeze. In such cases after cleaning the boilers, dry them thoroughly and place a pan of lime in each drum to absorb moisture. Do not replace manhole covers. Some companies prefer to clean and dry a boiler and then smear the insides of the drums with a heavy crude or fuel oil. This should be put on with a swab, and when putting this on an electric light should be used, not an open torch. Drums and tubes should be left open. Mud drums, headers and tube caps should all be cleaned and similarly coated.

In all places where freezing may occur, care should be taken to drain water from all parts or fittings, or, where these cannot be drained (as in the case of steam gauges) they should be moved and stood in warm places.

The above assumes that the boiler is separated from the main header by two valves, a gate and a non-return. In case this condition does not exist, or if the valves leak, a blind flange must be inserted between the boiler and the header.

Cleaning Boilers

The blow-off valves, stop valve in the connection nearest the header and the stop valve in the feed pipe next to the feed header should all be locked shut and the keys retained in the possession of the man in charge of the subsequent cleaning operations. Place on the handle of all of the above valves a suitable sign such as—MAN INSIDE BOILER; DO NOT TOUCH.

Manhole covers may be then removed and the boiler opened up for cleaning. It should be an invariable rule that the man who enters the boiler for purposes of inspection, and who is in possession of the keys locking the above mentioned valves, must give the final assent for the return of the manhole covers to their places.

Previous to entering the boiler it is advisable to determine whether there is any gas or bad air present by passing a torch or candle inside.

For locking the valves as advised above the following method is suggested—Make a loose cover for the hand-wheel out of sheet steel. This cover is simply a circular box made in halves and hinged at one side, with a hole in the bottom for the valve stem. On the side opposite the hinge an arrangement is made so that the box may be locked shut. This box can be painted bright red with the word "DANGER" in another color. For large steam valves the box may also have a sleeve extension to cover the valve stem, thus preventing the use of a wrench on the stem of the valve.

The cleaning of the setting of coal-fired boilers should not be commenced until all flue dust and other material, also the walls of the settings have been cooled to a temperature where there is no possibility of a man being burned by touching them.

The cleaning of gas-fired boilers will necessitate an additional precaution in the way of testing the chambers by means of a lighted candle or torch to detect the presence of gas or bad air. The gas valve leading to such a boiler should be locked shut and the key retained in the possession of the man in charge of the subsequent cleaning operations. A sign, MAN INSIDE BOILER; DO NOT TOUCH, similar to that placed on the steam feed and blow-off valves is to be placed on this valve also.

Leaks in Steam Pipe Systems and Other Structures Under Pressure

If for any reason, such as blowing out of gaskets, vibration, over-straining of pipes or general deterioration the joints of steam pipes develop objectionable leaks, the application of wrenches to bolts of such joints while under steam pressure should be absolutely prohibited. If such joints are to be repaired it should be done after the pressure has been removed from the particular section where the trouble occurs.

If the tubes of a fire-tube boiler develop leaks at the tube sheet, expanders should not be applied to the ends of the tubes while the boiler is under pressure.

If a leak develops at any part of the sections of a boiler whether in the headers to which the tubes are attached or at a riveted joint, the use of a caulking tool to stop this leak while the structure is under steam pressure should be prohibited. This applies to rivets as well as plates. All such repairs should be made after the steam pressure has been taken off the boiler.

If a leak develops at the hand-hole plate or around the tube caps of water-tube boilers same should not be stopped by tightening up the bolts while steam pressure is on the boiler. The same applies to leaks at manhole covers.

Rising stems of valves should not be permitted to be-

Continued on page 492

The Economizer in Power Plant Operation--II.

The Following Article Reprinted From a Paper Read Before the Boston Section of the A.S.M.E. Gives Some Valuable Data on Economizer Operation

The Heating of Feed Water

THE heating of feed water is a subject of interest and is having the serious attention of all leading engineers of the present day. With an attainment of the best combustion, an efficient boiler adopted, an economic prime mover, then the study of advanced engineers is to reduce the 20 per cent. or more fuel waste in the boilers and reduce the 20 per cent. of the total steam generated that is now required to operate the auxiliaries.

Now, first, let us consider the auxiliary requirements for a reciprocating engine run condensing, which we will assume is used for belt drive in a factory.

Shall the feed pump be operated by power or steam?

The opinion on this is diverse and the able practitioners consulted seem to be evenly divided.

Those favoring steam-driven pumps seemed to think them more reliable for steady operation with automatic control.

Those favoring power-driven types advanced that a six-plunger power pump provided with an automatic relief valve to bypass, has proved to be reliable and eliminated severe pulsations on the pipe lines.

For relay with power-driven pumps, some would provide injectors, particularly with reference to plants of moderate size; and other steam pumps.

Where steam-driven, all would use the exhaust in a secondary heater for heating feed after the water taken from the hot well or other original source had previously gone thrugh the primary in the exhaust between main engine and condenser.

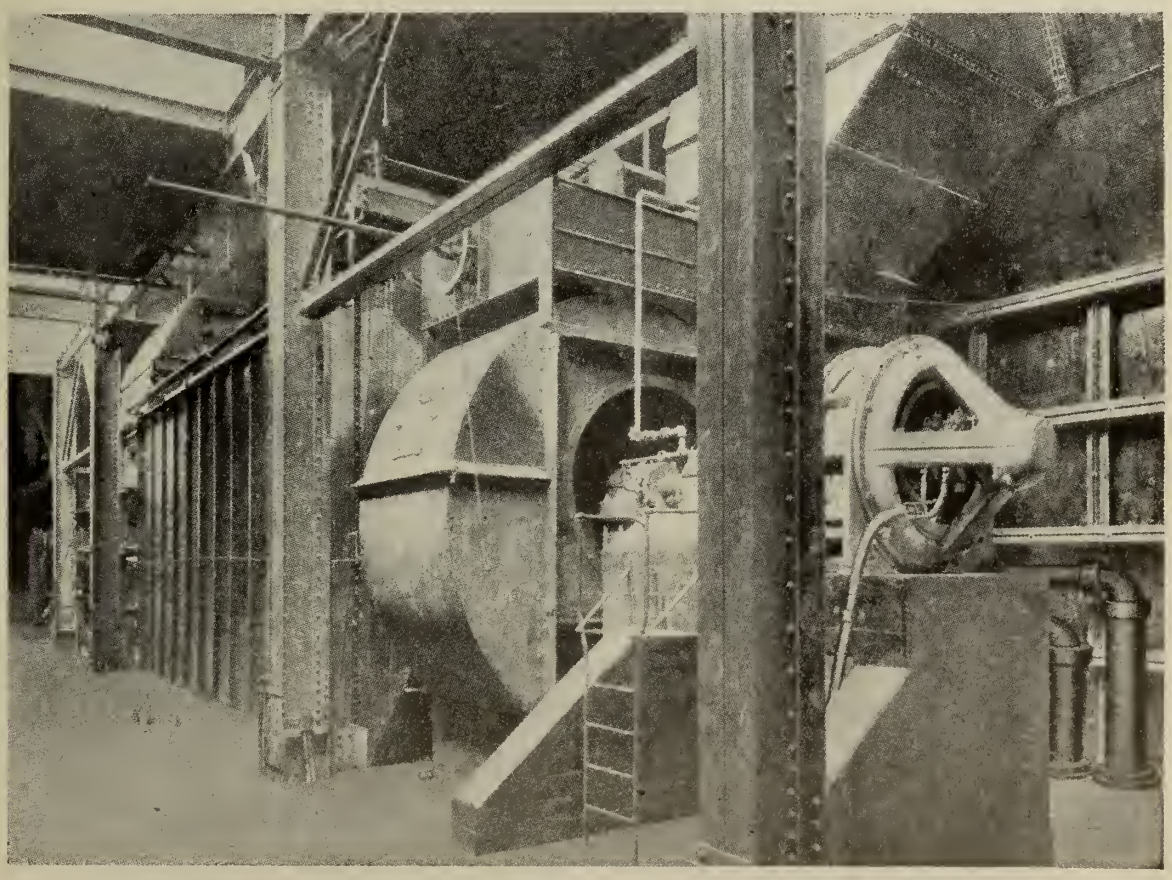
Presuming the condenser pump is not of a barometric type, shall the condenser water be circulated by steam or power pump?

Nearly all prefer this pump to be steam-driven, although they seem to regard the steam consumption to be high and many speak a good word for the economy of the old custom of direct connection to the marine engine, but concede the independent type has operating advantages.

If this steam auxiliary is of an economical Corliss type, it will require only about 3 to 4 per cent. of the steam used in the main engine and this exhaust will add about 30 degrees to feed water temperature, varying more or less, as 20 per cent. more or less of the boiler output on the average is customarily used for heating in an industrial plant and other moderate uses. The reciprocating engine for public service electric stations is not considered, as it is not present-day practice. If a twin vertical, high duty pump is used, about 9½ per cent. of the total steam is used to drive them and the exhaust would add about 80 to 100 degrees to the feed water. A compound pump will use about 6 per cent. of the total steam and the exhaust will correspondingly add between 50 to 60 degrees to feed temperature.

Hence it can be seen that with the 5 per cent. of steam that would be obtained from a steam-driven feed pump added to extravagant types of condenser pumps, an engineer could easily provide a feed water temperature at 200 degrees or better.

The most economical method for operating the auxiliaries would be power-driven feed pumps and Corliss



SIDE VIEW OF ECONOMIZER AT BLACK ROCK PLANT OF THE BUFALLO GENERAL ELECTRIC COMPANY.

condenser pump. The feed water would then leave the primary heater at 110 degrees; the secondary heater at 140 degrees, and from the economizer 240 degrees.

The belted feed pump would take only 8 i.h.p., say, for 1,000 h.p. at, say, 15 lbs. per h.p., or 120 lbs. against steam-driven at, say, 8x150 lbs., 1,200 lbs. steam per hour, or 1,080 lbs. saved by power driven from main engine.

The Corliss pump at 3 per cent. saves 6 per cent. of the total steam over the twin vertical, or one of similar steam consumption, which would have to be used to obtain 200 degrees temperature in feed, or 900 lbs. more saved, making a saving of 2,000 lbs. of steam otherwise to be manufactured. The combined use, therefore, of the belted feed pump and the Corliss condenser pump makes a saving of steam of at least 10 per cent. based on additional moderate amount of steam for heating, etc., used outside of engine and on top of this, the economizer heats the water to 240 degrees, or 40 degrees hotter than 200, giving another 4 per cent. This would make a total of 14 per cent. against running auxiliaries to give exhaust steam sufficient to deliver the water into the boilers at 200 degrees. This scheme, as just recommended, is being followed in many plants. Where plants can use some exhaust continuously in the mill, then more auxiliary waste can be allowed to such purposes, but the highest fuel economy will be had by limiting this supply to what can be thus fully used, and with sufficient to heat the feed temperature to enter economizer between 120 and 140 degrees.

I have been among power plants for over 20 years and every practical operating engineer I have met has always complained of the loss of steam used in small engines and auxiliaries. They know every piece of steam apparatus carries its own losses and if you get 80 per cent. recovery of their steam you are doing well.

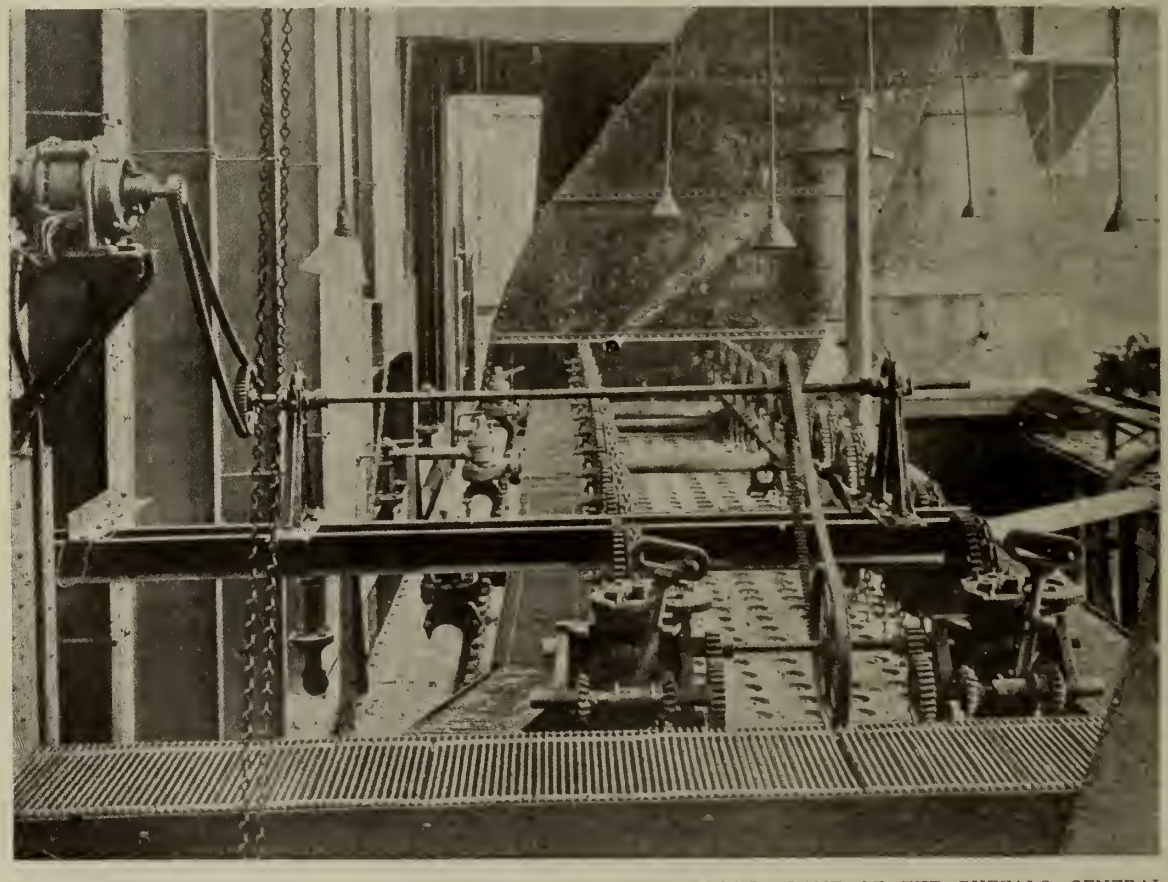
Capt. Manning tells me that it has been the practice in the Navy to heat the feed water by live steam and discharge the exhausts of auxiliaries into the main condenser to lessen the amount these use, and this has been their practice for over 15 years. Surely where every pound of water and fuel has to be carried aboard the ship our expert naval engineers would not be doing this if it were not provedly economical.

My outline for operating auxiliaries and heating the feed water through the feed water heaters and economizer showed a combined total saving of 14 per cent. Practically it will be nearer 16 per cent., because you will get only 20 per cent. recovery of the waste on the other method, and then the saving will be even greater, because the ratio of combustion being reduced in a given boiler unit for a less duty, produces a higher boiler efficiency, and therefore a compound saving is effected. Every conscientious expert who has ever tested economizers has almost invariably found this result true. Then, too, consider that the water is held nearly an hour's time, so many impurities have chance to be precipitated, therefore the water is pure and ready to ebulate.

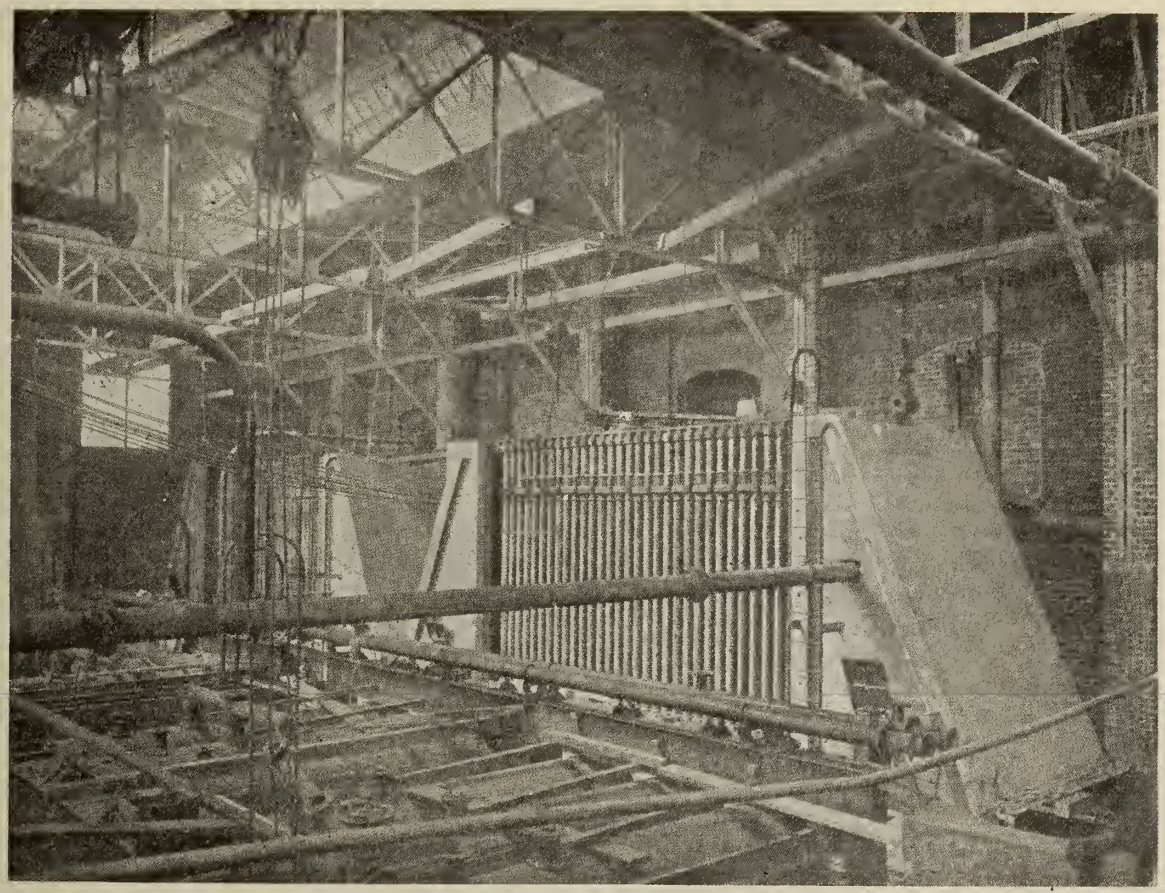
The use of the exhaust in the low pressure cylinder can be granted to produce useful economy. Some object to the method because the steam may be wet, necessitating the complication of reheating coils. Sometimes these coils are utilized to carry the live steam to operate the condenser pump. So while this low pressure duty does seem to work well in practice, and I know of no positive troubles, I gave my former outline the preference, as it looked simpler, was easily understandable and probably as equally effective in net economy. This alternative method supplies steam feed pump exhaust to the secondary heater instead of condenser exhaust, the latter being condensed or used to manufacture power in the engine.

The operation of exhausts from auxiliaries into the main condenser has met with objection that their leaky valves will destroy the vacuum, but I found its adherents, who claimed they had never had such troubles where the vacuum carried was not higher than 26 in.

With a barometric condenser the feed pumps will be steam-driven to provide a source of exhaust to the secondary heater.



TOP OF GREEN'S ECONOMIZER INSTALLATION AT THE BLACK ROCK PLANT OF THE BUFFALO GENERAL ELECTRIC CO. TWELVE ECONOMIZERS INSTALLED, EACH IN CONNECTION WITH ONE 1200 HORSEPOWER B. & W. BOILER OPERATED AT 400 PER CENT. RATING PRESSURE 275 LBS.



GREEN'S ECONOMIZER INSTALLED IN THE PLANT OF THE CALIFORNIA AND HAWAIIAN SUGAR REFINERY CO., CROCKET, CAL. THE CONCRETE FLUES SHOWN ARE AN INTERESTING PIECE OF DESIGN.

It may be asked why the author insists on a secondary heater or in effect to secure 150 degrees for entering economizer temperature. Why not be logical and run every auxiliary by power and save all their wastefulness and just take the water from the primary heater to the economizer? This could be done if someone were to be in charge of the plant to have any apparatus that could be reliably run, operated off the main power.

But in many plants where the boilers have to be fed with water at 110 degrees or thereabouts, it happens when economizer is shut off for repair or cleaning that the coaling is so heavily increased and the labor of keeping steam likewise, as compared with the ease had with economizer, that the engineer is loath to disturb its service—lets minor leaks run in, awaits the favoring time when the plant won't be too busy, and then has other things to do, knowing the rugged economizer can stand a while longer. The thorough cleaning and overhauling of once or twice a year that it should have is not given to it for years.

The same chief auxiliaries of the reciprocating engine of feed and condenser pumps and also another important auxiliary, the Exciter engine, are required in modern turbine stations and some comments on them follow:

The Feed Pumps. In some important plants it will be found that these are run motor-driven with steam relay, although elsewhere, steam-driven by duplex pumps, chosen for reliability, or small turbine-driven centrifugal pumps. A three-plunger power with motor chain drive and steam relay should prove a reliable and economical rig—or what will develop more probably will be centrifugal motor-driven pumps with small steam turbine to automatically relay.

Condenser Pumps. Practice on these is diverse between motor-driven and steam. Where steam driven the exhaust is sometimes led to the condenser, but the higher vacuum of turbines than to reciprocating is apt to generally give more trouble with leaks through valves of these small steam pumps or small turbines. Lately the Terry turbine has brought out a turbine with the steam flow reversed through the low pressure element and thus protecting the valve gland to enable them to run with an economical use of steam by condensing the exhaust.

Mr. William Pestell tells the author that the new turbine going in at the Manchester Station in Providence, R.I., is being planned to turn the exhaust of the condenser pump into the fourth stage of the main turbine. The pressure varies, but is expected to be about 8 lbs. absolute, or equal to 14 in. vacuum at this stage. Although the general use of the exhaust from steam-driven pumps in past years has been to feed water heaters, the present tendency is to find a right method that will reduce the steam these pumps consume.

The Exciter Engine. This has been usually engine-driven, because reliability was better with an engine than motor, as a motor trouble or a falling away of 5 per cent. to 10 per cent. would likely cause a shutdown. The exhaust has been generally used to heating feed water.

Primary heaters are in use in some turbine plants, but there has been so much steam from auxiliaries that they are not of much account, especially to heat of steam going to low vacuum. Except where all auxiliaries are motor-driven, as at Quincy Market, such a heater would be of no account.

It may be worth mentioning here that this plant is the largest cold storage plant in the world, with millions of dollars' worth of perishable stuff held in its vast warehouses, and must be kept going every hour of the year, especially in the summer months, where a short shutdown would mean tremendous loss. In this plant, city water is heated by primary heater to 90 degrees with 29 degrees vacuum on the condenser, and is raised by the economizer to 180 to 210 degrees. The economizer is admittedly 50 per cent. too small, but present space

conditions limit its extension. They also have induced draft. Their management spares no expense to have the most perfect equipment to be procured.

Mr. F. L. Fairbanks, the chief engineer, says he does not feed his city water back into the boilers, because there may be times when the auxiliaries are steam-driven and condensing, so there is a possibility of oil getting into the boiler. While such occasions are rare, only a few hours, perhaps, in the month and could be provided against; he also admits using a very trifling amount of oil in the steam to his turbines. This he does to prevent wear on the blades and accumulation of deposit on the low pressure blades—both effects causing a practical disadvantage to the efficiency and maintenance of the turbine. He therefore believes it pays to eliminate both these factors, as he claims he does, by cautious use in admitting oil and throwing away the condensed steam.

Another item of interest was the information that in one electrical station, where they had more steam from auxiliaries than the feed water heaters could take up and absorb, they changed over the exciter to be driven by a motor with a Terry turbine, on the same shaft and kept turning with the motor, and whenever the motor fell off below 5 per cent. the turbine power would cut in automatically and take up the load.

There may be another serious and important steam waste that can be had for feed water if the plant is operating forced draft. J. M. Whitam, Philadelphia, Pa., the well-known expert, speaking on the advantages and disadvantages of stokers, stated, "Those types requiring forced blast will consume 5 to 10 per cent. of all the steam made." This statement was made some time ago when conditions were not as strenuous as to-day.

A difficulty to precise figures is, that it is well-known with practical operators that the steam for auxiliaries is not appreciably lessened when the load falls off, so their steam consumption is relatively higher on the average than the figures I have employed.

It will be of interest as an example of latest practice to look at the equipment going in the Fisk Street Station of the Chicago Commonwealth Edison Co., of two turbines, one 2,500 kw. English Parsons, and the other a 20,000 kw. General Electric, which will bring the total service capacity of this station up to 165,000 kw.

Boilers

Steam is generated by B. & W. boilers.

Each boiler contains 2,440 sq. ft. superheating surface.

Each boiler contains 12,200 sq. ft. h.s.

Total surface in boiler, 14,640 sq. ft. h.s.

Ratio of economizer to boiler h.s., 70 per cent.

Normal rating per 10 sq. ft. boiler heating surface, 1,220 B.H.P.

If economizer is regarded as extension to boiler h.s., 2,070 B.H.P.

Steam pressure, maximum, 225 lbs.; normal, 210 lbs.

Superheat, 200 to 225 degrees.

Evaporation, 80,000 lbs. actual under continuous working conditions. Approximately, 2,400 B.H.P.

Temperature of feed entering, 280 degrees.

Grates—Two chain grate stokers to each boiler, each 13 feet long by 10 ft. 6 in. wide, or 273 sq. ft. area.

Ratio, B.H.S. to grate area.

Ratio if economizer regarded as add'l B.H.S.

Draft

One steel stack, 259 ft. 6 in. above boiler floor.

Inside diameter, 19 ft. 0 in.

Will serve to 8 boilers.

An induced fan provided to each boiler stated to have 80,000 cu. ft. per minute and designed to maintain 1½ in. draft in up-take of boiler.

Using economizer, 1 cu. ft. gas per minute per 1 lb. water per hour evaporated, I regard as good practice.

I do not know at present the size of those fans, but if they are not too closely designed and constructed to exact duty as above, then they could, no doubt, handle double volume if the grates could handle the coal.

Condensers. Both turbines have Worthington surface condensers, and the circulating centrifugal pumps are each motor-driven—for the larger turbine a Kinetic pump is employed. It is claimed that in tests made on this arrangement, a vacuum of 29.8 in. with barometer of 30 in. was had with water used in the jets of 74 degrees, whereas the temperature corresponding to the vacuum is 36 degrees—the water being actually 38 degrees warmer.

In connection with the Kinetic chamber is a feed water tank with float to regulate the supply in which the water is stated to be heated by steam jets supplied from connection between the high and low pressure cylinders of the turbine, or by the exhaust from the steam-driven feed pumps.

"The installation of boilers and economizer is similar in all respects to that of the 25,000 kw. Parsons unit. The exhaust from the steam auxiliaries is carried to Baragwanath heater, guaranteed to heat the water from 65 degrees to 130 degrees.

The economizers are designed to raise the temperature an additional 150 degrees.

The exciters on both turbine outfits are direct connected on the main turbine shaft. See plan view and photo, page 633. Apparently recent practice has overcome former difficulties to this method and, no doubt, some source of relay current to exciter is provided.

MAKING THE BOILER ROOM A SAFE PLACE TO WORK

Continued from page 488

come rusty or covered with dirt so that they cannot be moved the full extent of their travel at any time. A periodic inspection, not less than once a month, of all valves, stems, etc., in all the main piping systems about the boiler house is recommended. Too much importance cannot be attached to keeping the valves in such condition that they are always ready for use.

Great care should be exercised in using a wrench or bar in opening or closing a valve. The abuse of this means of facilitating the handling of valves may result in damage or accidents to seats, threads, stems, etc.

Steam should always be admitted into empty piping very slowly. If any portion of the piping has remained unused for an hour or more it is important that it be completely drained before steam is again turned into it.

Water columns should be blown out completely at least twice every turn. If a gauge glass is fouled internally so that the water level is not clear, the glass should be cleaned or replaced as soon as possible. If the fouling of the gauge glass occurs frequently it is due to some characteristic of the water such as suspended matter, scale solvents, lubricating oil, etc., for which some remedy should be devised.

Try cocks should be used at least twice every turn which will keep them in good working order.

General

No one should be allowed to remain unnecessarily in a boiler room. Visitors are not only in danger if an accident occurs but are likely to distract the attention of the boiler room employees and cause them to neglect their important duties.

Good ventilation should be provided for basements and subways to boiler rooms. In those places there is grave danger of the accumulation of noxious gases.

Remove or minimize every stumbling hazard in the boiler room. Tools in racks, steam hose in its place, proper drainage of wet places and safe disposal of fuel all will prevent accidents.

Scale in boilers causes bulges and ruptures of boiler shell—usually leading to explosions. Remove the scale frequently.

Power Plant Management—Lubrication--II.

Part Two of an Article Giving Some Interesting Data Relative to Lubrication Problems Encountered in the Power Plant

By ROBERT JUNE, Mechanical Engineer

Principles of Lubrication—Part II

ATTENTION was called in our last discussion to the very great importance attaching to the proper selection of lubricants for the various services about a plant. It was stated that this importance did not lie in the opportunities to effect savings in oil, but savings in power, through reduction of friction losses. Sufficient emphasis can hardly be laid on this point, for discriminating choice of lubricants may result in savings in power sufficient to pay the oil bill several times over each year.

We have already dealt with the general characteristics of a good lubricant, and with chemical tests for determining the presence of impurities and adulterants. It remains to discuss the physical tests of lubricants and the qualities most desirable for various service.

The following are the physical tests of lubricating oils commonly employed:

1. Color, Odor and Specific Gravity: These are of value to the specialist in identifying the sample of oil, but they are of little practical value to the majority of operating engineers, and need not be described.

2. Flash Point: The flash point of an oil is that temperature to which an oil must be treated at a given rate so that enough fluid is freed from its surface to be momentarily ignited when a small flame is applied to it. The Cleveland Open Cup Tester is the instrument commonly used for this purpose. A thermometer is suspended in the oil, which is slowly heated; the test flame is applied at every rise in temperature of 5 deg. Fah., until the flash occurs.

Flash point is determined as a measure of the oil's volatility. With steam cylinder oils, it is of primary importance, the required flash point depending on the temperature of the steam at the engine. In the case of oils for bearings, flash point is important because it indicates the presence of volatile kerosene or naphtha, with accompanying fire risks. Plant blazes are always apt to occur with oils of low volatility if used in bearings, and this possibility should be guarded against, if possible, in the selection of oils.

3. Fire Point: The fire point of an oil is that temperature to which it must be heated at a specified rate so that active combustion will take place, and continue, when the small flame is applied to its surface. Naturally, its temperature is above that of the flash point. It is unually found to range from 30 degrees Fah. to 65 degrees Fah., and in light lubricating oils, to about 40 degrees F. Fire point, like flash point, is of value when oils must be selected for service at high temperatures.

Cold Point: While the term "cold point" is commonly used, it is apt to be misleading, inasmuch as two cold points are commonly determined—first, the cloud point, which indicates the point of separation of the tiny particles of paraffine in oils of that base; second—the pour point, which indicates the lowest temperature at which the oil will run. These two cold tests are of value only where oils must be used under conditions of very low temperature and need not ordinarily be made.

4. Emulsion tests are made in four runs: To 40 cc of oil in each case, is added 40 cc of distilled water for the first run; 40 cc of brine for the second run; 40 cc or normal caustic soda solution for the third run; and 40 cc of boiling distilled water for the fourth run. In each case the mixture is stirred with a paddle at very high speed—say 1,500 revolutions to a minute. The oil should be kept at a temperature of 130 degrees Fah. during the test.

To pass this test satisfactorily, oils used on ice machines or with forced lubrication, should completely separate in less than twenty minutes. The salt water and normal caustic soda solution test need only be made where there is a possibility of water containing boiler compounds getting into the system. The boiling distilled water test is to be made only where there is a possibilty of steam or water at high temperature getting into the oil system. The great importance of this test lies in the fact that where emulsification takes place with any type of forced lubrication, there will follow clogging of oil lines and a formation of solids in the base of the bearings, with consequent large losses of oil and greatly increased friction.

5. Viscosity: Viscosity is the most important physical test of an oil. It may be defined as a measure of fluidity or body. Its value depends upon the internal friction between the particles composing the oil and their resistance to separation. Viscosity is really a measure of rate of flow of an oil at a predetermined temperature, through an orifice of standard size. It follows that the viscosity of an oil is inversely proportional to its fluidity.

Importance of Viscosity Tests as a Guide to Lubrication

All operating engineers have had bearings of machines under their care which increased in temperature when in operation to a certain point and remained at that temperature under normal working conditions. It is not uncommon to find bearings unusually warm and yet causing no worry or anxiety to the engineer in charge, because he knows that these bearings will not heat to any higher temperatures. These conditions are not evidence of satisfactory lubrication, because frictional heat in a bearing is an indication of loss of power, due to excessive frictional load; the power absorbed by friction having been transformed into heat. The causes of the high temperatures in the above described bearings may be credited to the viscosity characteristics of the lubricating oil in use. The viscosity of the oil was too high to give satisfactory results when the bearings were developing normal running heats, and therefore, the bearing was required to develop sufficient heat to reduce the viscosity of the oil to a working value, which allowed it to freely flow into the bearing. With better circulation, the oil was able to balance the production of frictional heat by carrying it away as fast as it was created.

This illustration shows the necessity of using viscosity values, not as a direct guide to the selection of a lubricant, but as an indirect guide. The method of selection of an oil from its viscosity characteristics must be based upon the temperature at which the oil will be expected to work, which in the case of a bearing, will be the normal working temperature of the bearing. At this working temperature, the viscosity of the oil should fulfil the mechanical and lubricating requirements of the bearing.

By plotting the viscosity-temperature curve of an oil, this selection may be simplified and comparisons made quickly with other oils. An example of the practical use of this method is given as follows:

"Assume an engine bearing to have a normal running temperature of 105 deg. Fah. when the engine-room temperature is 85 degrees. In this case, certainly no heat will pass from the air into the bearings. With the exception of the small amount of heat carried away by the engine frame, the 20 degrees excess temperature is a measure of the frictional heat developed in the bearing, and this frictional heat is a measure of wasted energy. If an oil is selected by means of its viscosity curve, produced from the same crude and having the same viscosity at 85 degrees Fah. that the oil in use has at 105 degrees Fah., the friction in the bearing will be reduced, because there will be no necessity for the viscosity of the second oil being reduced to meet the mechanical requirements of the bearings."

It is by far the most efficient practice to use an oil having the lowest viscosity that will insure the maintenance of the lubricating film in a bearing, and excessive viscosity is as much to be avoided as an insufficient supply of oil.

Viscosity of Little Value in Steam Cylinder Lubrication

In the case of steam cylinder lubrica-

tion, the viscosity tests of cylinder oils have very little bearing upon the actual lubricating value of the oil.

It has become the custom of engineers and chemists to compare the viscosities of cylinder oils at a temperature of 212 degrees Fah. (by some at 210 degrees Fah.). A viscosity at this temperature is totally useless as an indication of the lubrication value of the oil, since no cylinder oil is ever called upon to work at this low temperature. Steam at only 75 pounds pressure has a temperature of 320 degrees Fah., while at the usual pressures, the temperatures are much higher, as follows:

125 pounds to the sq. in. 353 deg. Fah.
150 pounds to the sq. in. 366 deg. Fah.
225 pounds to the sq. in. 398 deg. Fah.

It has been found by actual tests that the viscosity of cylinder oils are practically the same at 400 degrees F. and upwards. Therefore, this test is, as stated, of little practical value for cylinder oils, and attention is here called to it simply for the purpose of preventing a loss of time in making it.

6. Friction Tests: These are sometimes made in special testing machines, but the results obtained are of little practical value in widely varying conditions found in actual service.

From what has been said on the subject of physical tests of an oil, it will be seen that service tests must, after all, be the main, though not the only, reliance of the operating engineer; here different oils are tested out under actual working conditions and the lubricant best adapted for the particular service is determined by the process of elimination. There, are, however, certain general characteristics of oils best adapted for particular services and these we will take up briefly.

Steam Cylinder Lubrication: The chief requirements of a lubricant for cylinder oil where superheated steam is used, are high flash point and good body. Since there is practically no moisture with superheated steam, it is recommended that the lubricant be a straight mineral, uncompounded oil of the highest possible viscosity and flash-point. Where steam is not superheated, there is apt to be some condensation on the bottom of the cylinder. In order to aid the emulsification of cylinder oils with the steam, they may be sometimes compounded with "degras" (wool grease). The percentage of tallow allowable for the compounding purposes, is from 3 per cent. for fairly dry saturated steam, to 10 per cent. for low pressure and wet steam and long uncovered lines where the percentage of moisture in the steam will be high.

Cylinder oils should be fed the steam lines at least three fees above the throttle valve, thereby insuring proper and complete atomization. Care should be taken that cylinder oils which have passed out with the exhaust steam and have been received by the hot well, do not enter the boiler with the feed water.

Notes on Bearing Lubrication

Hand Oiling: Hand oiling is very wasteful, as the oil can only be recovered by means of the drip pans. Grit and dirt often give considerable trouble when hand-oiling is used, and close attention necessary to maintain any sort of efficiency from a lubricating standpoint, makes hand-oiling dependent entirely upon the personal efficiency of the operator.

Oils For Circulating Systems: Lubricants used for continuous feed oiling should be strictly neutral, filtered oils. Paraffine, base, or treated oils should be avoided, because of the possibility of emulsification from the frequent churnings, and the possibility of moisture getting into the system, and from other sources.

Gravity Oiling Systems: Combination oil cups and sight-feed needle valves should be used at all points of lubrication. Oil caps should always be kept full and ready for use in case the circulating system fails. In large installations, it is well to take a sample of the oil in use and from time to time take a test as the need for fresh oil can be quickly determined by noting the increased high viscosity. For all gravity feed systems, the point of entry of the oil to any bearings should be at the point of minimum pressure.

Forced Feed Lubrication: Care must be taken not to introduce the oil into the bearings at such points that it will pass through low pressure areas of the oil films, causing counter currents in the films, and escaping without carrying off its proper share of frictional heat. Where plenty of oil is being circulated, probably the best place to introduce the oil is on one of the lower quarters. Lubricants used in all forced feed oiling systems must be neutral, filtered and absolutely non-emulsifying. For the usual turbo-alternator installation, an oil of 150. to 180 Saybolt viscosity at 100 degrees Fah. will give the best results. The oils should have a low-gumming test and be free from al impurities. Treated oils are not satisfactory.

Ball Bearings: The lubricant used in ball bearings must be neither acid nor alkali, but must be neutral. A simple test for ball-bearing lubricants may be made by coating a highly polished steel surface with the oil or grease under observation. After exposing it to the heat of the sun for several days, any corrosive tendencies will be evident upon the polished surface of the plate. Oil containing any compounding of animal or vegetable oils should never be used in ball bearings, as it will produce gumming and become rancid. The best lubricant for these bearings is a strictly mineral oil. For high speed bearings, a light machine oil should be used, and for slower moving bearings, use a heavy viscous oil, or a straight petroleum grease. Petroleum greases have poor viscosities, however, and quickly run out of the bearings. Well-designed bearings are provided with suitable retainers for the purpose of holding the lubricant in the bearing and preventing its creeping out along the shaft. Engine grease or cup grease should not be used in ball bearings, unless it is carefully tested for the presence of free alkali, which will pit and corrode the bearing, if present. Greases should not be used in ball bearings running at over 1,200 R.M.P. Graphite is not satisfactory for use in ball bearings because of its tendency to pack. Oil is the best all-around lubricant for these bearings.

Ball bearings should frequently be flushed out with gasoline to keep them clean.

Roller Bearings: Heavy body oil and medium grease should be used for the roller bearings when the speeds are low; but under normal conditions the speeds are high and will allow the use of machine oil. When oil is used, it should be strictly filtered and neutral, and free from any emulsifying tendencies.

Lubrication of Air Compressors: Air compressor oils must be straight mineral oils and must not be too high in viscosity. They should be examined as to the nature and amount of the residue left after evaporation.

For compression temperatures of 350 degrees Fah. to 44 degrees Fah. the oil should not flash below 500 degrees Fah., and where the temperatures do not exceed 300 degrees Fah. an oil of not lower than 400 degrees Fah. may be used.

When feeding lubricating oil to air-compressor cylinders, care must be taken not to feed an excess of oil, which will result in gumming and carbon-forming deposits.

Refrigerating and Ice Making Machinery

Ammonia Compressor Cylinders: For the lubrication of the ammonia compressor cylinders, a pure mineral oil of good flash test (365 deg. to 400 deg. Fah.) and possessing a cold test of 0 deg. to 5 deg. Fah., should be used. The heat of compression of the ammonia gas requires that the oil have a good flash test, since it must not vaporize too quickly. The possibility of oil leaking, or being carried in vapor form, with the ammonia gases into the condenser pipes and expansion coils, requires that the oil have a good cold test to prevent its solidifying in the piping. A fairly low viscosity oil should be used, one having about 100 viscosity at 100 degrees Fah.

Stuffing Boxes: Hot ammonia gas has a very bad effect on the stuffing box packing of ammonia compression cylinders. A liberal supply of lubricating oil should be applied at this point, to reduce the possibility of overheating the stuffing box.

Lost Capacity: One reason for lost capacity in refrigerating plants is due to the carrying over of the lubricating oil by the ammonia gases, and the depositing of this oil on the interior of the condenser and expansion coils. This trouble is due largely to the common mistake of locating the oil separator entirely too close to the discharge of the compressor. The gases at this point are very hot, and the oil is mostly in vapor form. If the separator is located near the condenser, where the gases have slightly cooled and some of the oil condensed, it is much easier to prevent an

excess of oil being carried into the condenser coils.

Oil Traps: Oil traps, which may be made of a short piece of 3-inch or 4-inch piping, about two feet long, should be located at the lowest places in the expansion and condenser coils.

Measuring Oil Feed: All oil used to lubricate the ammonia compressor cylinders should be measured, and a record kept. If there is any unusual increase in the amount of oil fed into the cylinders, immediate investigation should be made to prevent "filling" of the system.

Oil in Condenser Coils: If lubricating oil has gotten into the condenser coils, it can be loosened by cutting off the water from one stand at a time, and allowing the coil to become hot, when the oil will be thinned and can be run off at the oil trap.

Steam Cylinder Oils: Cylinder oils used in the steam cylinders of refrigerating machinery should be purely mineral, uncompounded oils. A mineral cylinder oil is more easily separated from the exhaust steam than a compounded oil. Either a filtered or unfiltered cylinder oil may be used. Absence of compound is the most important requirement to prevent the formation of an emulsion, with the consequent difficulty of removing this emulsion from the exhaust and condensed steam.

Notes on Lubrication of Textile Machinery

Lubrication of Yarn-making Machinery: For preparatory woollen, worsted, and cotton yarn machinery, such as pickers, cards, combs and all heavy machinery, a heavy engine oil should be used, of 280 to 340 viscosity at 100 deg. Fah.

For Intermediate Machinery: Such as flyer frames, including slubbers, intermediate and roving, a medium viscosity engine oil should be used, of 175 to 200 viscosity, at 100 deg. Fah.

Lubrication of Spindles: It is essential that spindles be lubricated with oils especially prepared for that purpose. These oils must be limpid and free-flowing. They must, however, possess sufficient viscosity to form a protective film of lubricant between the bolster and the spindle.

The oil should have a good evaporative test. When heated for 12 hours at a temperature of 150 degrees Fah. the oil should not lose more than 4 per cent.

The flash test of any oil used in the lubrication of a textile mill should never be below 325 deg. Fah.

Excessive viscosity of spindle oils will tend to greatly increase the friction load of the mill.

The following viscosities are suggested as a guide for the selection of spindle oils for various purposes:

For bath of Rabbeth spindles, doublers, etc., of 95 to 100 viscosity at 100 deg. Fah.

For mule spindles, cup spindles, open bolster, sawyer type spindles, etc., of 140 to 150 viscosity at 100 deg. Fah.

For the general lubrication of ring spinning frames, cap spinning frames, etc., of 140 to 150 viscosity at 100 degrees Fah.

For the lubrication of the front and top rolls of cap spinning frames and for mule frames, of 270 to 280 viscosity at 100 degrees Fah.

A good rule is to oil all the spindles on the frame at noon hour. There are several makes of bolsters. The old type required that the spindle be lifted from from the bolster and the oil poured into it. When the spindle is replaced in this type, the excess oil is squeezed out and usually drips on the frame, and then to the floor. In other makes of bolster, the oil is poured through a tube into an oil cup, making possible the oiling of a great number of frames per day.

"Rail rods" should be oiled every week, when the rails are washed. Oil on the rail rods lasts a long time and they require only a small amount.

The other parts should be oiled at least twice a day.

In mills of any size, amazing results will be produced if a special man, or boy, is detailed to attend to the oiling and wiping of the bearings, with some degree of regularity. It will pay large returns to any mill owner if he will spend some of his time in investigating the lubricating conditions in his mill.

Lubrication of Knitting Mills: For this type of machinery a spindle oil of about 100 to 110 viscosity at 100 degrees Fah. will have the proper body to meet the mechanical conditions of the small running parts. For the general lubrication of circular knitters, a neutral, filter engine oil of 140 to 150 viscosity at 100 degrees Fah. will fill the lubricating requirements.

For the lubrication for the needle motion plates of horizontal knitting machinery, a filtered cylinder oil of 130 to 140 viscosity at 212 degrees Fah. will give the best results.

Highly filtered oils, called stainless oils, are demanded by some mills, under the impression that they will not cause oil spots in the finished pieces. This belief is without foundation, however, as any petroleum oil will "spot" and cause trouble, when the piece is being dyed. Oil spots prevent the dye taking uniformly. Some textile oils are compounded with lard oil to increase their saponification properties, with a view to aiding the removal of spots by washing.

Motors and Dynamos

The same principles govern the selection of an oil for use in the self-oiling bearings of electric machines as is used in the selection of an oil for high-speed engines, having splash-feed bearings. The body of the oil will, of course, vary with the size of the machine. The viscosity should be as low as possible. The oil should have only sufficient viscosity to permit the rings to carry enough of it up to the bearings, to provide ample oil for lubrication and should be sufficiently free-flowing to permit the free delivery of the oil from the rings to the journal. The viscosity of the oil must also be low enough to permit of its free circulation and cooling when it is in the reservoir.

FUEL SITUATION IN CANADA

Use of Coal in Pulverized Form Will Make Available Large Supplies Now Valueless

The fuel situation in Canada is one which must be faced in an effort to overcome the annual threatened shortage and the constantly rising price of coal.

Canada possesses immense coal reserves. Unfortunately, much of it is unsuitable for locomotive purposes, owing to its tendency to spark, also, owing to its high moisture content, it rapidly disintegrates on exposure to the atmosphere. Again, at the mines, both below and above ground, in mining the coal and in handling it, a vast amount of slack is created, which, up to the present, has been considered as waste.

A process for utilizing this slack coal, as well as run-of-mine coal, has for some time been under development. By this method the coal is pulverized until approximately 85 per cent. will pass through a 200-mesh screen and 95 per cent. through a 100-mesh screen. After the coal has been pulverized, it is fed from the bins by screw conveyors and blown into the furnace.

Good results have been secured by cement plants, by the metallurgical industries, and on locomotives. In the heating of large buildings the use of pulverized coal has proved an economical fuel.

The Commission of Conservation, Ottawa, has issued a report on "Pulverized Fuel; Its Use and Possibilities," by W. J. Dick, M.Sc., which explains in detail the use of pulverized coal and its advantages.

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POWER HOUSE advertising space is steadily increasing. The splendid list of industrial firms carrying liberal space in POWER HOUSE is an outstanding tribute to the value of POWER HOUSE as a direct-to-the-buyer-and-user of power house equipment in Canada. Our policy of "Power plant efficiency in equipment and service" is meeting with the hearty support of advertisers and readers. Our mutual interests are being acceptably protected and served.

INSTRUCTIVE ADVERTISING

The advertisements of technical papers are usually of an instructive character. Those in POWER HOUSE are exceptionally so, for the reason that POWER HOUSE maintains a policy of co-operation with our advertisers in the preparation of the highest class of advertising information. Engineers thereby become acquainted with the best lines and the merits thereof. We have before us a letter which reads: "We bought . . . . all advertised in POWER HOUSE, and that is what counts, buying right, and it saves a good many hours' hard work." It pays to advertise in POWER HOUSE.

Handy Tools for the Maintenance Man--I.

A Compilation of Various Devices and Methods Used by the Maintenance Man, Facilitating Wiring and Electrical Installations

By JAMES A. PERRY

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MANUFACTURERS' catalogues contain splendid descriptions of the many regularly-manufactured tools that the electrical worker uses, hence no effort will be made to repeat the description of these. It is, however, the intention to discuss a number of devices that have been found very useful in practical electrical work, and each can, for the most part, be readily made by the electrician from materials always available. Most of the devices are time and money savers.

First of all, any mechanic should have a convenient serviceable chest in which to store his tools. That shown in Fig. 1 has given excellent service in a number of cases. Its construction is sturdy enough that it will successfully withstand the hard knocks to which an electrician's chest is subjected. The design shown was, we believe, first introduced by C. C. Payton, of the Republic Iron & Steel Company, Sayreton, Ala. The heavy tools are placed in the bottom of the chest, while the lighter ones are carried in two trays. One of these trays is attached to the cover of the chest by a series of strap-iron links. The arrangement, obvious from Fig. 1, is such that when the cover is open, this tray, A, is drawn up with the cover. The other tray, B, slides in the usual way on 1 in. x 1 in. guides, while two ½-in. strings maintain it in alignment. When the top is open, both trays, A and B, and the tools in the bottom of the chest are at once accessible.

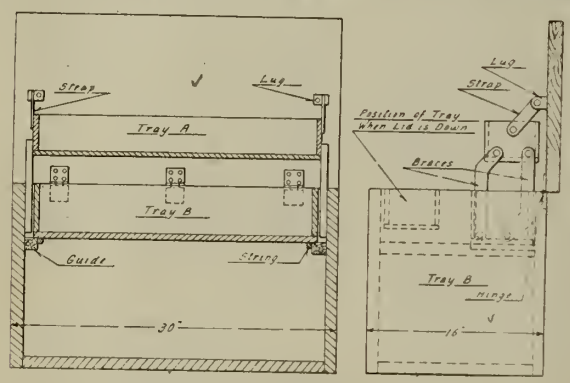


FIG. 1—A CONVENIENT TOOL BOX.

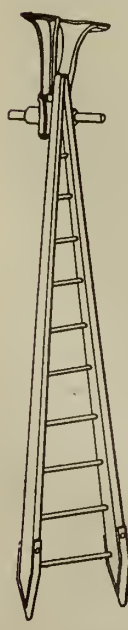


FIG. 2—A LADDER FOR THE INDUSTRIAL PLANT MOTOR TENDER.

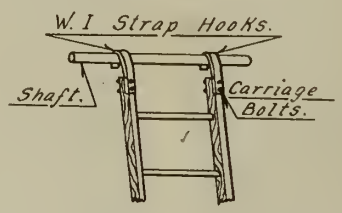


FIG. 3—HOOKS FOR MOTOR TENDER AND WIREMAN'S LADDER.

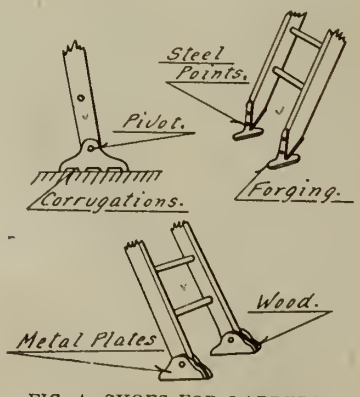


FIG. 4—SHOES FOR LADDERS.

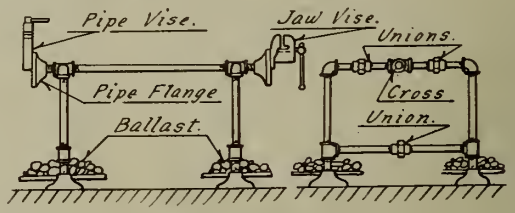


FIG. 5—A KNOCK DOWN PIPE BENCH.

To prevent loss, all tools should be marked with the owner's initials. The marking should be such that it cannot be readily obliterated. A permanent mark can be made on steel tools by the following process with materials that are nearly always at hand: First, the surface of the metal to be marked is covered with a thin coat of paraffine, or drippings from a tallow candle, painted on hot with a brush or rubbed on with the end of a stick. If paraffine or candle is not available, a coating of soap can be substituted. The soap is transferred to the surface by rubbing the end of a cake against it. With some tool that has a flat point somewhat like a screw-driver, except that it should be only 1/16 in. wide, the owner's initials are graved through the soap or paraffine, cutting down to the surface of the metal. Now the etching solution can be applied with a small stick of wood. The etching solution is made as follows:—One part of table salt (by bulk) is mixed with approximately two parts of powdered copper sulphate, or blue vitriol, and the two are dissolved in about ¼ in. of water in the bottom of an ordinary tumbler. After the solution has been applied it will etch the design in the metal to a sufficient depth in a few minutes. Then the tool can be washed to remove all traces of the solution, and the paraffine or soap.

Wiremen should provide themselves with safe ladders. Many designs are in use that afford the safety required. Only a few of these designs which have been given a thorough try-out will be described. The one shown in Fig. 2 is particularly useful around shafting, although it is also handy for work in the neighborhood of steel columns, and where the ladder must be leaned against the stiles or rails of a window. As the illustration indicates, the narrow top permits the ladder to be firmly sustained by a shaft hanger, or similar member upon which it would be difficult to support a ladder of the ordinary type. The lower ends of the two rails of the ladder are shod with strap-iron bindings which have pointed ends. This will prevent slipping on wood floors.

Where the ladder is to be used on concrete or metal floors, a shoe of one of the types suggested in Fig. 4 should be used. That at Fig. 4 A is supported on a pivot, and has a corrugated bottom, hence the shoe always lies normal to the floor. A shoe having pointed spikes extending from its bottom is shown in Fig. 4 B. This type is used where the floors are of wood. A shoe with a wood centre which will provide considerable friction, and hence tend to prevent slipping even on concrete or iron, is shown at C. Where wood—bass wood is the best—does not give sufficient friction, the centre member of the shoe shown at C can be coated with carborundum or lead, which will greatly increase its adhesiveness. Where lad-

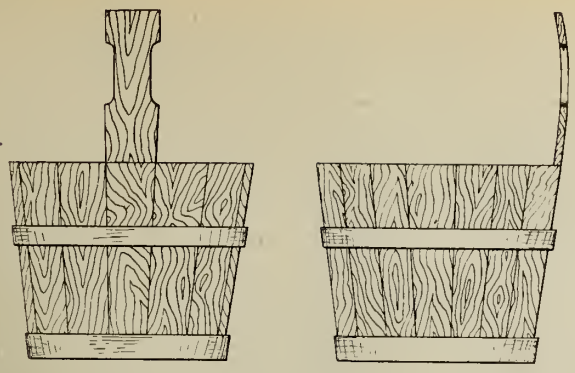


FIG. 6—CARRIER FOR MISCELLANEOUS SUPPLIES.

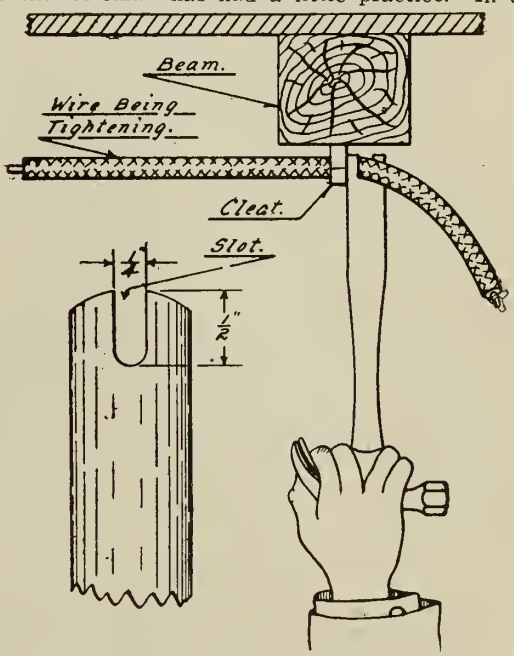
ders without narrow tops are in stock and must be used around shafting, strap iron hangers should be bolted to their upper ends as outlined in Fig. 3.

A portable bench for the conduit wireman is shown in Fig. 5. This device has been particularly useful where the bench has for some reason or other to be dismantled for transportation. It can be readily knocked down and shipped by rail in a relatively small chest at materially less cost than an un-knocked-down bench can be transported. Benches of essentially this same style have been used by pipe fitters in the Western States where it was necessary to transport the tools on pack animals. To knock down the bench, the unions, of which there are six, are unscrewed. Pipe flanges are mounted at both ends for the supporting of the conduit vises. Boards, if they are available, can be laid across the pipes at the top of the bench. They can also be laid across the bottom pipes to form a shelf. The plates are laid with heavy material of some sort to prevent the bench from rocking while pipe is being threaded. Where boards are placed across the lower pipes the load can be put on these instead of on the plates. It will be noted that every portion of the bench proper is of metal, making it very durable.

A useful little kit for carrying around small tools and fittings, such as cleats, bushings, rosettes, locknuts, and washers, can be made from a 100-lb. nail keg, as shown in Fig. 6. The keg is sawed in two at the middle, except that one stave, in which notches are cut for a handle, is allowed to extend. Some wiremen use half a dozen or so of these carriers on every big job, using each one for some different class of material.

A wireman should never erect wire in an open-work installation until all of the kinks or bends have been taken out of it. These bends can, of course, be eliminated if sufficient tension is put on the wire after it is up, but it is much easier and cheaper to straighten the wire before it is placed in the cleats. One good method of straightening wire is shown in Fig. 7. One end of the wire is attached to a nail driven in some stationary substantial object. A knob is run over the wire and then held at an angle and drawn the entire length of the conductor as indicated in the illustration. It is necessary to maintain some tension on the wire while the knob is being drawn along it. This method is best used for No. 14 or No. 12 wires, and may not be successful with larger ones.

There is probably no tool that an electrical worker uses more frequently than he does his pocket knife. If he has its blades ground as shown in Fig. 8, a great deal of time and worry will be saved. One of the smaller blades can be ground on an emery wheel as shown at A. The end is formed to a screw-driver point, of suitable size for socket and rosette work. Near the bolster a notch is cut in the blade. With this notch, fixture wire can be "skinned" very rapidly and without breaking it, after the wireman has had a little practice. In use, the



FIGS. 10 and 11—APPLICATION OF A SLOTTED HANDLE.

end of the wire is placed in the notch and the knife pulled along the wire. The insulation will soon come off.

The large knife-blade that is used almost exclusively for "skinning" wire can be ground as shown at B. As all wiremen know, it is impossible to keep a blade sharp if it is used for scraping insulation, and also for cutting it off. With the grinding suggested, the lower edge can be kept quite sharp, and used only for cutting the covering, while the concave ground upper surface, which provides two edges, is used for scraping or brightening the wire,

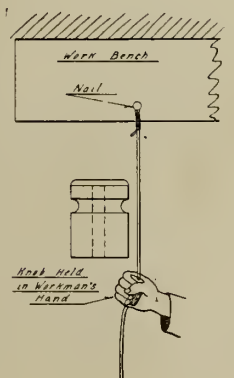


FIG. 7—STRAIGHTENING WIRE WITH A KNOB.

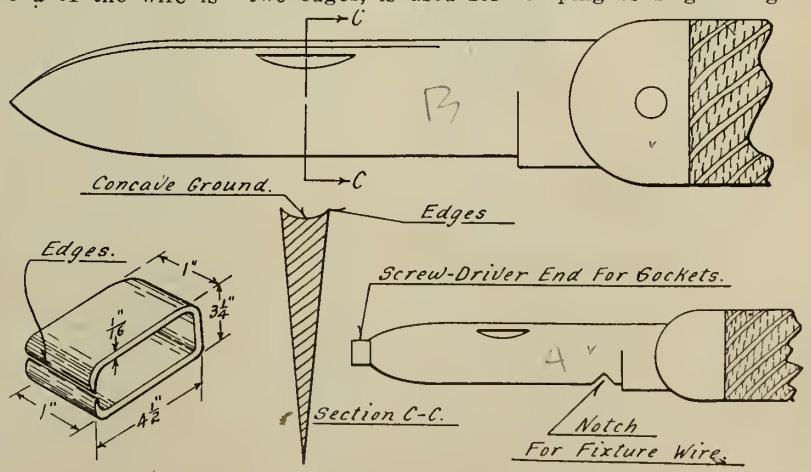


FIG. 8 AND 9—METHODS OF GRINDING KNIFE BLADES AND TOOL FOR SKINNING WIRE.

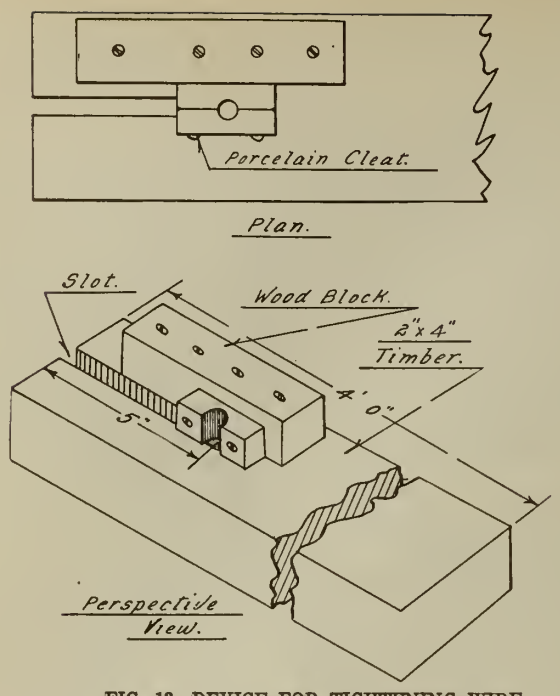


FIG. 12—DEVICE FOR TIGHTENING WIRE.

after the insulation has been removed. The concave edges are formed by cutting a groove along the top of the blade with an emery wheel. The edge of an electrician's knife will usually ultimately assume a curved contour as shown in Fig. 8 B, due to constant sharpening. It will be found that if the knife blade that is used for cutting insulation is ground out rounding, as shown at B, as soon as the knife is obtained, it will tend to prevent the blade from slipping off the wire.

A little tool, very useful for "skinning" lamp cord, can be made as shown in Fig. 9. In use, the lamp cord is held between the two edges, twisted around therein to cut the insulation around its entire circumference, and then the tool is pulled. The insulation—both the braid and the rubber—will come with it, and the strands will not be broken if the wireman uses just the right amount of pressure on the tool. It can be formed from a strip of steel or iron plate. The edges are made with a file.

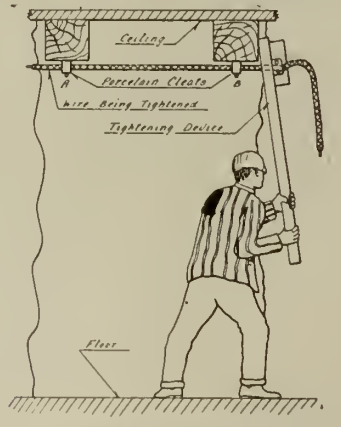


FIG. 13—APPLICATION OF WIRE TIGHTENING DEVICE.

Nos. 12 and 14 wire, in cleat work, can be tightened very nicely by the device shown in Figs. 10 and 11. A slot, ½ in. deep and ¼ in. wide, is cut in the end of the hammer handle, at right angles to the head. The slot being cut, the handle is used as shown in Fig. 10. All wires should be straightened as suggested in a preceding paragraph. After they are partially erected, the sag in them can be pulled out with the hammer handle.

The operation of tightening is as follows:—The conductor is fastened by clamping in one of the cleats at the far end of the run. Then at the near end of the run a cleat is installed, and the wire placed in it. The screws are set up only far enough so as to bind the wire after it is pulled through, and to prevent it from slipping back. Then the end of the wire is inserted in the slot of the handle, and the hammer is turned toward the centre of the cleat. The slack being drawn out, the cleat can be fastened with a screw-driver. After the wire has been drawn taut, intermediate cleats can be installed. It will be noted that this procedure eliminates the necessity of lining up the intermediate cleats by measurement.

Where wires heavier than No. 12 or No. 14 are being installed in cleats a tightening device, arranged somewhat as shown in Figs. 12 and 13, will be useful. Aside from the fact that it is a time saver, this arrangement has the advantage that the conductors can be pulled very taut without the damage to insulation which usually occurs when an endeavor is made to tighten conductors with pliers. The device comprises (Fig. 12) a 2-in. x 4-in. lever, about 4 ft. long, with a slot cut in its end. Adjacent to, and parallel with, the slot a block, possibly 5 in. long and

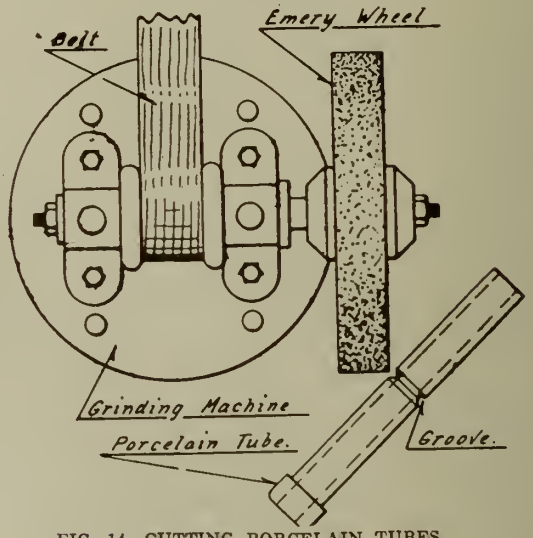


FIG. 14—CUTTING PORCELAIN TUBES.

2 in. square, is fastened with flat-headed wood screws. A cleat is screwed to this block as shown. This cleat may be either of porcelain, similar to those being used on the job, or preferably it can be cut out of wood (maple) or hard fibre. The wire hole in the cleat should lie directly over the end of the slot.

In using the lever, its upper end is placed against a beam or some other member of the building that can be used as a fulcrum, and the conductor is firmly clamped in the cleat. Pressure on the lever tightens the conductor.

A great deal of time is wasted by men that do not know how, in cutting flexible tubing. A majority of wiremen appear to use a knife. Probably the best method of cutting this material, except possibly the very large sizes, is with the pliers. The smaller sizes can be nipped asunder with the large side-cutting pliers almost as readily as can wire. The tubing is thereby flattened, but it can be readily reformed to its normal shape with the fingers.

Large porcelain tubes are difficult to cut without cracking. They can, however, be cut, if an emery wheel is available, by grinding a circumferential groove as shown in Fig. 14. After the groove has been cut, the tube will readily break around it, if it is held by the two hands and subjected to a bending force. After it is in two, the rough edges at the ends of the tube can be rounded off on the side surface of the abrasive wheel. It is easy enough by using this method to cut a large tube in two in 60 seconds, more or less.

To be continued

The Education of the Power Plant Engineer

In the Following Paper Read Before the N.A.S.E. at Springfield This Summer the Author Makes Some Very Interesting Observations Regarding the Status of the Engineer and His Training

By EDWARD H. KEARNEY

THERE is perhaps no trade or profession which is more misunderstood than that of the steam engineer. There is a popular misconception upon the part of the layman that a stationary engineer is a man who "runs an engine." He is to some minds a denizen of remote corners in dark alleys or "down in the engine room" in an isolated section of building where the engine is tethered to a brick foundation and where he plies his trade groomed in an unlaundered blue denim suit. To complete the mental picture of the unsophisticated he is permitted to carry a monkey wrench, a handful of soiled cotton waste and an oil can, as further insignia of his occupation. A graphic portrayal of an engineer either in action or repose would under these conditions show a man not endowed by nature with either striking intellectuality or even ordinary physical comeliness.

To this uninformed instalment of the human race the stationary engineer in addition to his admitted ability to "run an engine" is a "fixer." He is an emergency man, think they, who can and must fit himself into a wide variety of tinkering jobs; if the plumbing fixtures decide to become cantankerous why the first word on everybody's lips is "call the engineer." If the typewriting machine displays a disposition to take a day off it's ten to one that some bright mind suggests instanter that the engineer be appealed to for the concoction of a prescription which will suit the case. If the sewing machine, washing machine or flying machine display symptoms of non-inertia the man who is handy man first and in their opinion "runs an engine" as a secondary consideration is featured as the first choice to inject vim into the flagging patient.

It is exceedingly humorous at times to note in the advertising columns of the daily press the tendency to award a superiority of physical prowess to the members of the steam engineering fraternity. For instance, in one of our metropolitan dailies a few days ago there appeared an advertisement which in substance read something like this: "Wanted, an engineer with second class Massachusetts license. Must be used to hard work and not weigh less than 195 lbs. Part of his duties to be performed after regular working hours." Outside of the fact that the grade of license mentioned carried with it certain scientific qualifications, it would require deep investigation upon the part of applicants for the position or job, whichever might be the correct interpretation, to decide as to whether or not the "ad" mentioned had not been intended for insertion in a sporting paper devoted to athletics instead of a current daily. The specifications for physique certainly would lead one to think that cerebral gray matter was not a consideration worth mentioning. Hard work and long hours appeared as headliners in the advertisement; whether an interval at midday would be allowed for lunch was problematical; perhaps this sparring partner or White Hope, this erstwhile physical marvel when secured would be outfitted with a canteen and knapsack and take a bite as opportunity afforded while not enacting the part of Hercules, Sandow or some other with caveman characteristics.

The above is mentioned in substantiation of the fact that the ability and responsibility of the steam engineer as a class is capable of being misunderstood and the party responsible for the insertion of such an advertisement can be forgiven if the fault lay in his not being far removed in years from the adolescent stage or his experience in the engineering field being confined closely to his own back yard.

Another incident may be related differing somewhat as to scenario and illuminating in the sense that it strikes home forcibly the thought that on this occasion at least one man's mind was disillusioned as to the real status of the stationary engineer. At a gathering of stationary engineers held in recent years a local reporter called up previous to the opening session and requested that he be put in a position to secure some notes for copy in the following morning's issue of his paper. When he presented himself he was ushered into the suite of the president of the organization and in the conversation which ensued he expressed surprise that there were in existence organizations of stationary engineers which went to such great pains in making provision for the technical training and general welfare of their members. He frankly confessed that he had wholly under-rated steam engineers as a class, that his conception of a stationary engineer was not that of a highly trained individual, a man of great versatility, but that his chief stock in trade lay in his ability to "run an engine" coupled with such other unconventional tasks as stoking coal and acting the part of general factotum, with the omnipresent monkey wrench and lubricant container. As opportunity afforded he was introduced to some of the delegates at the meeting and was surprised to learn that almost without exception they were men who held positions of great responsibility, although not altogether removed from the atmosphere of engine room surroundings. So great was the disillusionment of this particular scribe that instead of the "few notes" which he was to accord to the meeting the following morning's edition contained a half page write-up in the news columns together with an editorial which treated of "The Importance of the Steam Engineer in the Community." For a new light had dawned upon him—his vision of the ever-present overalls, grease spots and all the other accompaniments which his mind had conjured up had disappeared and he had deeply imprinted upon his mind the lesson that "running an engine" is but one small detail in the average engineer's daily routine.

A few months ago there appeared in one of our city dailies a news item which must have brought a broad smile to the faces of some of the steam engineers in that section. It appears that the engineers in the water department had requested the city government to increase their salaries some few hundred dollars per year. It was in the natural course of events a matter for consideration by the Common Council and the majority of this board concluded that the granting of the increase in salary was advisable, taking into consideration the importance of the work in which the men were engaged. One of the councillors, however, raised strenuous objection and based his protests upon the fact that such action would breed discontent in the other city departments where "similar unskilled men" were employed. His pin-point intellect evidently failed to connect with the fact that a million dollar pumping plant upon which a city's population depended for service is not under ordinary conditions left to the supervision of or operated by "similar unskilled men." He was perhaps entitled to sympathy for the inconsistency of his comparison; the humor of the situation perhaps never appealed to him.

In the advertising pages of the engineering press we are at times confronted with sketches of an uncouth, frowsly-haired, wrinkled-visaged personage who has evidently been called to the manager's office, and as we behold his abject demeanor and penitential poise we are curious as to whether some great crime has been committed by him and for which infraction of the law summary and condign punishment is about to be administered. One would imagine that the one suit, universally ill-fitting overalls and a peaked cap of ancient ancestry, were the only togs of which his wardrobe boasted—that this unit of apparel answered for work, recreation and social occasions—that in it were combined all the essential adjuncts for use in waking

and sleeping hours. In his attitude as pictured we can almost hearken to the tattoo beaten by the vibration of his knees, the high pitched blows inflicted by his heart upon his ribs, and his tongue so swollen by fright as to render articulation impossible. And all this for what? Is it necessary in order to render conspicuous a supposedly meritorious feature in a power plant specialty to portray such a gloomy picture? The chances are ten to one that the engineer at Squaredeal's mill and that of other industrial enterprises wears a good business suit to work—looks the manager straight in the eye—and knows his end of the game better than the manager professes to—wears shoes not down at the heels at all—caps his think tower in jaunty fashion with the hatter's latest production, wears silk pajamas at night, owns or rents a comfortable home—is well educated himself, and is seeing to it that his children are similarly provided for—and perhaps drives a 50-h.p. gas bus into the bargain.

Happily this form of attracting attention to certain specialties is becoming obsolete and when it has become altogether extinct a glaring cause of misconception will have been removed.

The Realities

But let us leave misconception and turn to realities. What is the real status of the engineer and where may we see the fruit of his work? In almost any corner of the civilized world, whether in city or country, can be seen visible signs of the engineer's participation, and so broad is his field of endeavor that it would be hard to escape from coming into touch with some project in which he was not a direct participant. For instance, without leaving our tracks we see electric lights burning. To the uninitiated the production of this light means little beyond the fact that they see the electric light bulb and knew that by pressing a button or pulling a switch this light is turned off or on. To us as engineers we visualize the whole process of the generation and distribution of the electric current. We know that somewhere in this vicinity there is a power station; in our mind's eye we see a large building topped by a smokestack of considerable girth and height. Our mind then turns to the boiler-room and we know that there are located the boilers where steam is generated. Our mental panorama shows the machines at work which automatically stoke the coal as it is fed from the hoppers overhead. We note the incandescent fuel bed in the furnaces and can sense the heat thrown off. If the capacity of the boilers is mentioned to us, at once we conjure a mental picture of the space occupied by them and the form which they take in keeping with their design; we see huge steam mains and water mains; we know that it takes a large volume of water for boiler feed supply and a very generous supply for the condensing apparatus. Our trained mind instinctively follows in imagination the steam mains from the boiler-room to the turbine or engine room. Here we have a mental moving picture of the prime movers in operation and the immense electric generators to which they are rigidly coupled. We see the condensers and circulating pumps; also the pumps for feeding water to the boilers. We make a mental note of whether they are of the centrifugal or reciprocating type. We, as trained engineers, have mirrored before our gaze the vision of the switchboard with its bus-bars, cut-outs, lightning arresters, circuit breakers, condensers, transformers, voltmeters, ammeters, synchronizers, output meters, line fuses, switches, ground detectors and the dozens of other apparatus all so necessary in electric light generation and transmission.

Education of Power Plant Engineer

But these are only the high spots which we have mentally come in touch with as yet. We as engineers would want to know whether the station turned out alternating or direct current, the voltages carried on the lines; we would desire first hand information as to the design of the turbines and engines, whether Curtis, Parsons, Westinghouse or other design of turbines, or Rice and Sargent or Harris-Corliss or the old plain George H. Corliss engine—and we would like a flash know just what they looked like both inside and out. We might be so curious as to know what the load factor might be. The layman who gazes at these beautiful clusters of lights and lets it go at that might be heard to exclaim, "My, but there is a lot to it, isn't there? I never thought the engineer had to know so many things before." But this list of the apparatus utilized is as yet incomplete in that nothing has as yet been said regarding flow meters for steam and water, air compressors, safety stops, speed governors, indicators, planimeters, insulators, stoker engines, forced draft apparatus, pyrometers, hydrometers, gas analyzers for flue gas, vacuum pumps, draft recorders, coal weighers, coal testing apparatus, boiler feed regulators, reducing valves, pressure regulators, automatic stop valves, boiler cleaning devices, pressure recorders, and so on, almost *ad infinitum.*

The lay mind which sees the effect only and is uninitiated as to the cause would soon become bewildered in an attempt at description, much as if a medical man portrayed to his patient, wholly unlettered in *Materia medica*, the Latin name of an obscure disease, the ancient language method of treatment and the prescription most favored as the panacea for its cure.

Yes, the engineer must know these things. His position requires, too, that he must not only be on the outside looking in, but he must also be on the inside looking out. It would be of little use for the engineer to know how to "start and stop the engine," for machinery, like the human, has its days when it shows a disposition to stray from the path of rectitude. It is prone to have its days off and under these circumstances requires a guiding hand to restrain it from running amuck.

Information of little value could be obtained from a flue gas analyzer, a CO_2 recorder no matter how elaborate its setting if it was considered only as a thing of beauty perched like a piece of bric-a-brac or a treasured family heirloom on a conspicuous pedestal in the front parlor. To secure from it the information it is intended to impart it must be skilfully adjusted and operated. This is the secret of its proper functioning. Otherwise the results secured from it are of negative value. The engineer must be familiar with its mechanical construction as well as its operation in order that it may do its checking with top-notch accuracy. This line of logic applies to every piece of apparatus down to the most trivial accessory in the power plant. The engineer must by training be the doctor acquainted with the inner anatomy of the machinery and apparatus confided to his care. He must not only be able to "run the engine," he must in the mariner's parlance know it "from keel to truck." "Ah," says the layman, "now I begin to see why the stationary engineer is such a studious, sober-minded individual." But wait awhile; we have touched upon his knowledge of things mechanical, but not a word as yet as to his business efficiency.

Engineering as a Business

When a man engages in business and makes a success of his enterprise, we say that he is a good business man. He is conducting his business at a profit. He is turning over his wares at the best possible financial advantage to himself. Does the average layman ever pause to consider what the power plant represents in a business sense? He visualizes in the majority of instances that a steam plant consists of a conglomeration of machinery, a place where coal is fed to boiler furnaces, where boilers are used to generate steam pressure, where engines are running to produce power,—all this accompanied by heat akin to the fire room and the rattle and rumble of machinery in the engine room. How seldom does he associate power plant operation with being conducted upon the same basis as any other well-balanced business undertaking. Does he always look at the coal pile as made up of so many treasury notes? The coal fed to the boilers as representing glittering gold dollars? The fuel burned as money spent and from which a profit must be forthcoming? In other words, does he fully understand what efficiency—a term sometimes correctly, ofttimes haphazardly applied—really means in its relation to power plant operation? But no matter what the popular conception may be, the concrete application of efficiency as applied to the power plant means just this: that those closely identified with the steam plant must be business men just as surely as the dry goods merchandise man is a

man of affairs, or the wholesale grocer conducting business on an elaborate scale.

For power production is business—hardpan, down-to-bras-tack business Put on one side of the ledger the cost of site or rental of space occupied, cost of building and machinery installed, including boilers, depreciation which begins almost immediately after installation, insurance, taxes, repairs, salaries, miscellaneous supplies, and last but not least the money spent in bringing to the furnace door the black diamond—coal. Add these and the other smaller outlays and subtract from the total income derived from the enterprise. The balance, whether favorable or unfavorable, is the same financial problem that must be faced by those conducting any other form of business. Figures, they say, cannot lie; the issue permits of no dodging.

We took for illustration a simple electric bulb, the light from which showed the participation of the engineer in the production of one of the things which almost universally has grown to be looked upon as one of life's necessities. To us as engineers these are some of the thoughts which instinctively flash before our minds and yet only one small detail of power production has been touched upon. We could with equal consistency enter into the problems of the street railway power plant engineer, the refrigeration engineer engaged in the cooling processes in our artificial ice plants, cold storage warehouses and confectionery factories, the office building engineer interested in providing comforts and conveniences, such as electric lighting, elevator service, vacuum cleaning, iced and filtered drinking water, ventilating, heating, and other process work, the mill engineer brought to the front so prominently for the fidelity and patriotism displayed in his almost superhuman efforts to produce material for wearing apparel during the war period, the water works engineer and the hotel engineer each with his ever varying problems to solve. But why, the layman may inquire, is all this distinction? Why say power plant engineer, refrigeration engineer or office building engineer? Are they not all the same? Just engineers who "run an engine"? Yes, they are all classed under the same name and are the same from the outsider's pinnacle of observation, but like medical practitioners or lawyers some engineers specialize in one branch. It is too broad a field for one man to cover it all in a single lifetime. One doctor specializes on diseases of the heart, another on surgery; one lawyer may specialize in action of civil law, another may confine his attention to criminal procedure. The men above mentioned may properly be included in the broad application of doctors or attorneys although best known as specialists in one particular branch. So with the subdivisions of steam engineering. Engineers are most closely associated with that branch of which they have made a particular study.

Varieties of Training

The early lexicographers defined the term engineer as a man who "managed an engine" and we of the present day who follow the business of steam engineering can hark back, if not in memory at least as students of the history of steam engineering, to the time when this was literally true. Many of the older engineers of the last generation entered this field as graduates from shops where heavy machinery, such as pumping engines, perhaps boilers, and the old-fashioned slide and riding cut-off engines were built. After completing a course at the drill, lathe, planer and bench they received promotion to the assembling of machinery and were in due course sent out at erecting engineers. Many purchasers of large units of engines desired to retain the services of these men because of their familiarity with the new installations. This school of engineers were thorough mechanics, artists in the use of the scraper and file, and past masters in the work of assembling and installing machinery. The fire room was another fertile field from which engineering material was drawn; at least a beginning was made here, perhaps not as fireman at first but as coal passer or general utility man about the plant. By successive stages of promotion as the men were developed by experience they became valuable assistants in the plant and at last were included in the list of engineers.

It may be worthy of note that the initial training of these two classes of men was somewhat at variance, the graduate from the machine shop working backward, as we might say, from the engine room to the boiler room, and the fire room graduate following the evolutionary process in the opposite direction.

It is perhaps unnecessary to say that these were what are commonly termed practical men. They were good mechanics and men of horse sense; their education was not garnished with a finishing off course in an engineering school; their knowledge of the technique of steam engineering was limited; perhaps there were a few who knew the rudiments of steam indicator practice, but they were the exception rather than the rule, and the man who boasted of the possession of an indicator and reducing motion was looked upon as an oracle by his less fortunate engineering friends. He was the recipient of numerous invitations to come over to the other fellow's engine room and take some "cards." Many a Sabbath was desecrated in filming the antics of some antiquated specimen which was looked upon with eyes of affection by the engineer in charge. But what a change has been wrought in engineering practice in the years which have intervened. Measured by our standards, power plant engineering was then within short reach of the primitive stage. The development of electric lighting machinery had much to do with defining a line of demarcation which separated the old order from the new. Modern methods are in the ascendency and the World's best brains are turned to solving steam engineering problems.

The stationary engineer must be a student if he contemplates being a factor in the game. That the slacker will be lost in the shuffle goes without saying. Education is in the air; these are halcyon days in the engineer's career. The older generation of engineers can be forgiven if they were just practical men devoid the finer technique of the business. It was not their good fortune to have the opportunities for study which are now presented to us. That the successful steam engineer of the future will be a composite of engineer, draftsman, electrician, chemist, executive and business man is indisputable. Everything points in this direction,—the man who can "run an engine," and this as a limit will be caught in the swirl of the eddy currents and eventually be landed high and dry upon the bank where he will no longer be a participator—a spectator only. Fortunate indeed is the young man who can take a course in mechanical engineering at some of our better known scientific schools. He will not know all there is to be known about steam engineering and allied subjects at the time of his graduation, even though he take a post-graduate course, for as a well known college president once said, "We do not pretend to make finished material out of our graduates; all that we purpose doing is to 'teach them to think systematically.'"

For those who never have had, and possibly never will have, the doors of a college thrown open to them for the study of the scientific end of steam engineering there is no cause for despair; there is always an opportunity presented to him who shows a disposition to learn, for with evening schools of every kind and description, college extension courses, correspondence courses, an extensive supply of engineering literature which can be brought to our door with little trouble or expense, privately conducted engineering schools, vocational schools, evening drawing schools, and others in almost endless variety, it is hard to picture a condition where a disposition to obtain knowledge cannot be met.

We are never too old to learn. It may be that with the passage of years we find it harder to absorb and retain technical information than we did in our early twenties, but this should act as a stimulus rather than as a deterrent.

But no matter in what school we receive our engineering education, whether it be through the means of a full course in a technical institution, a completed scholarship in the school of hard knocks, or any of the ramifications or amplifications of both, we cannot afford to withdraw selfishly into a cocoon and isolate ourselves from the society of our fellow engineers. There is no better, no more practical course than that of social intermingling, the heart-to-heart way of extracting information and giving a little in exchange for what we receive.

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Facts of the Future

EVERYONE knows that the coal resources of the world will not last forever, and speculation as to our future source of heat is a matter of some interest. The world's supply of coal will not last forever and at the present rate of exhaustion a few hundred years will find coal playing in the role of a more or less semi-precious mineral. Fuel oil, too, will be placed in the same category.

The internal combustion engine may well be the means of solving at least a portion of the problem, and Old John Barleycorn will be resurrected to a more useful life. When it is considered that almost any waste vegetable product can be converted into ethyl alcohol, it is readily seen that a source of power becomes available almost inexhaustible in extent. Waste from the products of the forest and field and vegetation of other types will serve to provide at least a portion of the fuel necessary, and where water powers are not available the internal combustion engine will reign supreme.

The suggestion of Sir Oliver Lodge to the effect that an excavation be made some ten or twelve miles deep has much to commend it from an investigator's standpoint, nad wells of extreme depth might, perhaps, supply us with heat. The suggestion for the digging of a pit of this depth has been mooted before by the "Khan," a newspaper correspondent, whose articles appear in some Ontario dailies. In his case the suggestion was made that a bit of the money spent by the nations of the world on armies and navies be used for the hole, a suggestion which might be forwarded to the League of Nations.

Solar energy can be utilized by those in the warmer climates, and the deserts of the world will bloom like a rose though, perhaps, not in a Biblical sense. At the present time, with comparatively cheap fuel, solar energy does not seem to be a commercial source of energy.

Inter-atomic energy, ever since the discovery of radio-active matter, has been thought of as a possible source of energy available for the future. With the fuller knowledge regarding the composition of matter now becoming available through research work something may be done with this source of energy in harnessing it for man's use.

A Joyful Thought

There is a keen, a subtle joy, in autumn's cooling clime, that makes it quite a pleasure to tear off yards of rhyme. We sing no more of summer days, of rivers or of lakes, of squattin' on a piece of rock just where the breaker breaks.

Nor yet of strips of wooded land, of cottages nor camps, with a hundred bugs and spiders and a dozen kinds of ants.

Begone such things, there, flee away, you're but a memory now—likewise the country scenes as well of piglets and of cow. We think of sterner things this month, of taxes and of coal, there's window sash and double doors to rend and vex the soul.

And underwear as thick as pie, it costs like silk and plush, to cover up the system from the snow flakes and the slush. But let us sing in joyful way, oh cheery be our tune—and blast it out at morning time, and then again at noon.

While seasons come and seasons go, there's recompense for each, the spring time has its budding tree, the fall its squash and peach. But, ah, to us, the thing that is of all things wondrous fine, concerneth not the things we see, nor things on which we dine.

We blush almost with modest joy to mention this here thing, of which we're moved upon this day to versify and sing. But when the warming rays of Sol get on their northern slants, your winter coat will cover up the patches on your pants.—ARK.

The Engineer of To-morrow

Address by Fred W. Raven, of the N.A.S.E., before the C.A.S.E. at Brantford

MR. PRESIDENT, officers and members of the Canadian Association of Stationary Engineers. It is indeed a pleasure to again visit your honorable body in convention assembled. Since a year ago, many things have happened. The great world's war has closed and the reconstruction period confronts us. The future holds much in store for us all, and especially for the engineer. To those who have fought for us, we honor. To those who have made the supreme sacrifice, we commend to God's Holy keeping.

To be worth anything to-day a man must be able to do something; he must have character and ability to stand on his feet and face the world. To command men, a man must first command respect and must be confident that he is equal to any emergency He must not lose his head or become rattled, nor fly off in a temper. The man who feels that his job is larger than he can manage is naturally nervous and irritable. He is conscious that he may be landed in a hole at any moment, and so he frets and fumes and keeps others upset and ofttimes ready to blame anyone for his own shortcomings. The man who is bigger than his job is always cool and confident that he is equal to any emergency, and never becomes rattled. No man can take out of the world more than he puts in. Many have tried it, but failed. It still remains true the "man must earn his bread by the sweat of his brow."

And so it is with an organization, it must have character and stability, and when a body of men organize, whether for honorable or lawful purposes, it is no more than right that they give to the public the reason and necessity for such organization. The Canadian Association of Stationary Engineers, having no objects that can be criticized, no plans not warranted by common sense, no desires not in accord with the demands of justice, we believe that it is only right and proper you give to the people of this community the reason for your existence. Your ranks are filled by competent men who believe that by a thorough knowledge of their profession, gained mostly by practical experience, they are better able to deliver to their employer and the public that efficiency which brings natural remuneration for services given, coupled with safety and conservation of our natural resources. If the North American continent is going to be the workshop and market of the world, the man of the hour, "the engineer," must be a steady, sober and industrious operator. With our shops, factories and buildings filled as they are with very valuable machinery and highly-paid workmen, it behooves the engineer and manufacturer to get closer together. The engineer, of all employees, is the best man for the manufacturer or employer to get acquainted with, and any employer who neglects this warning will fail to compete with those who are far-sighted enough to see these benefits. Much trouble in the past, and much in the future could and will be avoided if the employer studies his men and the necessities of his plant. Visit the workshop with a nod and a smile of greeting once in a while, and see the results that will come from it.

During the past generation engineers have placed a stamp on the world more marked than any other group of men. The engineer's knowledge is not only needed in the engine room, but in public affairs more to-day than ever before. Public activity must be carried on by groups of men to be effective rather than by individuals, therefore, if an organization of engineers is a benefit to a city, or province, or to themselves, an organization of manufacturers, taking an active interest in such an organization as this, must be the best of its kind and bring beneficial results to all concerned.

I sometimes wonder if we are doing all we can for our organization, or, if we get out of it all that is possible. The man that does his duty to his organization cannot fail but obtain great results for himself and all connected with him. An institution of this kind ought to appeal to all thinking engineers on account of the great good it can do. Our meetings need not be on education all the time, we should not take everything too seriously, or too lightly, but rather our meeting should strike that happy medium, that will enable us to gather in all necessary knowledge and sunshine that comes our way, and at the same time dispense it where the clouds hang lowest and the shadows are the darkest.

No institution, not even a fraternal one, can long exist without a substantial foundation. There must be something that appeals to the membership, real, strong, substantial and enduring, with a foundation that means personal liberty and the development of human character to a standard of excellence and efficiency. It is fit and proper that it should be so in this organization because of the commanding position it occupies in the engineering world.

When a man strives and lives with that part of himself which treats others as he would be treated himself, he is living a life of the best example. He is at that turn in the road where life seems the brightest and he cannot help but be happier, bigger and better. When a man keeps in his mind the Golden Rule, which to my mind precedes all creeds, all beliefs, it points the way to new thoughts, new teachings, and when a man is at peace with himself and with his neighbor, every sound suggests music and the clouds of frenzy and hate fall asleep under this beautiful June sky. Every flower recalls the perfume of earlier days, the hum of the bee as it weaves its winding path from flower to flower, will bring back the happy childhood days and the song of the birds.

Education is one of the greatest avenues to personal happiness, success and wealth; without education, life is without a future, so when a man strives to educate himself in our profession, and the general knowledge of the world, I have no fear for his future, no matter how high he climbs. Fame, fortune and favor have wings, but with character and education it develops the citizen and makes a nation.

Do not be afraid of anything in this world when you think you are right. Fear makes you doubt the very ability and talent you possess, and literally robs you of so much a year in both material gain and mental development. Do not be afraid to bring out your own individuality; a man strong in himself may make a weak imitation of someone else. We do not consider anything particularly as all roads lead to Rome; never mind if you choose a different one from your neighbor, providing you get there without loss of time. Do not be afraid to tackle any problem which seems hard at a glance—look it over again and again. Do not hide your light under a bushel, no matter if the light be even a small one. The greatest importance is to keep it burning—give it room—feed it well, and some day it may enlighten the world.

It is not in the nature of things that all men should be equally successful, but we should never lose sight of the fact that a small man's part is of equal importance relatively, as that of the greater. Employment and happiness are associated together, just as naturally as the sun with the day and the moon with the night, just so much as we make our employment productive to that extent that we can also take a greater interest in our surroundings. To the man who accomplishes less than he ought to, the world seems hard and unyielding, but it lavishes contentment and plenty on him who finds his happiness in thorough, earnest and vigorous prosecution of a work made successful by his own untiring efforts. To him who gives freely of his knowledge, much is received in exchange. The world will appear more cheerful, the leaves of the trees greener, and the flowers brighter to him who occasionally thinks of his fellowman.

Our Question Box

Questions and Answers Relative to the Act and its Regulations

Relative to the Act and Its Regulations

Question 1.—I am thinking of starting as a fireman in some power plant, or other place where steam boilers are used, and would like to know just how the Graded Certificate Act would affect me, and whether it applies to all firemen?

Answer.—If you start as a fireman, or are firing at the present time in a power plant of less than 50 boiler horsepower, or in a plant where the boilers are operating at 20 lb. pressure, or less, a certificate is not required. Nor is it required if you are firing on a locomotive, steamship or agricultural engine or boiler. If you are firing, or going to fire, a hoisting engine boiler you will come under the Act and must hold a certificate, unless the hoist is located at a mine or quary, in which case you are exempt. Except for the particular classes of work exempted above, all firemen must hold a fourth class certificate.

Question 2.—I am a night watchman and have a friend who is thinking of becoming one in a nearby plant. Do I come under the Graded Certificate Act?

Answer.—Yes, if you are night watchman in a plant of 50-boiler horse-power or over, and carrying over 20 lbs. of steam. The same exemptions apply as to firemen, although in your case your position won't be such that you are liable to be night watchman, etc.; on locomotives, etc.

Question 3.—Is any period of training allowed to fireman before they are required to take out a certificate?

Answer.—Yes, six months, at the end of which time the fireman must present himself for examination.

Question 4.—What certificate must a fireman or watchman hold?

Answer.—A fourth class certificate will be required.

Question 5.—Is any period of training mentioned in the Act and its regulations?

Answer.—No; no period is mentioned either in the Act or in the regulations, but this will be subject to the ruling of the Board.

Question 6.—What sections of the Act and its regulations mention firemen and night watchmen?

Answer.—Sections 5 and 11 of the Act, and paragraphs 2, 66, and 40 of the regulations.

Question 7.—Who all must hold certificates under the Act and its regulations.

Answer.—Subject to the exemptions set forth, all engineers in charge, all engineers operating under the engineer in charge, firemen and night watchmen, must hold certificates.

Question 8.—What are the exemptions?

Answer.—Plants having less than 50-boiler horse-power, plants operating at less than 20 lb. pressure, locomotives, steamships, agricultural boilers, and only those hoists which are used in mines or quarries.

Question 9.—In plants which come under the Act, who are not required to have certificates?

Answer.—Firemen with less than six months' experience, workmen acting under the personal direction or supervision of any engineer holding a certificate under the Act and who is in actual charge of a steam plant, or to the employees of engine builders or steam plant contractors engaged in installing, setting, or testing a boiler or steam plant. This does not apply to hoisting engineers, and note the distinction between a workman under the actual supervision and direction of a qualified engineer and a person operating under the engineer in charge. That is to say, coal passers, cleaners and laborers working in or around power plants are exempted from the workings of the Act, but firemen, night watchmen, and engine room employees, come under it as defined in the regulations. The charge engineer has to have a certificate of the proper grade for the operation of the plant as specified in the regulations, while those under him are only required to have fourth class certificates.

Question 10.—What certificate must an operator hold who is under the direction of a chief holding a certificate?

Answer.—He must hold a fourth class certificate.

Question 11.—How is the boiler horsepower calculated?

Answer.—Under the Act a boiler horsepower means the evaporation of 34 lbs. of water per hour from and at 212 deg. Fahr., or expressed in heating surface—15 sq. ft. of heating surface for return tubular boilers—12 sq. ft. of heating surface for locomotive type boilers, and 10 sq. ft. of heating surface for water tube boilers.

Question 12.—Has the horsepower of the prime mover, whether engine or turbine, anything to do with the Act?

Answer.—No. Horsepower throughout the Act means boiler horsepower only.

Question 13.—Does an engineer in charge of a plant with power supplied by electricity from an outside source, and steam used only for heating at a pressure less than 20 lb., come under the Act?

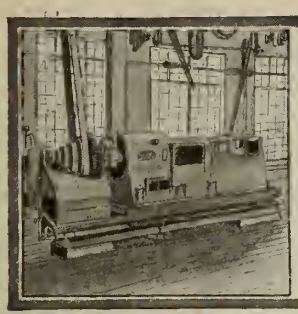
Answer.—No, unless steam is generated at a pressure greater than 20 lb.

Question 14.—What are the requirements for a fourth class certificate?

Answer.—The applicant must have had at least six months' initial experience as a fireman or otherwise. He must be of at least 19 years of age, of good character and sobriety, must be a British subject, or must have resided in Canada for one year.

Question 15.—What kind of an examination is set for a fourth class certificate?

Answer.—It is oral and practical in its nature. The main purpose of this examination is to determine the candidate's familiarity with the apparatus under his care and to ascertain his knowledge of its proper care. Steam boilers and pumps are what his examination will be based on, and knowledge of safe operation will be required. Hydraulics is mentioned in the Act and this will be limited to a knowledge of pump operation, valves, etc., and will be elementary in nature.



NEW POWER PLANT EQUIPMENT

A UNIQUE AND DISTINCTIVE LABOR-SAVING TOOL

LABOR-SAVING, time-saving, production-improving machinery and tools are fast becoming dominating factors in all industries.

The humble jack, in the form of the No. 328 Simplex Pole Pulling and Pole Straightening Jack, occupies the unique and distinctive position of being the only jack especially intended for and successfully operating under all conditions of pole construction and maintenance work.

It was designed at the suggestion and with the assistance of engineers and other officials of the leading telephone

and telegraph companies in the country for the express purpose of pulling and straightening poles for telephone, telegraph, electric light, power and railway companies, municipalities, and other public utilities having pole equipment.

Patents pending on this jack have recently been allowed, with broad claims, and will shortly be issued.

So successfully does this jack handle every phase of their construction and maintenance pole work that several hundred such companies throughout the country have adopted it as standard equipment.

As indicative of this great economy accompanying this unusual jack's service, it is claimed that with it one or two men can pull the largest pole, whatever the depth, soil or season conditions, in a fraction of the time it takes the usual gang of five or six men to do the work. Also, one man with this tool is said to straighten a pole in one minute, that usually takes several men several minutes to perform.

This jack is constructed of the very best materials and along rugged lines, and so designed that in both raising and lowering, its operations are so perfectly controlled as to insure absolute safety to pole, overhead lines, and other equipment, and operator.

This jack's various exclusive and distinctive features, above outlined, equip it to safely, economically and efficiently handle every phase of the varied, extensive and exacting pole operations of the largest public utility companies.

The high cost of labor in their construction and maintenance operations is causing public utility companies to give, more than ever before, serious attention to more economical and effective ways and means of meeting these high maintenance costs.

In this service the No. 328 Simplex jack mechanism is proving itself "a friend, indeed, in time of need," by heavily reducing the labor and other costs, at the same time very materially increasing pole-handling efficiency all around.

Those concerned in public utility pole construction and maintenance work who are not conversant with this unusual tool and the niche it has carved for itself in public utility pole efficiency and economy will find it a most interesting and instructive subject.

The Simplex No. 319 emergency jack is another Simplex tool of distinctive and exclusive design, very similar to the No. 328 pole jack, and which is adapted to an almost unlimited range of general utility service. Like the No. 328 Simplex above described, this jack operates to any angle at full capacity. This exclusive service ability in connection with its several different lifting and pushing points and attachments, enables it not only to meet any and every emergency that comes within the scope of jack service, but vastly wider range than performed by any and all other jack construction. In fact, so perfectly adapted is this jack to moving every object that needs to be pushed or lifted, that it well may be termed the jack of a thousand uses.

The unusual versatility and efficiency of the No. 310 Simplex makes this jack worthy of the interested attention of very many not concerned or interested in ordinary jack service.

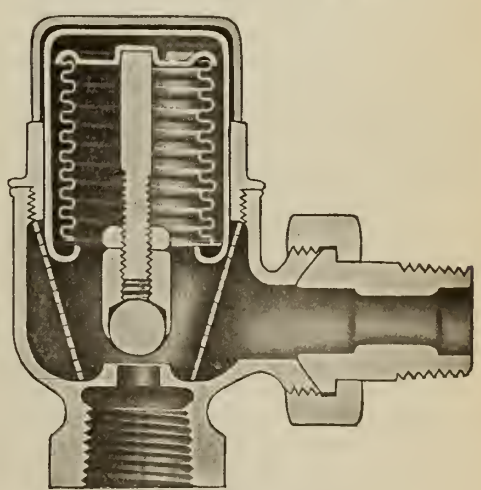
The manufacturers of these jacks, Templeton, Kenly & Company, Ltd., 1020 South Central Avenue, Chicago, Ill., will gladly supply interesting and instructive information and literature on either or both of these jacks.

NEW RADIATOR TRAP

The "Sarco" radiator trap is a development of the "Sarco" steam trap used everywhere for high and low pressure. It uses a spirally corrugated tube of large diameter. This, with the outer case, forms the expansion chamber, which contains a volatile liquid. The inside of the diaphragm is directly exposed to the steam or vapor. This arrangement results in quick and wide opening and closing of the valve. Slight change of temperature within the trap, due to condensation collecting in same, will give a wide open movement of the valve and permit of the prompt discharge of condensation.

We direct special attention to the Sarco diaphragm as it is unique in design and conspicuously better than any hitherto used in radiator work. Spiral corrugations insure that when the tube is expanded or contracted the movement is equal on every turn of the spiral. Annular corrugated tubes on the other hand contract and expand to the maximum degree at a given point; the movement at that point being considerable, the life of such tubes is restricted. With the Sarco spiral the movement is scarcely perceptible at any turn of the tube and the life of the diaphragm is constantly much longer than with the annular design.

Reference to the illustrations will show



NEW SARCO TRAP.

other special points, notably the new valve head, which is a bronze metal ball, freely turning in a socket. This insures a perfect seat and offers a wearing surface many times greater than that of any other type of valve on the market.

The construction also permits the pro-

vision of a strainer of ample surface. The importance of this need scarcely be emphasized. It effectively prevents clogging and protects the valve head and seat, eliminating practically all wear. The strainer has a discharge area some ten times that of the valve itself, and there is, therefore, little danger of stoppage, and there is no need for the cleaning of the strainer except at long intervals.

With this strainer the heating system can be started up at the beginning of the season without any danger of valves being blocked or injured by scale or rust.

The new Sarco radiator trap is tested and adjusted under conditions which reproduce the working conditions when installed. It is a factory-adjusted trap and requires merely to be connected to the radiator and to the return exhaust line. It will work on any degree of vacuum and on any steam pressure up to 20 pounds per square inch without strain or without readjustment.

Correspondence Re Graded Certificates

After years of agitation, an Ontario Government has granted a graded certificate act to the stationary engineers of Ontario. The act is one which has been needed for a long time, and presumably the engineers are to be congratulated on having secured it. However, after the first enthusiasm wears off, and it is examined more closely, cause for rejoicing is not so apparent.

The writer is considering the legislation from the point of view of one who has had considerable experience in the operating of industrial steam power plants, and knows exactly what the requirements and rewards of the position are. The question arising in my mind is this: Under the legislation as it stands, what inducements are there to attract a young man to power plant engineering.

The act follows in some respects the law in force for some years past in Quebec, while some portions of it are based on British Board of Trade rules. It perpetuates some of the objectionable features of the Quebec legislation, while it outclasses in severity in one respect the British Board of Trade, upon whose regulations nearly all other laws are based.

One of the points to which strong exception can be taken is the renewal feature. Why should a man who has successfully passed an examination and proved himself to be competent under the law's requirement, be compelled to pay yearly for the privilege of remaining competent? "It's only a dollar," some will say. Quite so, but why the renewal at all. If a man is competent in 1919, why is he not competent in 1920. He is, but the Government has to get revenue to keep up the Department. Therefore, the engineer must pay it. Why should he? The graded certificate is a protection for the manufacturer and the general public. Should not they contribute to the cost of keeping up the examination board. The yearly renewal fee takes the thing out of the realm of a certificate, and makes it a license. In other words, the engineer is taxed so much per year for the privilege of earning his living. Furthermore, the lowest-paid man is charged the same license fee as the highest but one.

The fee for examination is right and necessary, but, why saddle the candidate for a fireman's examination with the same fee as the candidate for a second class engineer's certificate? In the nature of things the examination cannot be as great a demand on the examiner's time in one case as the other. Furthermore, the man with the fourth class license cannot demand the same reward for his labor as the man with the second class.

However, the foregoing points are perhaps minor ones to many people's minds, though to the writer's they are real subjects for criticism. When in charge of a plant, there was no item of my personal expenditure that was so grudgingly spent as the renewal fee for my certificate, or license.

Now, let us take up the case of a hypothetical young man, who is starting in to work next Monday as a fireman. In the hopeful way of youth, he is picturing the day when he will have the proud privilege of spending 24 hours a day on the plant as chief. He finds that after six months' experience he is examined for a fourth class certificate, which will entitle him to operate under a certificated engineer in a plant of 50 h.p. or over. He must then put in 1½ years as a boiler engine room subordinate before he is entitled to examination for a third class certificate. Having successfully passed this ordeal, a further three years' servitude is demanded before he can become a candidate for a second class examination. That means that he must look forward to five years' steady work from the time he started in before he can obtain a second class, and take charge of a plant of 150 to 300 h.p. That is very good, and will ensure a man having experience before getting charge of a plant of any but very moderate size. It is when he wants to realize his ambition of being a first class man that he hits a snag. He finds that he is condemned to seven years in a plant of 300 h.p. or under before he can obtain a first class. He must shown seven years as chief or as operating engineer. What does this term operating engineer cover legally? I have always understood that the operating engineer was the man actually in charge of the power house. However, a fourth class certificate entitles a man to operate, under a chief, a plant of 50 h.p. or over. That means a plant of indefinite power. We take from that the suggestion that operating experience under a chief is as valuable as experience in absolute charge. However, this clause may be interpreted, a man who has succeeded in five years in obtaining a second class certificate, and wishes to take charge of a plant of 305 B.H.P. must wait for five years before he can be proun)unced fit to do so. On the other hand, he can, with no further delay, take charge of a shift on a plant of 3,000,000 horse power, if he can find one.

The writer was asked recently by an old member of the C.A.S.E. how a man who had been fifty years at the game would be affected by the legislation. The answer I gave him was, "The old man will be all right, but the young one has a hard row to hoe."

Ten years is too long an apprenticeship to serve. The probationary time should not be stuck on the end when a man's experience is ripening. If put on anywhere it should be at the beginning of the time, when he is young, and expects to serve an apprenticeship. If a man is fit to be responsible after two years as an oiler or fireman to take charge of 150 h.p., why should he take five times as long to be fit to take charge of a plant of 305 h.p.

After obtaining a second class certificate, one year more should be ample time to qualify for a first class. That would mean six years, and if a man isn't fit after six years to qualify, he won't be much better after four more.

Was this ten-year clause put in by the wishes of the engineers themselves, or by any particular portion of them? I would like to hear some opinions of engineers on this phase of the act.

By T. H. FENNER.

A new practical application for the metal selenium, has been suggested by a French scientist, L. Ancel. It is the use of selenium cells as smoke recorders in chimneys. A selenium cell is mounted on one side of a chimney or flue; on the opposite side is fixed a lamp.

The amount of light falling upon the selenium and hence the resistance of the cell will depend upon the density of the smoke in the flue; the fire can, therefore, be controlled by the galvanometer records. Ancel describes the device very briefly; he mentions that the cell should admit of easy access so that the smoke settling on the glass cover of the cell may be wiped off, and also that selenium cells are very sensitive to infra-red heat rays as well as to light. It is not settled yet, in fact, whether the light effect on selenium is not essentially a heat effect; that point would in a way militate against the reliability of the selenium cell to act as smoke recorder. Another novel application of selenium cells, mentioned by Ancel, consists in controlling the contact sulphuric acid process by the degree of the transparency of the gases in the reaction tube. Ancel, however, does not give any technical data.

The Operators' Point of View

ORAL OR VIVA VOCE

By Llewellyn

How One Engineer Secured His Certificate

SAY, chief, what does the word oral mean?

Oral, or viva voce, means by word of mouth, that is, an oral examination is where the examiner asks questions and you just tell him the answers instead of writing them. Quite simple, is it not?

For instance, several years ago, some half dozen young chaps, myself included, waited in the hall to be ushered into the sanctum one by one to go through the ordeal, when suddenly my name was called. I went in, and with my knees almost knocking together and my heart thumping like a steam hammer, I felt rather confused when face to face with two examiners who looked at me in such a manner as to suggest, what can we do for you?

With quite a struggle I succeeded in recovering my voice sufficiently to break the silence by saying, "Good morning, gentlemen," and the following dialogue took place:

"What kind of boiler have you at your plant?"

"A horizontal return-tube boiler, with ——."

"Yes. What ornaments or fitting are there on the front end?"

"There is the gauge-glass and try cocks, the ——."

"What in the world do you want a gauge-glass for?"

"So that you may know the height of water in the boiler."

Then they sat back in their chairs and had a good laugh at me. I was indignant and was about to make a remark, when, remembering that self-control is one of the essentials of an engineer, I kept silent.

"You say you have water in your glass. How much?"

"Usually about two-thirds full."

"Then what is in the rest of the glass?"

"Steam."

"How do you know there is steam there? Can you see it?"

"No. Steam is an invisible gas, but if you open the drain-cock at the bottom the steam will force the water out of the glass. The top of the water column is connected direct to the steam space of the boiler."

"I see, so when you want to know if there is any steam in your gauge-glass you open the cock and blow out the glass, eh? How often do you blow your glass out?"

"Two or three times a shift, depending on the condition of our feed water. If it is very vile, then oftener."

"Well, now, you tell us this, glass affair is to show the height of water in boiler; you also say it is connected to the steam space of your boiler. What kind of a rig is it, anyhow?"

"There are several designs based on the same principle, consisting of a metal column connected to the steam space on the top and to the water space on the bottom, so located that the centre of the water-glass gives a safe working level. The glass is secured to the column by a strong brass fitting having a suitable stuffing box, ring, and a nut, with the aid of a rubber ring, making a steam-tight joint. On the side of the column there are three test cocks and a ——."

"What are these test cocks for?"

"To give the height of water in the boiler in case your glass gets broken or becomes choked up."

"What are their location?"

"The lower one should be not less than two or three inches above the top row of tubes or highest point of fire line and the second cock not less than two or three inches above the first or at normal water level, and the top one about the same distance above the second one."

"So you only use these cocks in case something goes wrong with your glass?"

"Oh, no. They should be used two or three times a shift so as to keep them clear and prevent them getting choked up."

"Well, are there any other fittings on your boiler?"

"There is the steam pressure gauge and ——."

"How should the steam pressure gauge be connected to the steam space of your boiler?"

"By an inverted syphon, a pipe having one coil bent on it, or some similar arrangement whereby some of the steam may condense into water so as to protect the delicate mechanism of the gauge being injured by the high temperature of the steam. A cut-out cock to be placed between the syphon and the boiler unconnected with any other fitting."

"Yes, but what is this gauge for?"

"This gauge indicates what pressure you have in your boiler."

"Oh, I see, if your gauge shows 100 pounds per square inch you have absolutely 100 pounds pressure per square inch in your boiler?"

"No."

"Why, then?"

"Because absolute pressure is figured from a perfect vacuum."

"What are you giving us now?"

"Well, the pressure indicated by the gauge is the pressure above the atmospheric pressure, which is about 14.7 pounds per square inch."

"Suppose your boiler pressure was 5 pounds below the atmospheric pressure, what would your steam gauge read?"

"The pointer would be at zero and you would have a partial vacuum in your boiler."

"Where would be a good place to have your feed water connection?"

"The arrangement should be such that the water will be discharged at the coolest part of your boiler. A convenient arrangement is to have the pipe enter the front end of the boiler about three inches above the top row of tubes; the pipe should be continued inside the boiler nearly to the back end and in such a manner as to discharge the feed water between the shell and tubes so that the feed water will be heated to a good temperature before being discharged into the boiler."

"How can you regulate the feed water?"

"By a stop valve on the feed pipe close to the boiler."

"Yes, but if you open the stop valve what is going to prevent the pressure in the boiler forcing the water and steam back to your feed pump?"

"There is a check valve just below the stop valve close to the boiler."

"What good will that do?"

"A check valve being a non-return valve will permit water to pass into the boiler but is instantly closed when the pressure on the boiler side is greater than that on the pump side."

"What do you consider one of the most important fittings on a boiler?"

"The safety valve."

"Why do you have a safety valve?"

"Because when the pressure in the boiler reaches a certain point it automatically opens and releases the pressure thus preventing an explosion."

"What kind of valve have you between your boiler and safety valve, a globe valve or a plug cock?"

"No valve should be between. The safety valve must be connected direct to the boiler."

"What kind of stop valve do you prefer on you main steam line?"

"A self-closing stop valve situated on top of a riser about three feet high with a horizontal length to the header on main steam line so as to give flexibility and in case one of the boilers in a bat-

tery giving out the steam will be shut off from the disabled boiler automatically.'

"Suppose you got too much water in your boiler, what would you do?"

"Let some out by cautiously opening the blow-down cock."

"Where is the blow-down cock connected on your boiler?"

"To the bottom of the shell near the back end of boiler."

"What kind of valve is it?"

"A packed cock. Globe and angle valves are not allowed."

"Of course you only use this valve in case your water gets too high?"

"It should be used once a day at least according to the state of your feed water so as to blow out any sediment and to keep the valve in working order."

"You say if your water gets too high you can blow off some, and if your water gets too low, what then?"

"If the water gets too low the fusible plug would melt and relieve the boiler of dangerous pressure."

"Where should these plugs be located?"

"To that part of the boiler first liable to become overheated. In a horizontal tubular boiler about three inches above the top row of tubes in the back end. In the crown sheet of a horizontal fire box boiler. The lower side of the upper drum of a water-tube boiler, and the lower tube sheet of a vertical boiler are considered suitable places for these plugs."

Now I've got to get busy. Drop in again sometime, good-bye. So my friend left me after I had given him an idea of an oral examination.

C. A. S. E. BANQUET

Toronto No. 1 lodge of the C. A. S. E. held a most enjoyable function on Thursday, October 23, at Young's Banqueting Hall, Yonge Street, Toronto.

The occasion was the first annual dinner of the lodge, and about 130 people sat down to a good dinner at 8 p.m.

The members were accompanied by their wives and sweethearts, and a few invited guests were also present. These included Dr. Riddell, superintendent of the Trades and Labor Council, accompanied by Mrs. Riddell; Mr. Mosely, who has now been appointed to the Board of Stationary Engineers; Mrs. Mosely; Mr. Metcalf, chief provincial boiler inspector; Mr. T. H. Fenner, of the POWER HOUSE editorial staff, and others.

The entertainment, which followed the dinner was excellent and varied. Mr. Reed sang Scotch dialect songs with the skill of a Lauder; Miss Dean performed a brilliant piano solo; Mr Balmfirth, the indefatigable secretary, gave a reading, and later appeared in a sketch, assisted by several of the ladies.

The toasts were all honored in the wine of the country, namely, water. Mr. Balmfirth, after proposing the health of the King, which was loyally honored, called on Mr. Mosely to propose the health of the Government. Mr. Mosely acceded to the request, though, he said, it was difficult to know who was being toasted. Dr. Riddell responded to the toast, and in a well-chosen speech called the members' attention to the gratitude they owed the Hearst Government. Other toasts were "The ladies," proposed by Mr. Taylor and responded to by Mr. C. B. Turner; "Our guests," proposed by Mr. Bly, and responded to by Mr. Fenner.

The affair ended at midnight, everyone leaving the gathering with pleasurable feeling. Toronto No. 1 is to be congratulated on the effort.

ZINC FOR ELECTRICAL WIRES

W. K. Whippleman

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The papers state that zinc is now being used in Germany for electrical conductors instead of copper, because of the scarcity of copper. How does zinc compare with copper as a conductor? If the conductivity of copper is taken as 100, the conductivity of zinc is 28.5. That is, zinc conducts an electric current only about one-fourth as well as does copper. In view of this it is apparent that zinc could not be effectively substituted for copper in most electrical appliances.

TRADE GOSSIP

The Pennsylvania Crusher Company, Philadelphia, have issued bulletin No. 1004, descriptive of their hammer crushers adapted for the fine crushing of bituminous coal.

The Chain Products Co., of Cleveland, Ohio, have issued a very attractive and useful catalogue, which is especially useful to anyone interested in chain products of any nature.

This book, known as their catalogue C30, consists of 111 pages, and is divided into three sections. The first is devoted to coil chain, the second to chain specialties, and the third to miscellaneous attachments. Several wire and chain tables form a closing part of this book, which should be in the hands of those interested in weldless chain.

In Barton Tp.—Firestone Rubber Co. will probably locate in Barton Township, just outside the eastern limits of Hamilton. A large tract of land has been secured, part for industrial purposes, and the balance for employees' homes. The Barton Township ratepayers are voting on a tax exemption proposition. In the meantime the Firestone Co. have leased the old Canadian Cartridge plant, Hamilton, and will start building the machinery there for the new rubber plant. Mr. Cook, formerly superintendent of Canadian Cartridge Co., is to have charge of the machine building.

Granby Starts By-Product Plant.—The Granby Consolidated Mining Company at Anyox, B.C., have now put their by-product plant in full operation. Toluol, benzol, sulphate of ammonia, and coal tar are among them. The coal tar will be shipped to Vancouver and resolved into pitch and creosote, and will be sufficient for all B. C. requirements in these lines.

Secure Power Supply.—The International Paper Company has just recently entered into contract with the Shawinigan Power Company to supply all the power requirements for the large new development at Three Rivers, Quebec. It was first thought that the Paper Company would undertake the exploitation of power generation on their own initiative, but after a thorough survey of the power situation, it was decided that it would be more successful and economical to purchase their power from outside sources. The ultimate horse power that will be required is problematical, as this will be augmented from time to time as the needs become greater. The initial output of the mill will be about 200 tons of newsprint per day, and this will call for about 20,000 h.p. The plant, when in operation, will employ about 1,500 men.

St. John, N.B.—Angus McLean, general manager of the Bathurst Lumber Co., and Major V. J. Hughes, of Montreal, manager of the Canada Iron Corporation, appeared before a meeting of the Provincial Government this week in connection with the plans for the development of water power on the Nipisquit River. The contract, Mr. McLean said, is to be carried out by Morrow & Beatty of Peterborough, Ont., under direction of Wm. Kennedy, Jr., hydraulic engineer. It is proposed to build a dam at Grand Falls on this river to develop 10,000 horse power, to be transmitted to Bathurst, N.B., for the operation of the pulp and saw mills and other industries controlled by the Bathurst Lumber Co. Two generators will be installed at once and arrangements made for the installation of a third, if necessary. The transmission line will carry from 50,000 to 55,000 volts and will be erected on steel poles.

Fuel oil is frequently spoken of as "crude oil," but this is incorrect, as the crude oil, that is, the petroleum oil as it issues from the well, contains certain light fractions of the petrol and paraffin series, which it is not only desirable to extract from the crude by distillation on account of their higher values, but which, if left in the crude oil and used as fuel would be a wasteful procedure, and further, would lower the flash point, which has been very properly fixed for fuel oil by British authorities, viz., Lloyds' Register of Shipping 150 deg. Fah., British Admiralty 175 deg. Fah., London County Council 175 deg. Fah. The crude oil is therefore subjected to what is known as a "topping process," which is a distillation which cuts out those lighter fractions, leaving a product having a calorific value of about 19,000 B.Th.U.s. per pound.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00.
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 25
Steel bars, base, Toronto	4 25
Steel bars, 2" to 4" base	5 50
Steel bars, base, Montreal	3 75
Best grades	15%
Iron bars, base, Montreal	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.	....	7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard	30, 10%
Cut leather lacing, No. 1	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers ..... list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank ..... add	$0 75
Nuts, square, tapped ..... add	1 00
Nuts, hex., blank ..... add	1 00
Nuts, hex., tapped ..... add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass	55
Wood screws, O.&R., brass	55½
Wood screws, flat, bronze	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A. ...list plus	20
Emery Cloth ..... list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon	1 80
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd.	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING.

Standard ..... 10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets ..... list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws ..... list plus	20
Collar screws ..... list plus	20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts ..... add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. ..... add	2 00

METALS

	Montreal	Toronto
Lake copper	$22 00	$21 00
Electro copper	21 00	20 75
Castings, copper	21 00	18 00
Tin	55 00	55 00
Spelter	9 25	8 50
Lead	7 25	6 50
Antimony	9 50	9 50
Aluminum	36 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

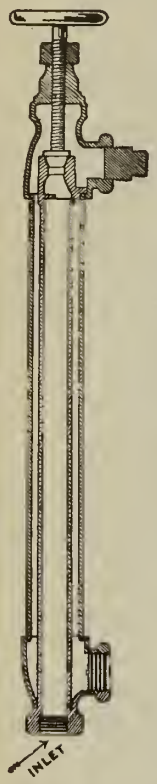
Packing, square braided	$0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

Requires Very Little Attention



Do you want efficient and reliable steam trap service without having to give the trap constant attention? Then adopt

The Long Patent Steam Trap

Has important features which CLAIM your attention. Absolutely guaranteed. The Long Trap is automatic and requires no valves except those which control the admission of steam to the apparatus to which the trap is attached.

The trap is regulated to work against any pressure between 1 and 200 pounds. Being open at starting, it cannot become air bound, this doin away with air cocks or vents — Does Not Freeze.

It is capable of draining from 90 to 1,500 feet of one inch pipe.

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explanation to

J. T. LONG
84 Adam St.
MONTREAL, CAN.

If your dealer does not sell it write direct. No. 2

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 TO 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

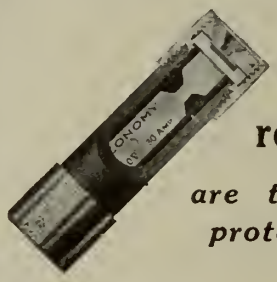
An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

WANTED — FIRST-CLASS ENGINEER TO take charge of steam plant; prefer a man with knowledge of Detroit Stokers, also one who has had some experience with electrical machinery. Box 154 Power House, 143 University Ave., Toronto.

WANTED—BY LARGE ONTARIO BOILER manufacturer, an experienced draughtsman, familiar with the designing of tubular, locomotive and stationary boilers. Box 153, Power House.

At the October meeting of the Canadian Railway Club, which will be held at the Windsor Hotel on the evening of the 14th, the subject will be Competition, Combination, and Co-operation, and will take the form of a lecture by Major S. T. Robins, general manager of the Dearborn Chemical Company.



ECONOMY renewable FUSES

are the RIGHT fuses to protect YOUR electrical circuits

—because they afford the right sort of protection; their reputation lends assurance that you can safely depend on them for accuracy of rating and all-around efficiency in operation.

—because they cut annual fuse maintenance costs 80% as compared with the use of one-time fuses, owing to the fact that an inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency.

—because it's the work of a moment to replace the link and renew the fuse.

—because a good sized stock of "Drop Out" Renewal Links always on hand represents but a small outlay. *Write for Catalog 24*

ECONOMY FUSE & MFG. CO.
OF CANADA, LIMITED
UNITY BLDG. MONTREAL
Manufacturers in Canada of
S. & C. HIGH POTENTIAL FUSES—TO 150,000 VOLTS

Must be sold at once 100 H.P. SYRACUSE GAS PRODUCER PLANT with Bruce Mac-Beth Engine. We will erect on your foundations and start up. A bargain. Producer practically new. Engine equipped for natural gas or producer gas. Will sell separate if desired.

SYRACUSE INDUSTRIAL GAS CO.
Syracuse, N.Y.

WANTED

Representatives to handle special line of British made "Elastic Steam Jointing Cement" (for all joints) and Iron Cement for castings, etc. Exclusive territory offered parties conversant with trade. Replies treated confidential. Apply Box 151, Power House.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.

Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

Keep Canada Humming

Canada is running a great National Store.

Great Britain and other lands come here to buy our surplus agricultural and industrial products. These are the orders that are keeping Canadians busy and prosperous. That is where the money comes from that is paying our farmers for their surplus products and providing full pay envelopes for our workers.

But Great Britain and our allies are temporarily short of "cash." So Canada must extend them "credit" — just as any storekeeper extends credit to any customer whose financial standing is good.

The success of the Victory Loans 1917 and 1918 made possible the giving of these credits.

Continuation of these credits and the maintenance of our valuable overseas markets—depend upon the success of the Victory Loan 1919.

You will therefore plainly see how closely bound up with the Victory Loan 1919 is the prosperity of everyone in Canada, without exception.

Do not think your individual co-operation "does not matter."

It does matter!

Unless Canadians to the last man support the Victory Loan, it will not be the success that our continuous prosperity demands.

Let every Canadian do his share to keep things humming.

BUY VICTORY BONDS

"Every Dollar Spent in Canada"

THIS SPACE DONATED TO THE VICTORY LOAN 1919 CAMPAIGN BY

POWER HOUSE

TORONTO, ONT.

ECONOMIC Carling BLOWERS SUPERIOR

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

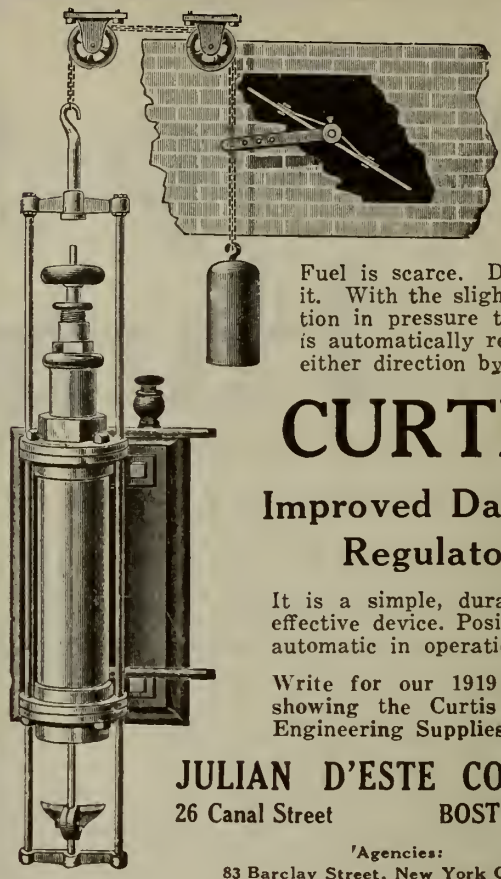
Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers WORCESTER, MASS
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities

Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong



Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1919 catalog showing the Curtis line of Engineering Supplies.

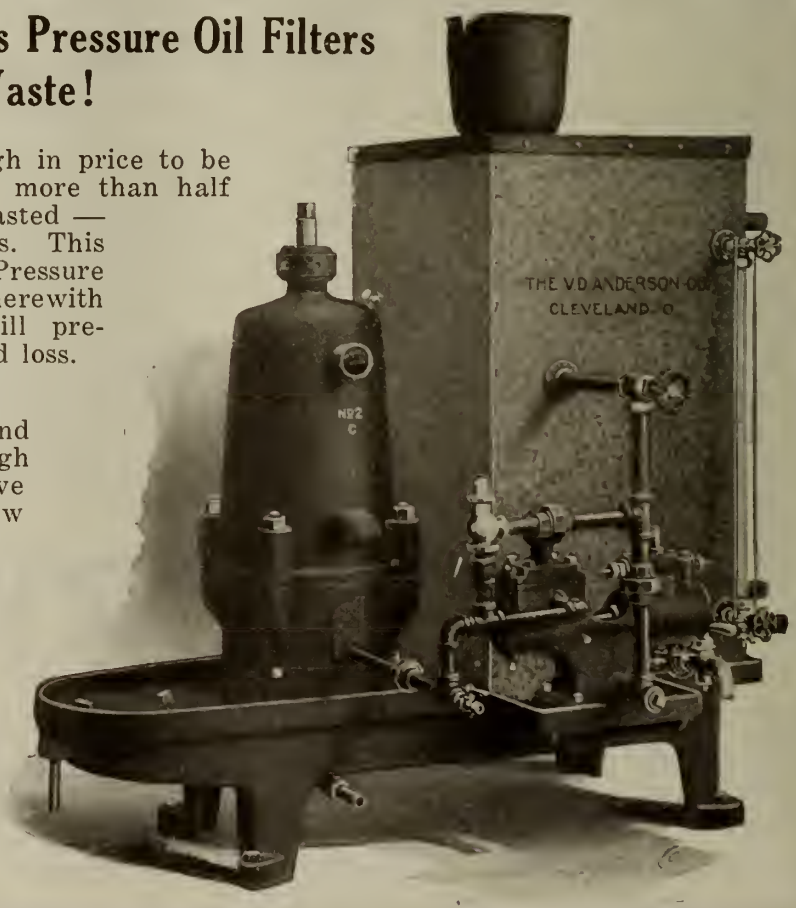
JULIAN D'ESTE COMPANY
26 Canal Street BOSTON, MASS.

Agencies:
83 Barclay Street, New York City
174 North Market Street, Chicago, Ill.

Why Waste Oil?

Anderson's Pressure Oil Filters Prevent Waste!

Oil is too high in price to be wasted. Yet more than half your oil is wasted — lost on wipers. This Anderson Pressure Oil Filter herewith illustrated will prevent this dead loss.



Place drip pans beneath engines and machinery. Then pass this oil through the **Anderson Filter** and you will have oil just as clean and as pure as the new oil you purchase.

You can use oil over and over again with the Anderson Filter. No other filter will do the work so thoroughly.

There are a few more points about the Anderson that we would like to take up with you. Pleased to have you drop us a line.

The V. D. Anderson Co.
West 96th St., Cleveland, Ohio

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

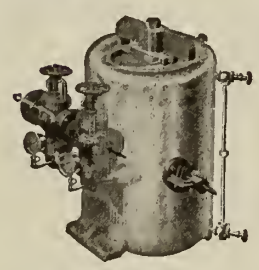
Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

MASON SPECIALTIES

Mason No. 55 Pump Pressure Regulator.



Reilly Multi-Screen Feed Water Filter.

We'll Solve Your Problems!

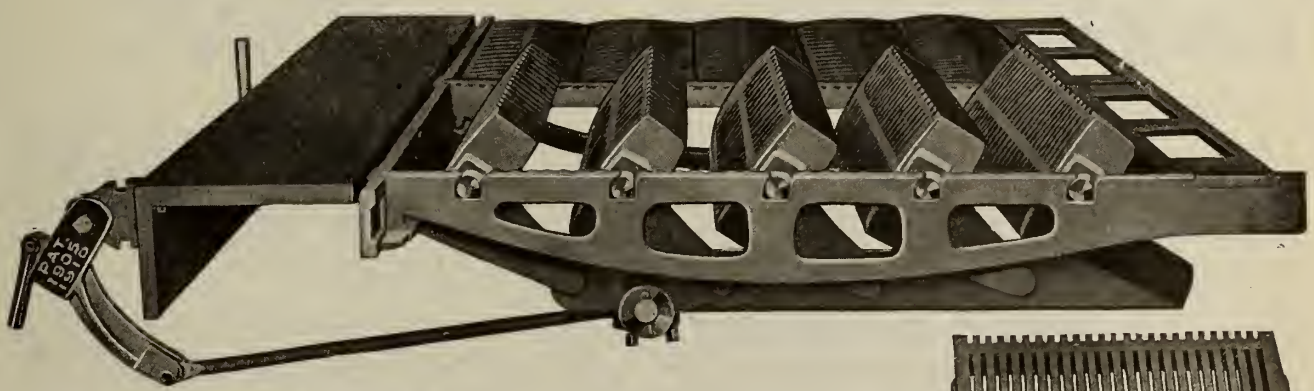
When you link up with MASON you are not only assured of getting power house specialties famous for their **quality of manufacture** and **reliability in service.** You are also offered the advice of competent engineers. Men who are trained to treat power house problems. Men who are concerned with **result.** Their advice means **economy and efficiency** in your plant. And their services cost you nothing.

The Mason Line Includes:

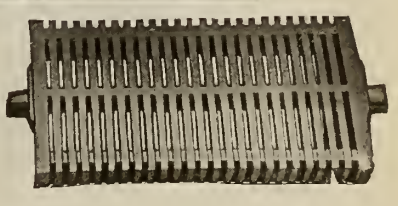
Mason Reducing Valves (Genuine).
Mason Pump Governors.
Mason Pressure Controllers.
Bundy Steam Traps for every service.
Coppus Turbine-driven Blowers.
Sims Hot Water Generators.
Sims Storage Heaters.
Sims Open Feed Water Heaters.
Bundy Oil Separators.
Ashton Gauges and Safety Valves.
Everlasting Blow-off Valves.
Babbitt Sprocket Rims.
Strattom Steam Separators.
Reilly Multi-coil Feed Water Heaters.
Reilly Evaporators and Distillers.
Reilly Multi-screen Feed Water Filters.

Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.

The Mason Regulator & Engineering Co., Limited
Successors to H. L. Peiler & Co.
Montreal Office and Factory
135-153 Dagenais St.
Toronto Representative:
The Arthur S. Leitch Co., 1002 Kent Building



CYCLONE GRATES



Burn All Grades of Fuel With Maximum Results No Clinkers No Waste

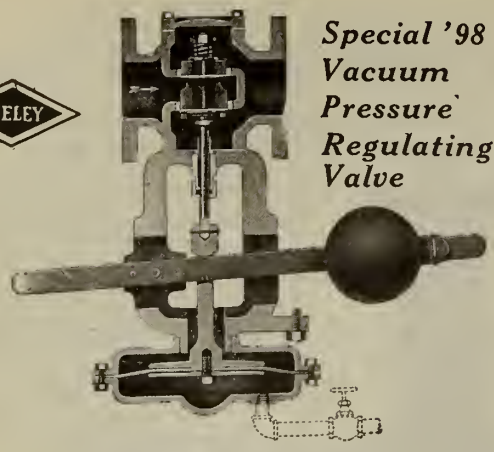
Investigate Our 30-Day Trial Offer

CYCLONE GRATES Burn all grades of coal and give maximum results. Their 60% air space and 90% under-draught insures perfect combustion. No fuel in ashpits where they are installed; no clinker formations either. To prove to you that CYCLONE GRATES are easy to install, and when installed will save you a lot of fuel expense and give you the best furnace satisfaction you have ever had, we are prepared to make you a 30-day trial offer. Why not investigate?

The Canadian Steam Boiler Equipment Co., Ltd.
Sole Makers for Canada
20 McGee Street Phone G. 3660 Toronto, Ontario

AGENTS:
OTTAWA—J. W. Anderson, Room 7, Bank Street Chambers
ST. JOHN, N.B.—F. W. Blizard, 329 Charlotte St. MONTREAL—Mason Regulator Co., Ltd., St. James St. HAMILTON—Robt. Fitzsimmons, 8 Grove St. WINNIPEG—Vulcan IronWorks.

KIELEY



Special '98 Vacuum Pressure Regulating Valve

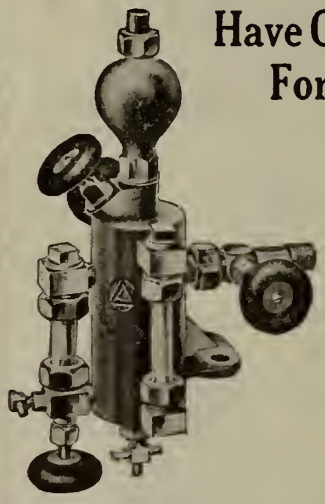
Responds to Slightest Fluctuation

The independent diaphragm feature of the Kieley Special '98 makes this type of valve especially appropriate for use in connection with vacuum or vapor heating systems, or any other service where close regulation is of importance. Both straight and differential patterns respond to slightest fluctuation. Maintains desired pressure at any point of heating system or supply mains by adjusting weight on lever. This valve is advanced in design. Let us explain it in detail.

THE ARTHUR S. LEITCH CO.
KENT BUILDING, TORONTO

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

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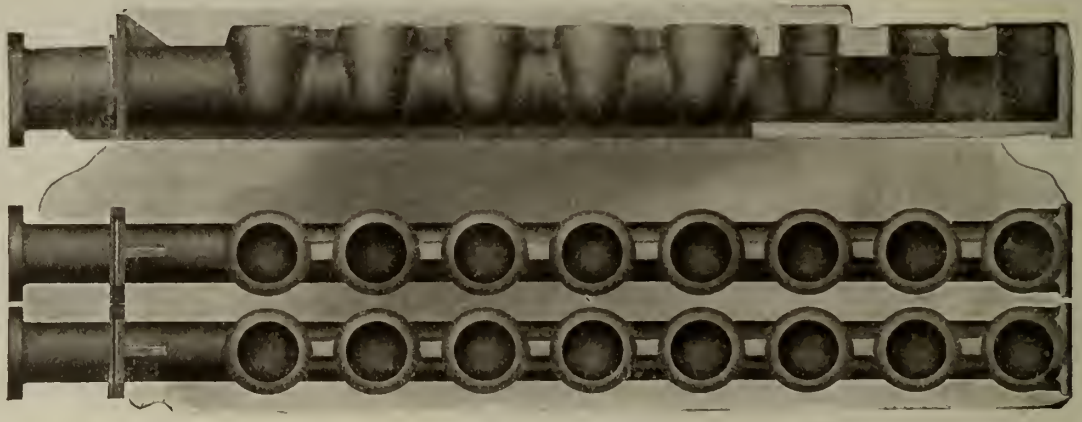
THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

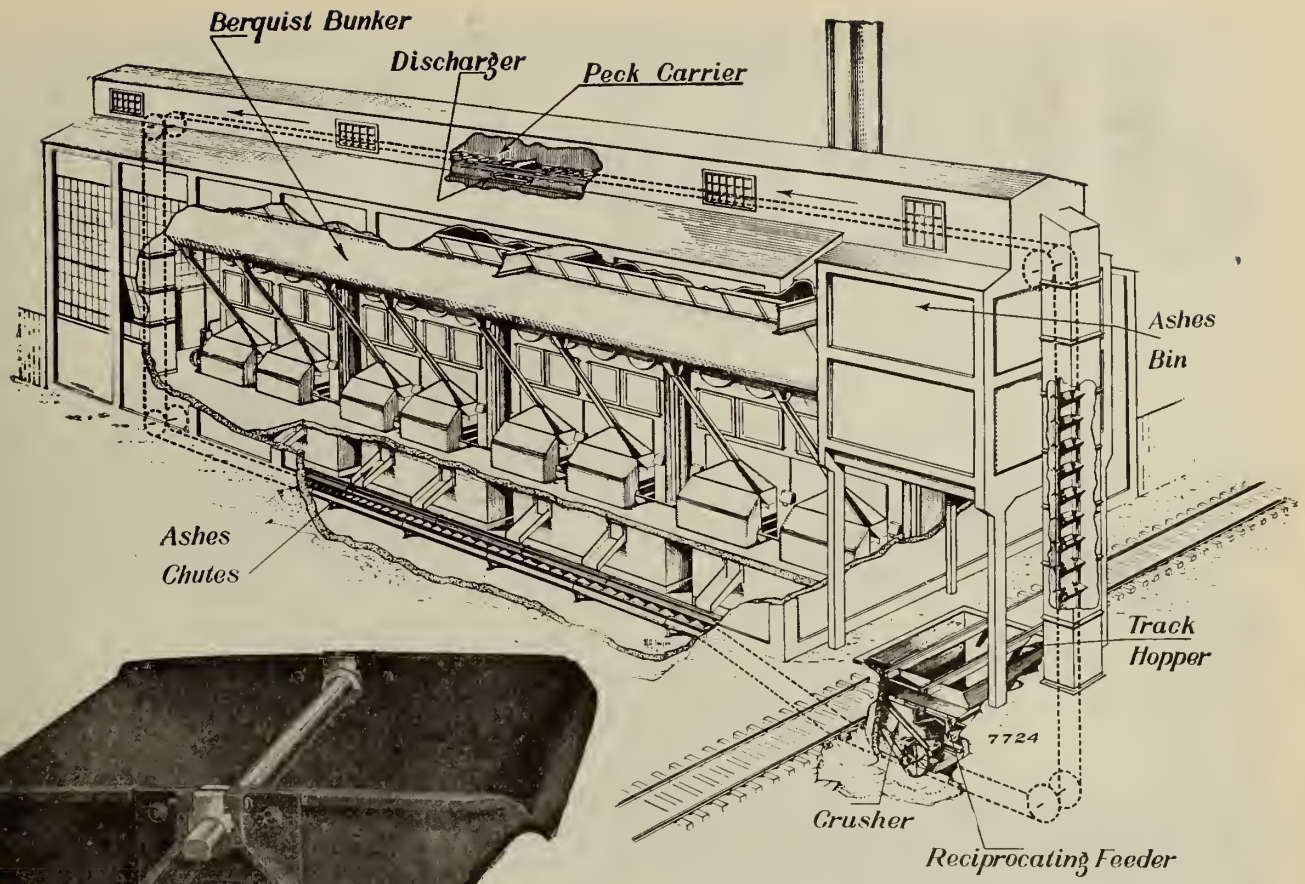
CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

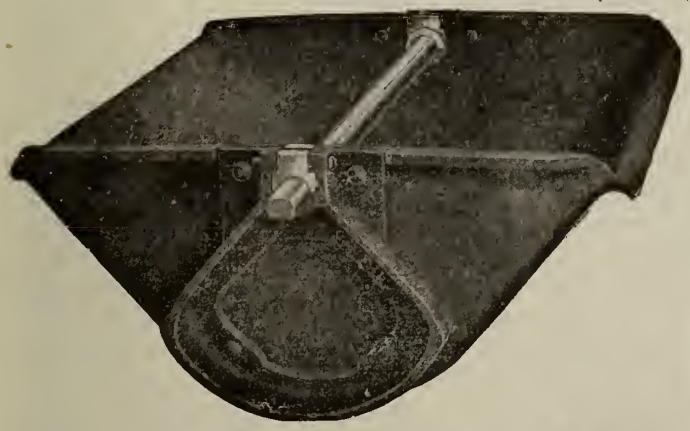
Bottom Headers Article No. 4



The bottom headers are provided with tapered sockets to receive the tubes as previously described. The ovoid construction, which is well illustrated by the accompanying cut, leaves an extra large space between the headers. This construction prevents soot collecting on the bottom headers and eventually blocking the space to the soot pit and also gives ample space for inserting a man's arm for adjusting the scrapers if this should become necessary. The end of the header is extended to pass outside the economizer and connect with the branch pipe. The headers are supported on collars cast at either end as shown in cut.

GREEN'S ECONOMISER, LIMITED.
TORONTO





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Coal Handling Machinery

GRAVITY Bucket Carriers, consisting of a continuous series of buckets pivotally suspended between two endless chains, represent the highest development of the conveying art. As the buckets at all times maintain their carrying position by gravity, a single Carrier can transport material horizontally, vertically and again horizontally, or in any desired path.

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We also design and build elevators and conveyors for handling all kinds of material; coal and ashes handling machinery; coal crushers; chutes; screens; belt conveyors; locomotive cranes; grab buckets; portable loaders; electric hoists; Link-Belt and sprocket wheels; silent chain drives; transmission machinery, etc., etc.

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CANADIAN LINK-BELT COMPANY
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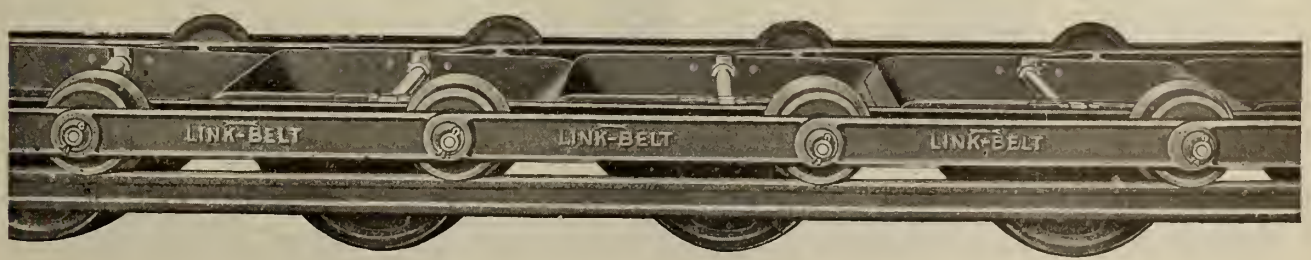
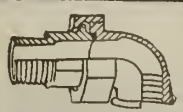
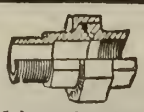


JEFFERSON

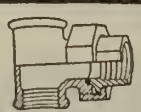
"Look for the name on the nut"



Union Elbow, an economizer of the most pronounced type. Also made all female.



Male and Female Union. Takes the place of an all-female union and a nipple. Makes a short connection.



Union Tee, with union on the outlet. Made also with male end on outlet.

The Guardian of the Pipe Line

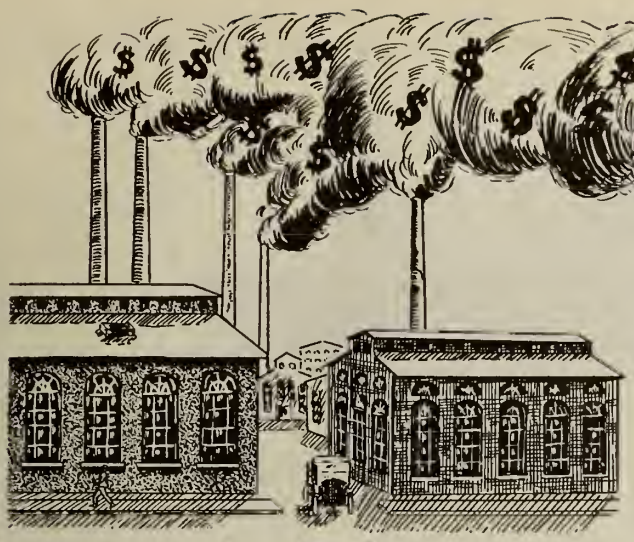
Above ground—in breakers and power house—below ground—in shafts and pump rooms—you'll find Jefferson Unions guarding the pipe lines from leaks and breakdowns.

Protect your plant from expensive shutdowns and costly repairs. Insist on genuine JEFFERSONS. It's easy to be sure because the name is clearly stamped on the nut.

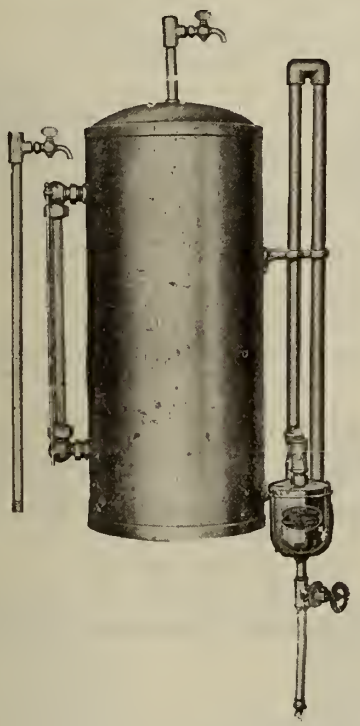
A "just-as-good" union costs about as much as a JEFFERSON—you pay as much or more to put it on the line and moreover you have the added cost of taking it out when it fails. Save this time and money—play safe and standardize on JEFFERSON UNIONS.

Write for our Catalog UNIONS.

The Jefferson Union Co.
Lexington, Mass.



Dollars Going Up In Smoke



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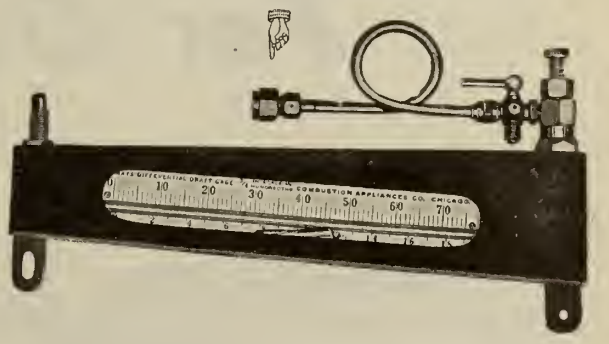
HAYS combustion testing apparatus effects a huge fuel economy. It is a friend of the fireman and a very profitable investment for the plant owner.

It shows at once if draft is proper—if there are holes in the fire—if settings are leaking—if firing periods are improperly timed and other causes of fuel waste.

Gas Collector with water-flow regulator.

The Hays Differential Draft Gage indicates the draft over the fire or the drop in draft through the boiler.



HAYS Automatic CO_2 and Draft Recorders, Automatic Gas Collectors, Draft Gages and other Hays Equipments installed on your boilers keep you posted as to just what conditions your boilers are operating under.

Hays Combustion Efficiency Appliances are leading the way to increased efficiency in boiler firing, a most effective way in offsetting high coal prices.

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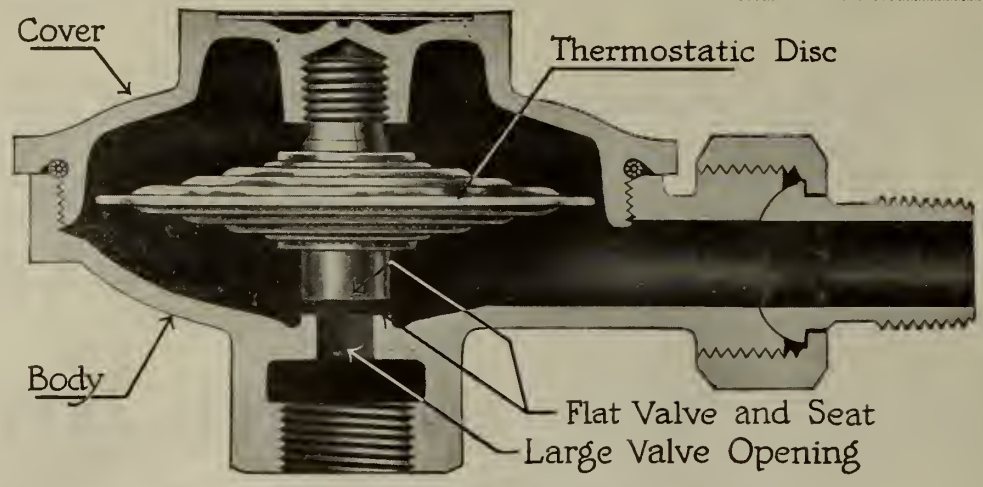

INSIDE FACTS

The cover and thermostatic disc are securely fastened together: therefore there are only two major parts to a Dunham Radiator Trap. The disc is of special composition phosphor bronze, enclosing a volatile liquid which is extremely sensitive to temperature changes over a wide range—10 pounds pressure to 15 inches of vacuum. No adjustments are ever needed: we do that at the factory.

The DUNHAM HEATING SERVICE

The above illustration shows all of the trap. Note the absence of loose parts in the path of flow: there are no sliding contacts, nothing to gum up, no guide or pin. The valve seats squarely. No wonder that the efficiency of the Dunham Radiator Trap equals its simplicity. *The complete details will interest you.*

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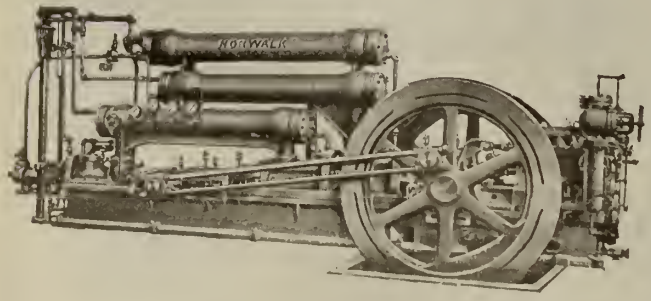

24 inch Stroke Chain-Driven, Four-Stage Air Compressor

THERE are Norwalk Compressors still in use and giving good service which were installed a score of years ago. They have needed few repairs and fewer replacements.

Write for Bulletins on air, oxygen, hydrogen, acetylene, or carbonic acid gas. One or all on request.

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Cast Iron Screwed Fittings

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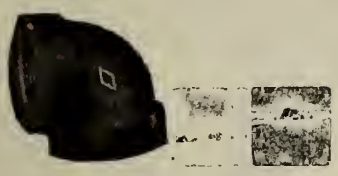
These fittings are of good design and weight, and are suitable for steam working pressures up to 125 lbs., or water working pressures to 175 lbs.



Straight Elbow

Straight Tee

All sizes, ¾″ to 6″ inclusive, carried in stock.

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Straight Tee

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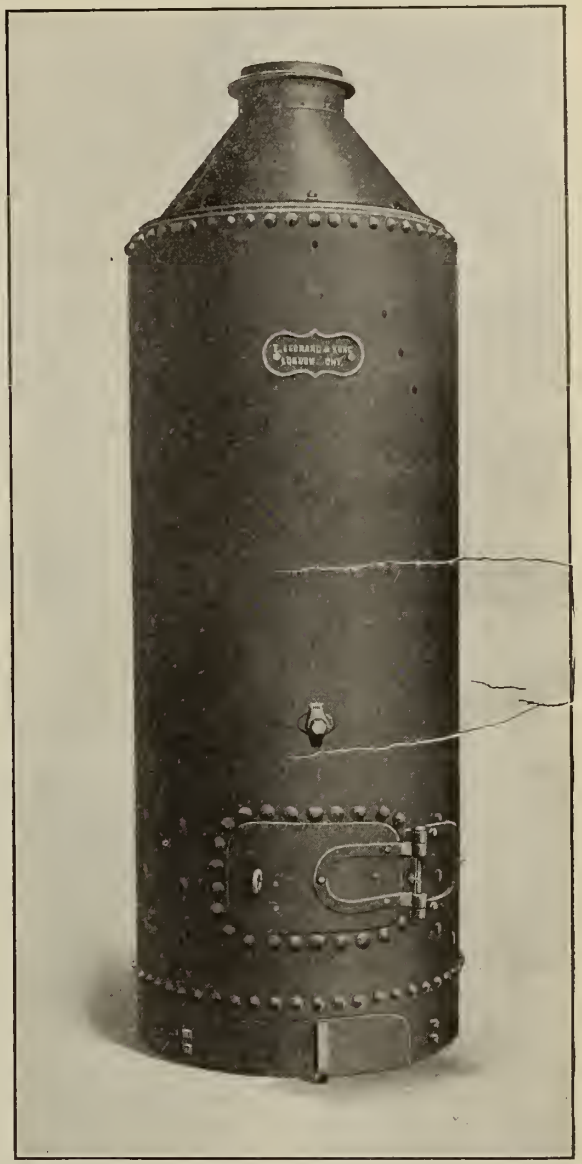

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FOR STEAM, WATER, AIR, GAS, ETC.

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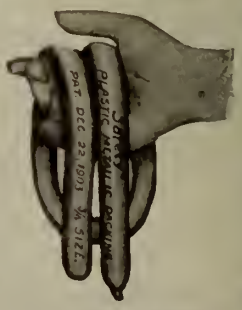

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The Johns-Pratt Co.
Hartford, Conn.

Ask Your Dealer *Or Write Us Direct*

19-12

RALPH CONNOR

On "The New Canada and Its Needs"

RALPH CONNOR, the famous Canadian novelist, who served for several years at the front and saw the war from many angles, is convinced that Canada must be prepared to make important changes if she is to profit by the lessons of the war. He has written a series of articles embodying his views and calling vigorously on patriotic Canadians to awake to the needs of the hour. The articles, which deal with economic, social and Imperial topics, were written for MACLEAN'S MAGAZINE and the first appears in the November issue, under the title: "The New Canada and Its Needs."

Every Mother Who Lost a Son at the Front

will read with deepest feeling Nellie McClung's wonderful story, "Men and Money," which also appears in November MACLEAN'S. Mrs. McClung wrote this story with a purpose—to show the ease with which the world forgets the contribution these mothers made. But it is also a very fine story—real, human and gripping.

"The Idle Hands at Ottawa"

By J. K. MUNRO

The recent session of the Dominion House was in many respects an idle one. There was not a great deal done, so the members had a lot of time to stir up things, and the result was some hugely interesting political situations. All of which J. K. Munro tells about in his usual unsparing and tersely humorous way.

Remarkable Features of a Remarkable Number

The November MACLEAN'S is cram full of other big features—famous writers on vital subjects and everything Canadian. Look over this list:

Baroness Orczy—The author of "The Scarlet Pimpernel," best seller of best sellers, is represented by a serial story, "His Majesty's Well Beloved."

Robert W. Service.—The great poet of the Yukon and the battle front contributes a strong poem, "The Outlaw."

Basil King.—This great novelist who lives abroad contributes an interesting discussion on "Why I Remain a Canadian."

Janey Canuck.—An article on Mrs. Murphy's experiences as the first woman magistrate in the whole of Canada.

Camilla Kenyon.—A new novelist who promises to become a great favorite, tells a humorous story of adventure, and treasure, "Spanish Doubloons."

Stephen Leacock.—A humorous sketch entitled, "My Memories and Miseries as a School Master."

"Two Men and an Idea That Grew and Grew and Grew."—By Charles Christopher Jenkins.—A sketch of two remarkable and practically unknown Western millionaires.

"A Little Bit of Chicken Feed." By Allen C. Shore.—A bright story combining love and business themes.

"The Rainbow Death."—By Madge Macbeth. An interesting detective story.

"The Search for Missing Men."—By Gertrude Arnold. An article on hospital experiences at the front by a young Canadian V.A.D.

MACLEAN'S will be Twice-A-Month

starting February 1st, next year. An important point to remember. If you want to keep up with things **nationally Canadian**, you'll have to get the MACLEAN'S Twice-A-Month habit.

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It is a great pleasure to recommend any one, looking for the best babbitt metal on the market, to you. Our experience has been entirely satisfactory from every viewpoint, especially so in connection with the courteous and intelligent handling of all orders.

Cordially yours,
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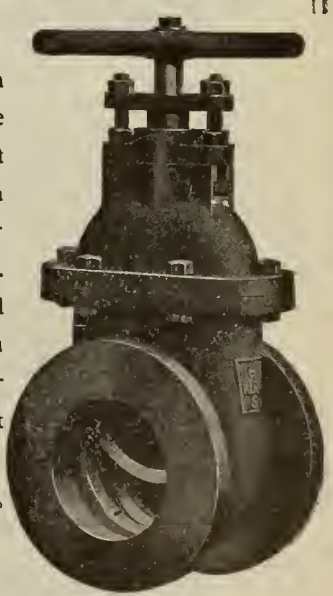

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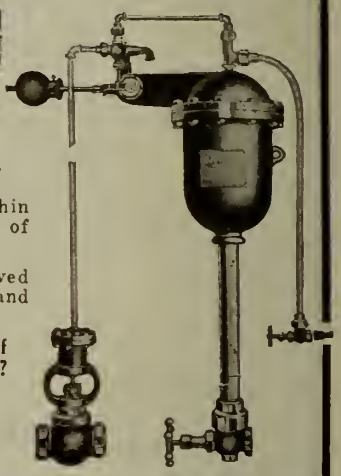

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The "Vigilant" keeps water within ¼" of middle gauge regardless of load or firing.

Years of service test has proved it the utmost in reliability and efficiency.

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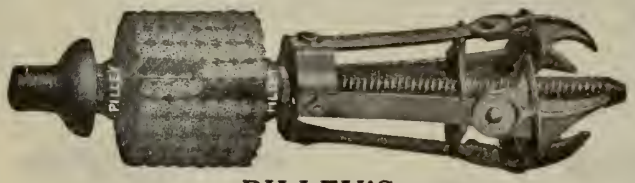

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Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
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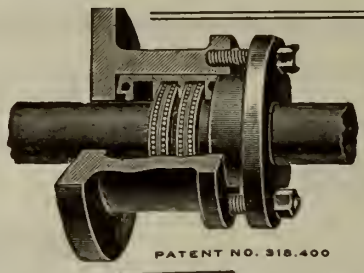

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" "	774,490	" "	898,066
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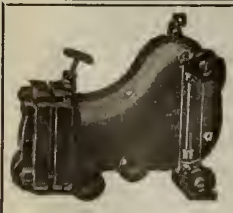

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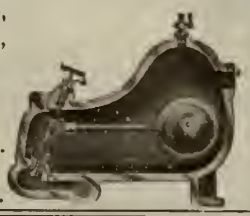

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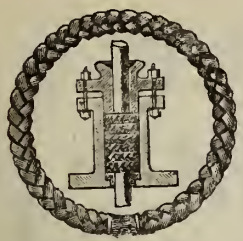

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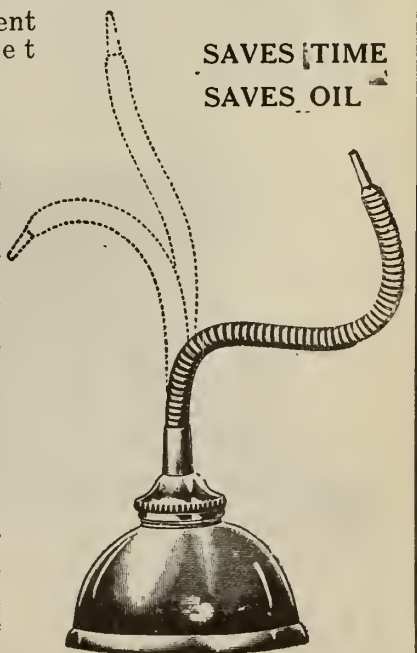

Note the flexible spout. It enables you to oil all places—many places that previously could only be reached with force pump cans with specially bent spouts.

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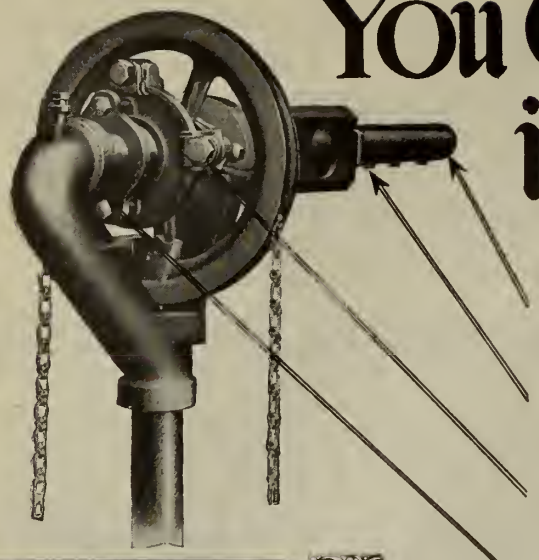


WHY?

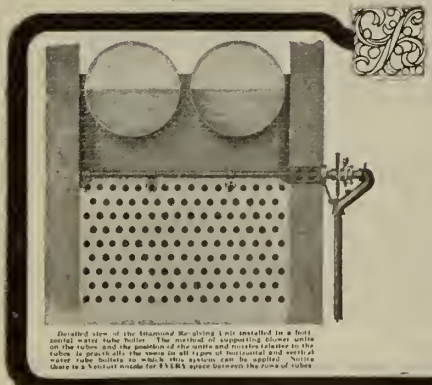
BECAUSE:

CALORIZED METAL—Blower units are constructed of metal treated by the calorizing process. This process renders the metal capable of withstanding continuous temperatures of 1800 deg. F., whereas untreated iron and steel begin to oxide rapidly at 1100 deg. F. This means that Diamond units can be placed in portions of the boiler otherwise inaccessible for cleaning.

VENTURI NOZZLES—The nozzles from which the steam issues are designed on the principle of the Venturi tube. With identical pressures steam is emitted at three times the velocity possible from a straight-walled nozzle, thus insuring the absolute maximum in cleaning efficiency.

AUTOMATIC STOPS—The range of action of the steam jets is absolutely controlled. At no time can they be directed against baffles or brick work, with consequent deterioration of the latter.

GENERAL CONSTRUCTION—Stanch, rugged, mechanically correct, Diamond Soot Blowers are noted for their dependability under all conditions of service. Mechanics, material, design have all been carried as far as they can be carried, but having been carried that far, they merge into the soot blower itself, and there the equipment stands complete, a single unit, not a list of features. Ask for Bulletin 192.



Detailed view of the Diamond Re-gining Unit installed in a bent metal water tube boiler. The method of supporting blower units on the tubes and the position of the units and nozzles relative to the tubes is practically the same in all types of horizontal and vertical water tube boilers to which this system can be applied. Notice there is a Venturi nozzle for EVERY space between the rows of tubes.

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Windsor Ontario

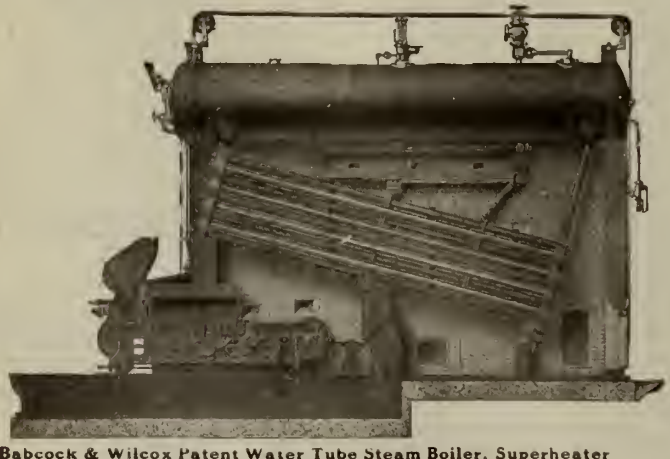
Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 20,000,000 H.P. IN USE.



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MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Can. Link-Belt Co., Toronto, Ont.

CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK AND CROSSHEAD PIN OILERS
Lunkenheimer Co., Cincinnati, O.

CRANK SHAFTS
J. H. Williams & Co., Brooklyn, N.Y.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Allis-Chalmers, Ltd., Toronto.
Jeffrey Mfg. Co., Montreal, Canada.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

CURB PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

CYLINDER OIL
E. H. Kelloey & Co., New York.

DAMPER REGULATORS
Defender Automatic Regulator Co., St. Louis, Mo.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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The Mason Regulator & Eng. Co., Ltd., Montreal
Green's Economiser, Ltd., Toronto.

DRAFT RECORDERS
Jas W. Hays Corp., Michigan City, Ind.
Defender Automatic Regulator Co., St. Louis, Mo.

DRAFT GAUGES
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Morse Chain Co., Ithica, N.Y.

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

DRY CLEANING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.

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Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

EJECTORS AND SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Jeffrey Mfg. Co., Montreal, Canada.
Can. Link-Belt Co., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont

ENAMELWARE FITTINGS, IRON PIPE
Empire Mfg. Co., Ltd., London, Ont.

ENDS, ROD AND YOKE
J. H. Williams & Co., Brooklyn, N.Y.

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Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
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Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.

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Sterling Engine Co., Buffalo, N.Y.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Montreal General Tool Co., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
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The Jeffrey Carrier
at the
UNION PACIFIC R. R.

THIS illustration shows the Union Pacific Railway Plant at Gilmore, Neb., where a 24-in. JEFFREY Improved Carrier delivers 60 tons of crushed coal per hour. The carrier also conveys ashes into a concrete bin located just inside one of the wide walls. The JEFFREY Equipment in this plant is one of the strongest links in the maintaining of its fires at a minimum cost.

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Handle it Mechanically

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THE reliability of Lunkenheimer Pop Safety Valves has been demonstrated through many years of satisfactory service, on all types of boilers.

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Mackinnon Steel Co., Ltd., Sherbrooke, Que.
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Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
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Escher Wyss & Co., Montreal, Que.
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Leonard & Sons., E., London, Ont.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar Boico Supply, Ltd., Toronto, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.
GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
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The Mason Regulator & Eng. Co., Ltd., Montreal.
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Laurie & Lamb, Montreal.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
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Graton & Knight Mfg. Co., Montreal
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.
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Babcock & Wilcox, Ltd., Montreal.
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Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.
HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.
HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber Limited, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Pratt & Cady Co., Inc., Hartford, Conn.
HYDRANTS
Kerr Engine Co., Walkerville, Ont.
HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.
HYDRAULIC MACHINERY

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

An Exchange of Money That Pays—

When you buy Victory Bonds you simply exchange one kind of money for another.

A dollar bill is Canada's promise to pay.

So are Victory Bonds.

But Victory Bonds pay 5½% interest.

Consider the security behind Victory Bonds—
Canada and all that is contained therein.

Consider the good rate of interest—5½%.
Victory Bonds pay nearly twice as much as Savings Banks.

Consider the saleability of Victory Bonds—
Their use as security for a loan—
Their prospective advancement in price—

Canada must have this money to clean up our obligations to our army and maintain the prosperity of our Country.

These are the best reasons in the world for exchanging one kind of money for another.

Every Canadian should put all his weight behind this Loan.

He should exchange every dollar possible for Victory Bonds—and every dollar he can save for the next ten months.

BUY VICTORY BONDS

Every Dollar of this Loan will be Spent in Canada

The Canadian Fairbanks-Morse Co. Limited

Halifax St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Saskatoon
Calgary Vancouver Victoria

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Scale in Your Boilers

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

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METLSKIN is neither "Compound" nor "Cure-all."

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Rochester, N. Y.

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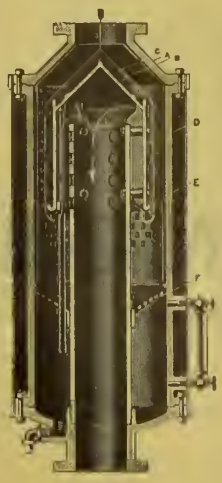
Canadian Fairbanks-Morse Co., Limited

St. John Montreal Quebec Ottawa Hamilton
Toronto Windsor Winnipeg Calgary
Vancouver Victoria Saskatoon

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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DIRECT SEPARATOR COMPANY
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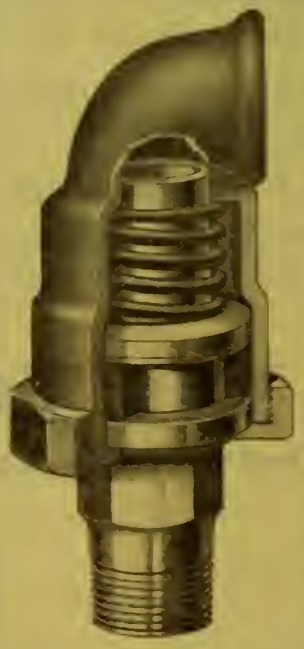

Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

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CANADIAN
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This Book Tells How

Here is a booklet that will help you to obtain actual belting economy in your plant.

It is unusually complete with descriptions, recommendations, rules and tables which will enable you to quickly determine the scientifically correct belt for any given condition.

It explains Standardization as applied to Belting, tells you how to determine the right belt for the right place on the one true economical basis—the work to be done.

Write for it—we'll be glad to send it to you.

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To .....

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EVERYTHING MECHANICAL

Why Longer Tolerate

Heater Trouble and Expense?

You do not have to put up with those bothersome and expensive repairs common to ordinary heaters. You do not have to continue paying out money for fuel just to have a considerable portion of it wasted by inefficient heaters. Then, why do you? It would pay you over and over in money saved and satisfaction gained to replace your old heaters with

Alberger Heaters are furnished in capacities from 200 to 200,000 gallons per hour.

ALBERGER
MULTI-
HEAD
HEATERS

Once you do, you will never experience the cost and trouble of repairing internal defects, such as leaks, split tubes, cracked heads, etc. Nor will you ever have occasion to wait for hot water. We would like to explain fully. **May we?**

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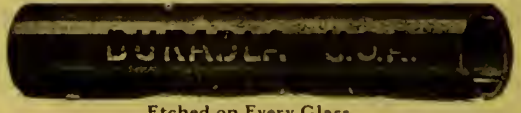
DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY



Etched on Every Glass

DURABLA HIGH PRESSURE GAUGE GLASS

The method of determining the fact that DURABLA American made high pressure gauge glass possessed the elastic properties necessary to withstand sudden and radical changes of temperature was explained in detail last week.
DURABLA U.S.A. glass which had passed the severe change of temperature test was next subjected to live steam to determine whether it would remain clear. After ninety-six (96) hours in a steam digester in which live steam was constantly passing through the glass at a pressure of one hundred (100) pounds, no erosion could be detected, and the glass was as clear as when first applied.
DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

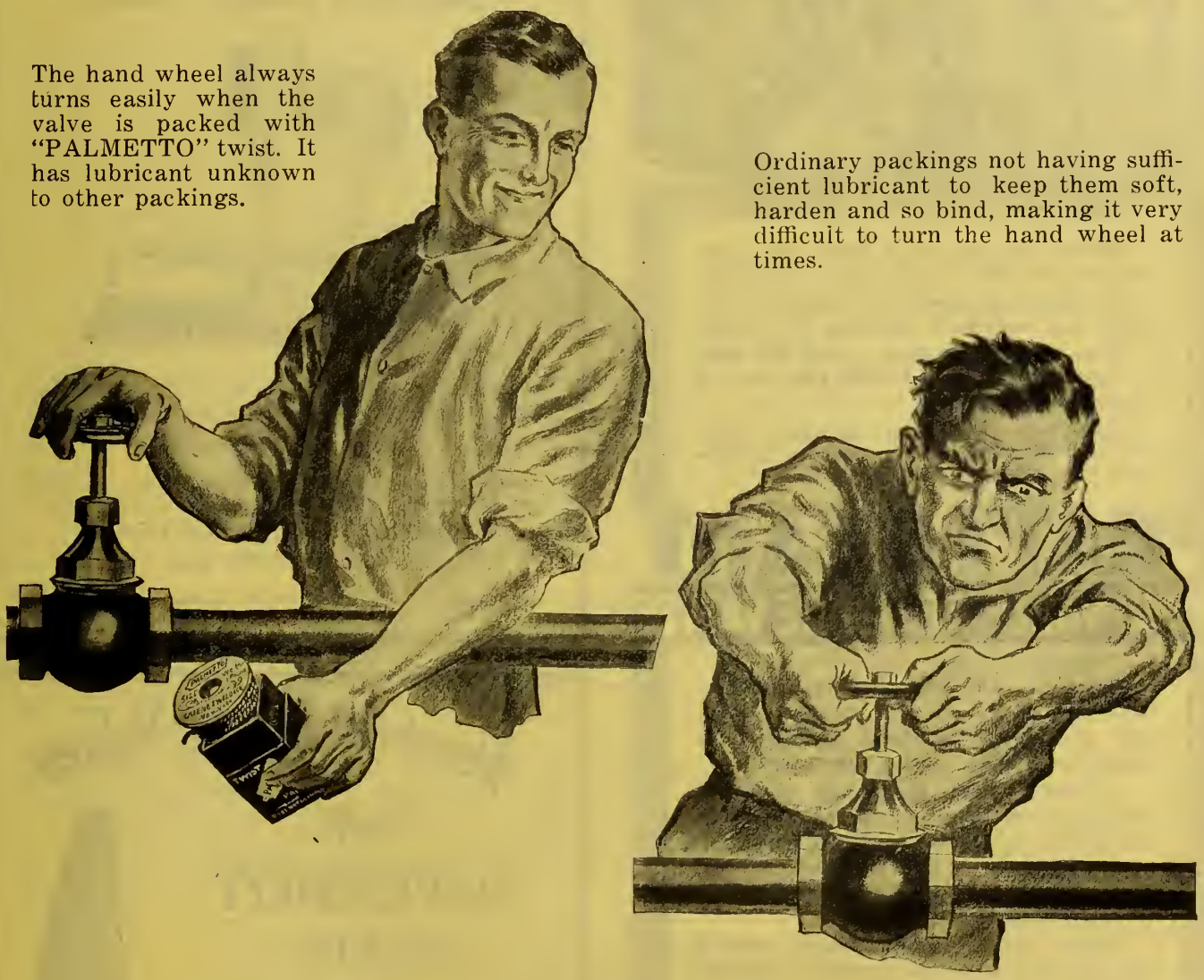
CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

STOP AND CONSIDER

why the hand wheel of a globe valve is so often hard to turn. It's because the packing has not sufficient lubricant to prevent its leaking.

The hand wheel always turns easily when the valve is packed with "PALMETTO" twist. It has lubricant unknown to other packings.

Ordinary packings not having sufficient lubricant to keep them soft, harden and so bind, making it very difficult to turn the hand wheel at times.



TRADE MARK

"PALMETTO" TWIST PACKING

REG. U.S PAT. OFFICE

is made to give long satisfactory service in globe and other small valves.
The materials of which it is made are heat resisting and perfect lubrication of each single strand prevents hardening.

Any size valve may be packed from one spool by unstranding.

GREENE, TWEED & CO.,
Sole Manufacturers
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Let us send you a sample spool to test.

CANADIAN
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EVERYTHING MECHANICAL

When the seat of a Pratt & Cady Renewable Seat Gate Valve becomes worn, you can insert new bronze seat rings in a very few minutes. The valve is then as good as new. And the cost is nominal compared with the cost of a new valve.

Anyone with a wrench can easily make this change. There is nothing to become loose or drop out and obstruct the line.

PRATT & CADY
RENEWABLE SEAT GATE VALVES

The gate in these valves is a double-faced, wedged-shaped casting with side grooves, by means of which it slides on guides in the valve body.

Guides in the body are of equal thickness and the wedge can be taken out of the valve and replaced with the opposite faces in contact and give an accurate fit. In making repairs this is important.

These valves being double seated can be used with the pressure applied at either end.

Gauges are used in machining all parts to insure accuracy and interchangeability.

Made of bronze and iron in all sizes. Adapted for steam, air, oil, gas or water service.

Large stock at branches insures prompt service.

May we send you our Catalog?

PRATT & CADY CO., INC.
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Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Power Pumps and Asbestos Packed Cocks.

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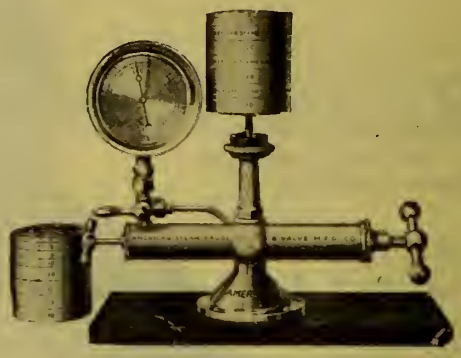
THE AMERICAN DEAD WEIGHT GAUGE TESTER

Simplifies Gauge Testing



Especially adapted to shop and engine room testing. Check your own gauges.

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THE SUPERHOT GRADE

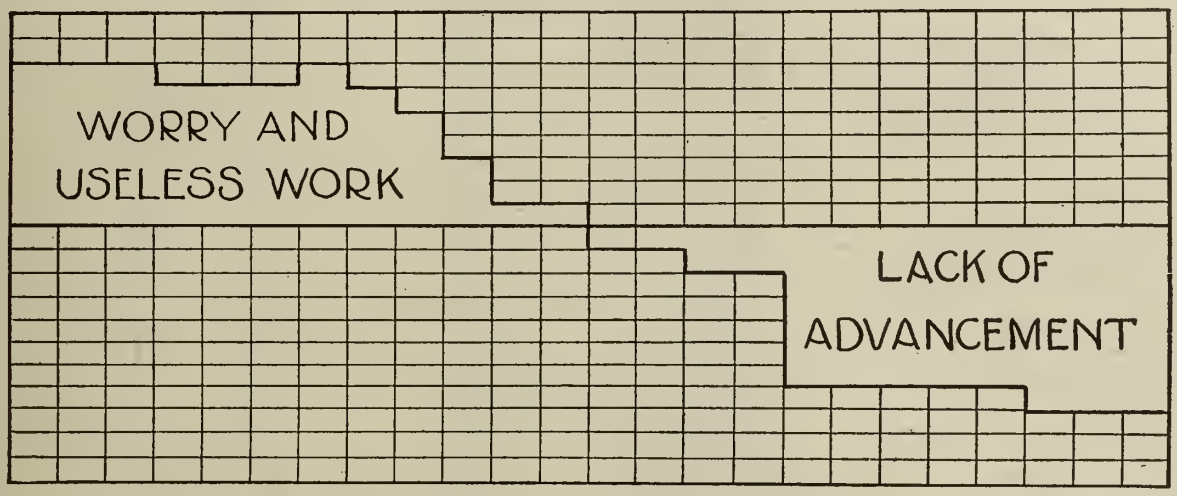
for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

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Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

Starrett
Hack Saw Chart
MATERIAL TO BE CUT
No. of Blade for Power Machine
Light Machine
Medium Machine
Heavy Machine
Light Angles Channels Tee Iron Ornamental
Heavy Angles Channels Tee Iron
Light Structural
Heavy Structural
Steel and Iron Pipe Conduit and Brass Pipe
Solid Stock Cold Rolled Machine Steel
Tool Steel Cast Iron
Brass
CUT THE CHEAPEST WAY
Use the right Starrett blade and remember the importance of gradually increasing the weight or pressure as the number of cuts increase. As soon as the blade is "eased" into the cut put on enough weight to keep the blade cutting at its maximum efficiency. The safe way is to follow the Starrett Chart. Send for Catalog and Chart "CD."
42-969
Get the Starrett Hack Saw Booklet—Sent Free
THE L. S. STARRETT CO., ATHOL, MASS., U. S. A.
THE WORLD'S GREATEST TOOL AND HACK SAW MAKERS

A Continent-Wide Service

MACGOVERN & COMPANY POWER MACHINERY

In Stock for Immediate Shipment

ALTERNATING CURRENT GENERATORS
Convertible to
SYNCHRONOUS CONDENSERS

3 Phase, 60 Cycle.

K.W.	K.V.A.	VOLTS	SPEED	MAKE AND TYPE.
	30	2300	1200	WESTINGHOUSE—G.
	30	2300	1200	FAIRBANKS-MORSE—A.B.
45		1100	900	WARREN ELEC.
45		240	1200	GENERAL ELECTRIC—ATB.
	50	2300	300	FAIRBANKS-MORSE—D.
50		2300	1200	GENERAL ELECTRIC.
50		2300	1200	ALLIS-CHALMERS.
50		240	1200	
50		550	1200	CAN. GEN. ELEC.—ATB.
60		2200	600	WARREN ELEC.
62½		2200		CAN. GEN. ELEC.
	75	2200	900	BULLOCK.
75		2300	900	GENERAL ELECTRIC—ATB.
80		240	900	ALLIS-CHALMERS.
	90	2300	900	ELECTRIC MACHINERY.
100		240	900	GENERAL ELECTRIC.
100		550	900	CAN. GEN. ELEC.—ATB.
100		600	900	GENERAL ELECTRIC—ATB.
100		2200	900	BULLOCK ELECTRIC.
100		2300	900	GENERAL ELECTRIC—ATB.
110		2200	600	WESTINGHOUSE.
	150	220	900	WESTINGHOUSE.
	150	1200/2400	900	WESTINGHOUSE.
150		2300		GENERAL ELECTRIC.
150		2300	600	WESTINGHOUSE.
150		2300	450	WESTINGHOUSE.
150		2300	514	GENERAL ELECTRIC—AT.
165			225	WESTINGHOUSE.
	200		600	GENERAL ELECTRIC—ATB.
200		2400	600	ROYAL ELECTRIC—SK-C.
220 H.P.		2200	600	GENERAL ELECTRIC—ATL.
	240	2300	600	ALLIS-CHALMERS

K.W.	K.V.A.	VOLTS	SPEED	MAKE AND TYPE.
	250	480	600	CROCKER WHEELER.
250		2300	600	GENERAL ELECTRIC—ATB.
	300	2300	164	FORT WAYNE.
300		550	600	WESTINGHOUSE.
	312½	2300	600	ALLIS-CHALMERS-BULLOCK.
325		2200	164	WESTINGHOUSE.
450		2400	360	STANLEY
460 H.P.		2200	187½	GENERAL ELECTRIC—ATB.
500 H.P.		2200	240	GENERAL ELECTRIC—ATI.
500		2300	400	GENERAL ELECTRIC—ATB.
540		2300	360	GENERAL ELECTRIC—ATB.
560 H.P.		480		WESTINGHOUSE.
	600	600	257	WESTINGHOUSE.
600		2300	225	GENERAL ELECTRIC—ATB.

2 Phase, 60 Cycle.

72		2400	1000	CANADIAN GENERAL ELECTRIC.
	75	2300	900	CROCKER WHEELER.
120		440	720	WESTINGHOUSE.
150		2200		BULLOCK.
180		440	514	WESTINGHOUSE.
	200	1150	720	GENERAL ELECTRIC—AQB.
400		2200	450	WESTINGHOUSE.
	450	2400	360	GENERAL ELECTRIC.
	533	200		BULLOCK.
	600	440	360	CROCKER WHEELER
1000 H.P.		2200	300	GENERAL ELECTRIC—AQB.

3 Phase, 25/30 Cycle.

125		220	257	CAN. GEN. ELEC.—ATB.
	150	2300	500	GENERAL ELECTRIC—ATI.
160		440	750	GENERAL ELECTRIC—ATB.
300		6600	375/450	WESTINGHOUSE.
425		2300	500	WESTINGHOUSE.
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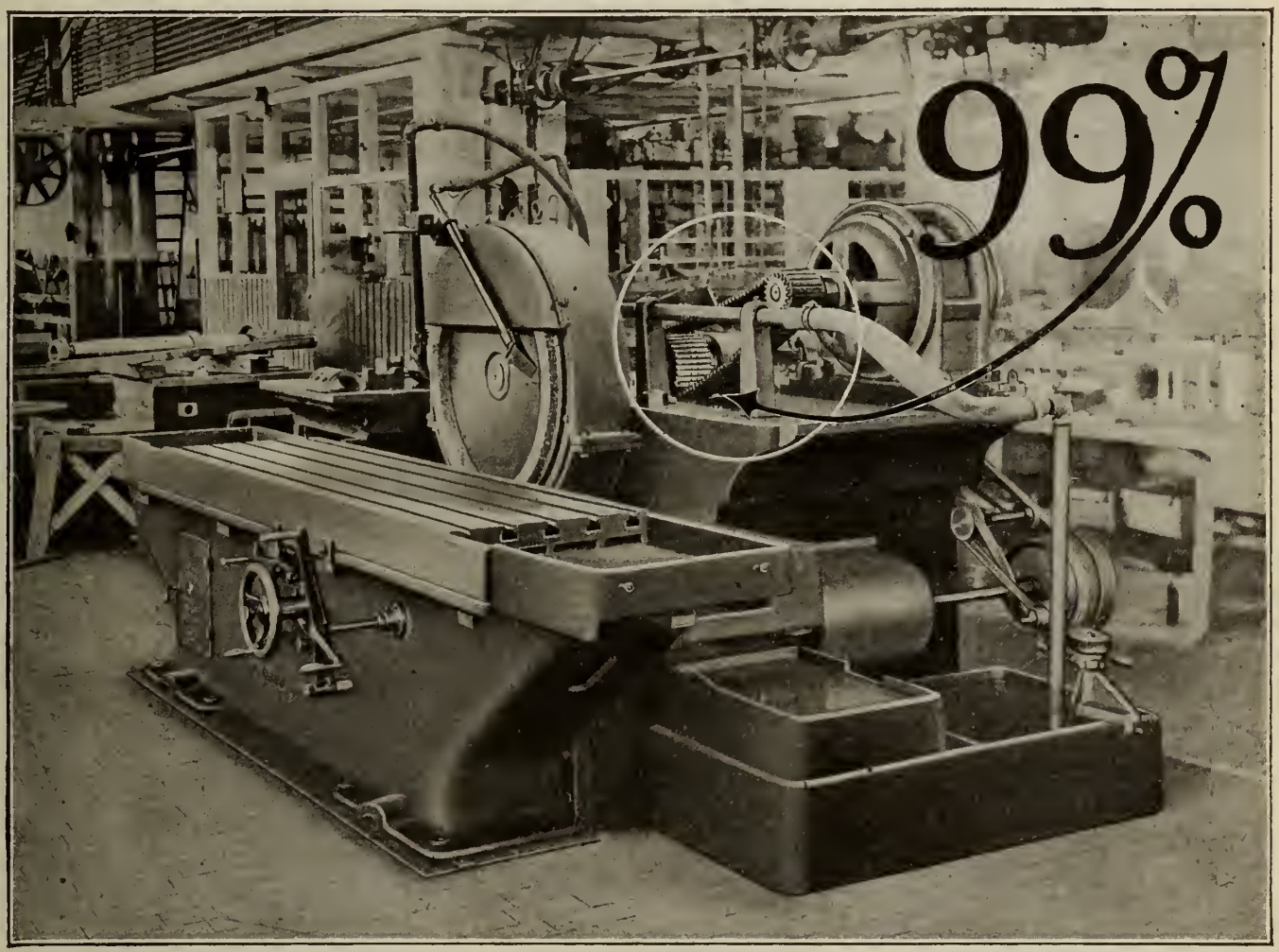

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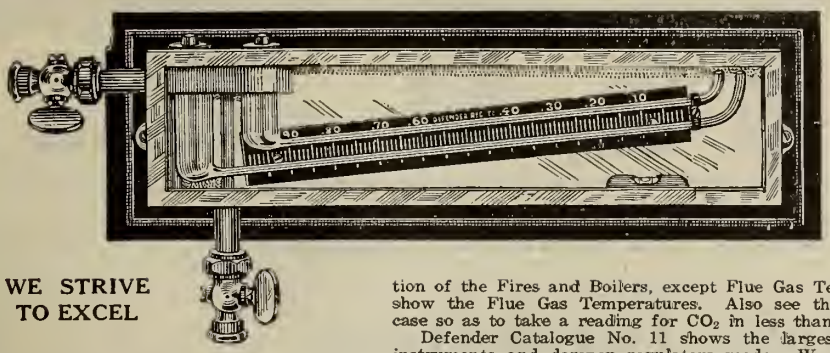

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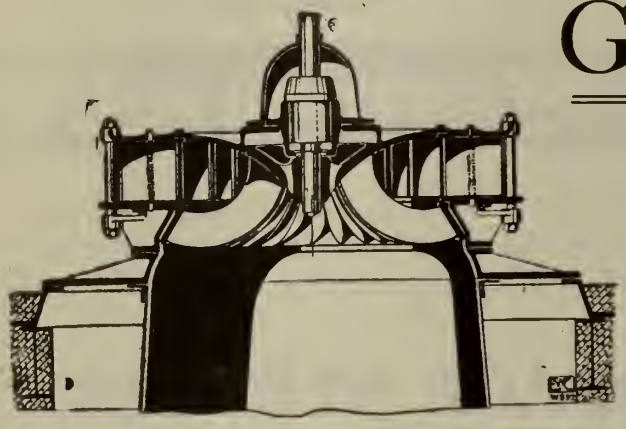

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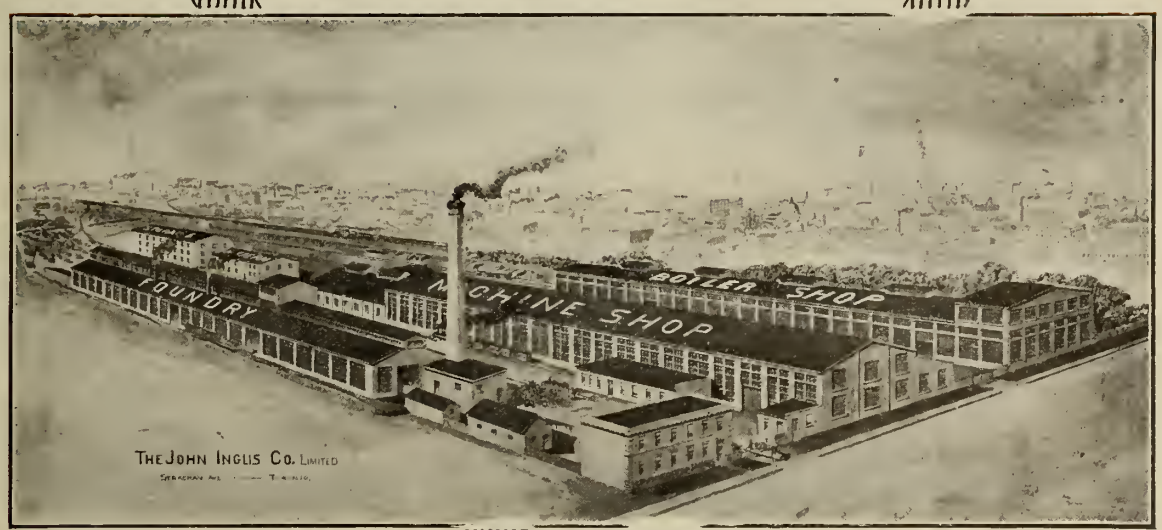

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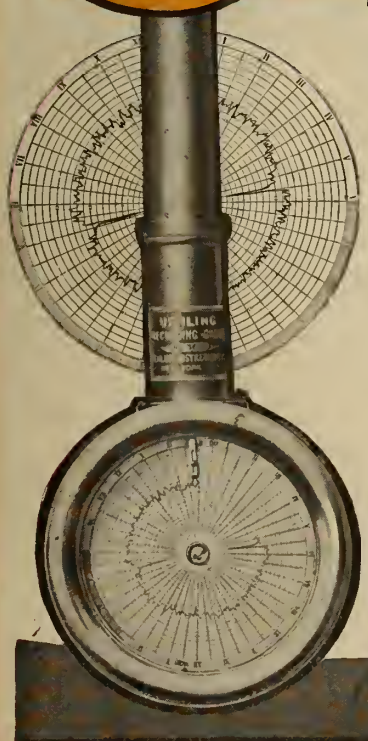

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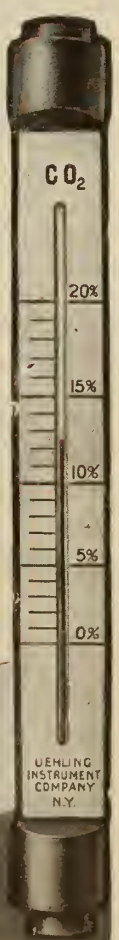

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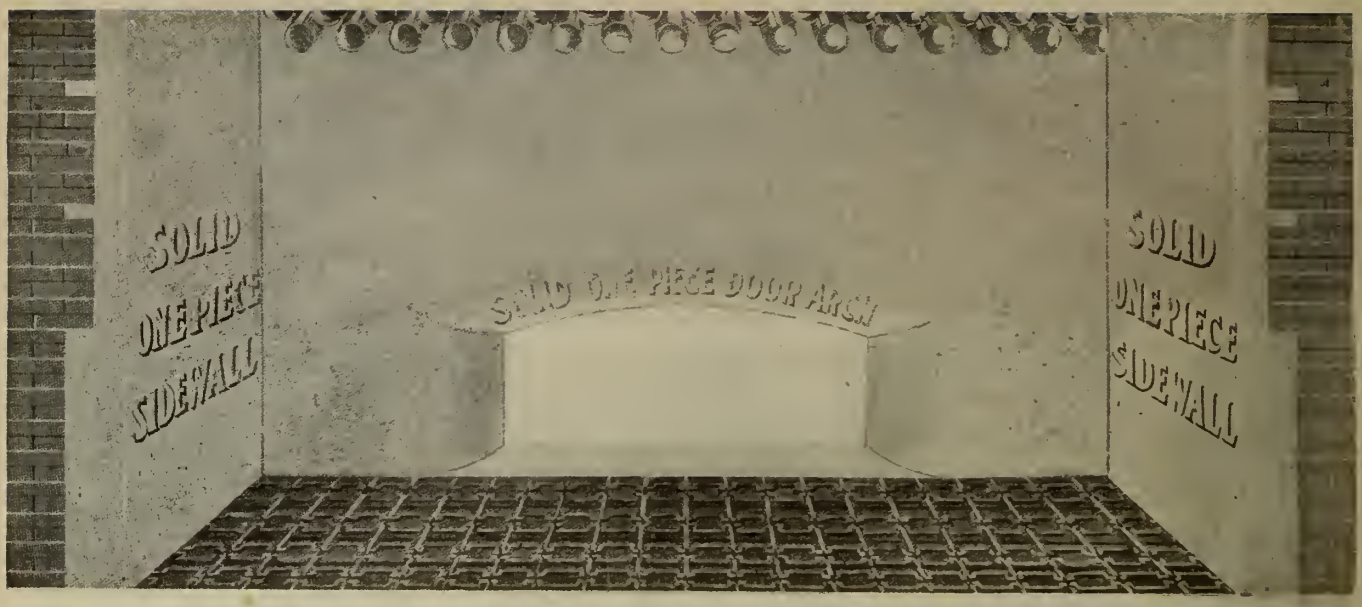

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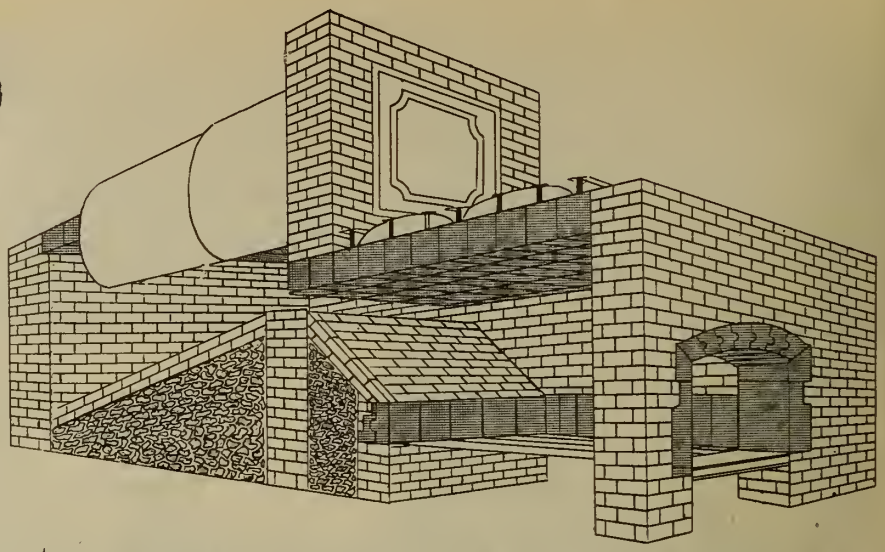

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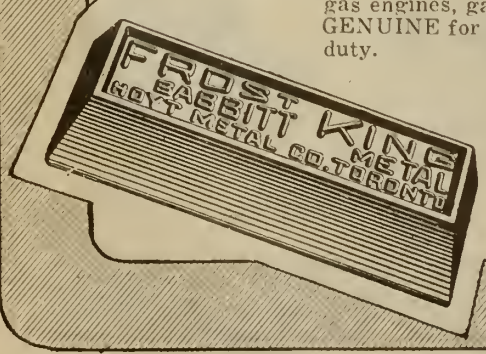

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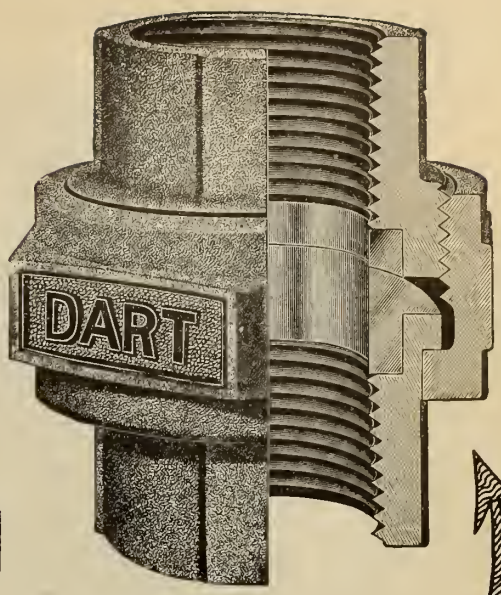
Regardless of Alignment of the Pipe



Dart Unions are the exclusive product of a firm that has been manufacturing nothing else but pipe couplings for over a quarter of a century. They get our entire attention in construction, which accounts for their remarkable accuracy.

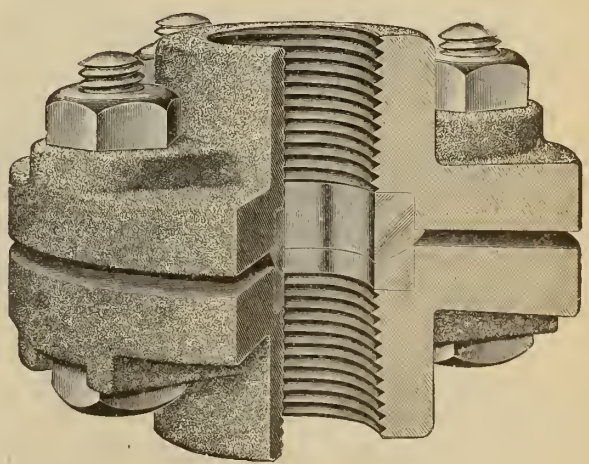
DART Union Pipe Coupling

DART

Trade Mark

Face and Seat are BRONZE

This means no deterioration



The Bronze to Bronze feature, together with the Extra Heavy Malleable Iron Pipe Ends and Nut make loosening up in service **impossible.** The Ground Ball Joint makes easy the connecting of pipes, regardless of their alignment.

Absolutely guaranteed.

ORDER FROM YOUR JOBBER.

Manufactured by Dart Union Co., Limited, Toronto, Ont.

When considering Boilers, don't forget the CONNELLY WATER TUBE BOILER. Can be built up to 4000 H. P. in one unit, being designed to give the greatest power in the smallest cubical space. Let us give you information on this boiler.

RETURN TUBULAR BOILERS -- TANKS -- STEEL STACKS

Manufactured by E. LEONARD & SONS, London, Ont.

TORONTO OFFICE:

E. J. PHILIP & SONS

57 Queen St. West, Toronto, Ont.

Temperature and Pressure Controllers

Recording and Indicating Instruments

Republic Flow Meters for Steam, Water, Air or Gas

Water Filters and Softeners

Anderson Steam Specialties, Traps, Separators, Filters

DURABLA

TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

DURABLA HIGH PRESSURE GAUGE GLASS

In previous issues severe tests have been detailed in proof of the fact that DURABLA American made high-pressure gauge glass possesses the elasticity necessary to withstand sudden and radical changes of temperature, and, furthermore, that it will remain clear.

It was considered desirable next to know what the strength of DURABLA U.S.A. glass would measure after having been subjected to the strain of the tests already mentioned. Unusually high tensile strength was proved by the fact that the glass remained unbroken after hydraulic pressure of over two thousand (2,000) pounds per square inch had been applied for two minutes.

DURABLA U. S. A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

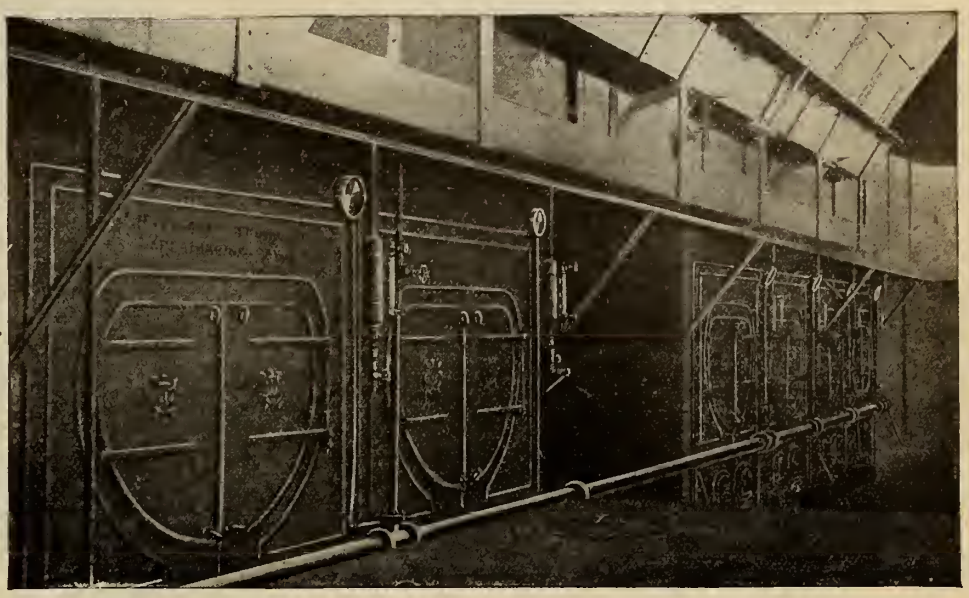
DURABLA

We Say: "Try Us!"

For your next boiler equipment.

We make boilers in all types--with the best of materials--including Brains.

35 years at it.



Engineering & Machine Works of Canada, Limited

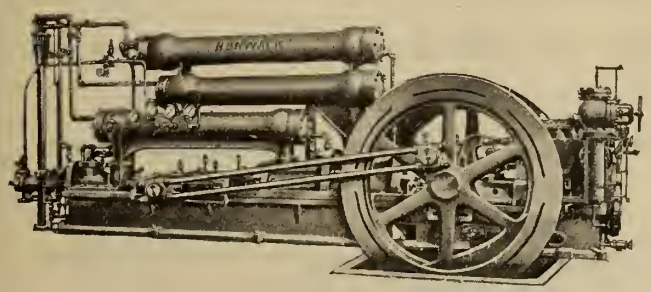
ST. CATHARINES, ONT.

Eastern Sales Offices : Hall Machinery Co., Sherbrooke, Que.

NORWALK

AIR & GAS · COMPRESSORS

Users in Every State in the Union



24-Inch large four-stage, single steam cylinder-driven air compressor

agree that Norwalk compressors do the work for which they are designed and sold—and continue doing it far beyond the length of life expected of them by the users.

It is this combination of operating efficiency and durability that has made the Norwalk name the synonym for maximum satisfaction wherever compressors are used.

The Norwalk line covers all compressing requirements. Send for literature on either gas or air models.

THE NORWALK IRON WORKS COMPANY

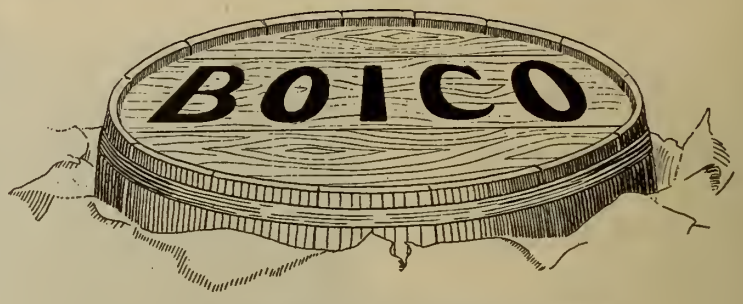
Pioneer Builders of Compressors

South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.



Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**
BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

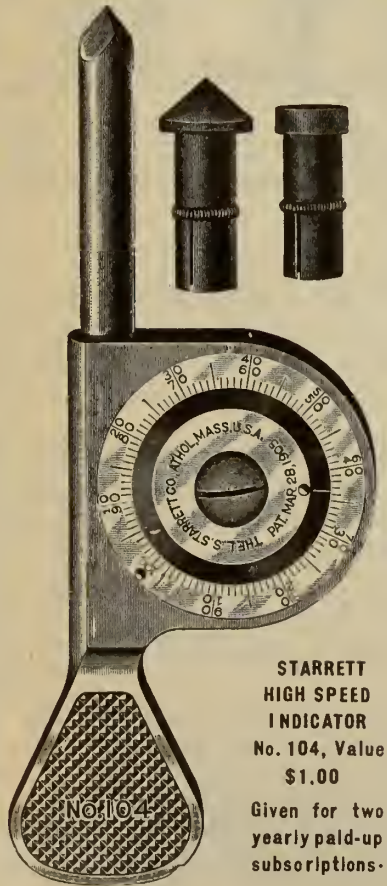
Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 376 Dufferin Street **Toronto**

Eastern Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec



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if you are a subscriber to "POWER HOUSE." If you are not a subscriber, send in your own subscription together with two others, and the indicator you are entitled to will be mailed to you immediately.

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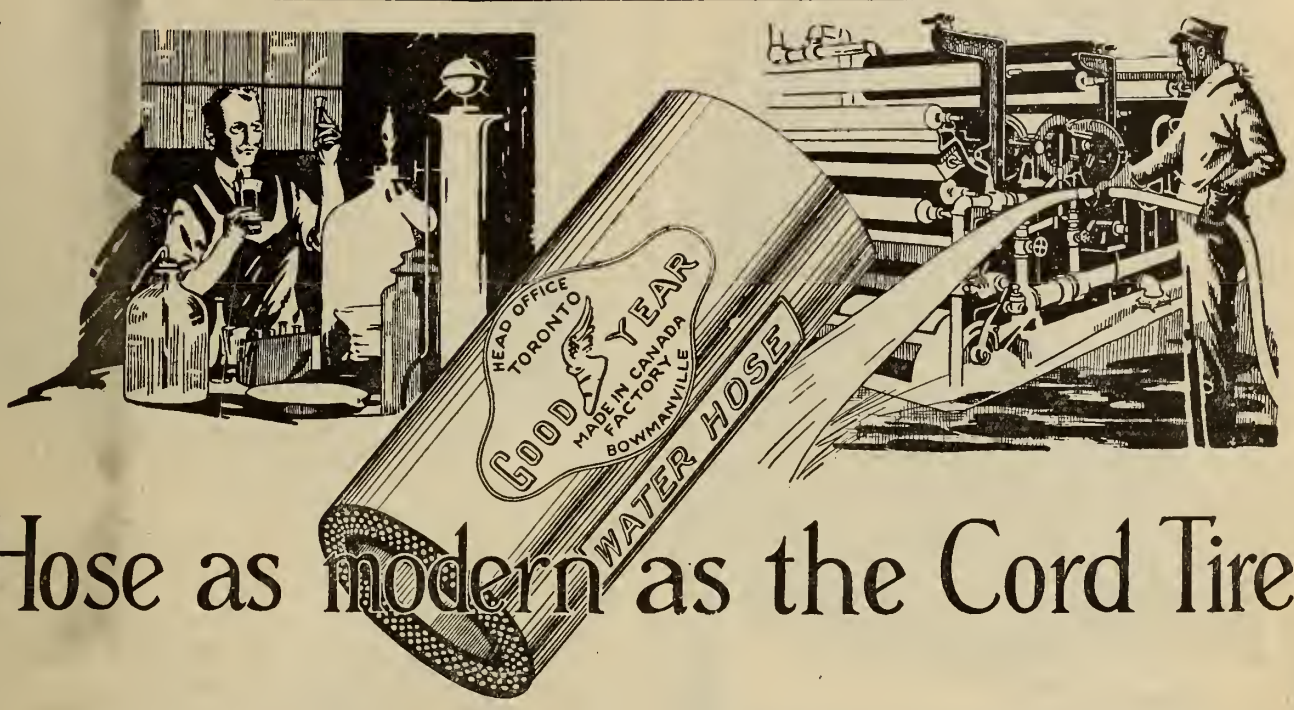
"POWER HOUSE" is designed to give Canadian Engineers, Superintendents and Power Users all the latest and best information in the engineering field. A little work among your engineer friends and acquaintances will earn for you this handy indicator without any trouble. Try it and see how easy it will be.

PUBLISHED MONTHLY AT $1.00 PER YEAR
Start in TO-DAY to earn one of these Handy Tools

POWER HOUSE 143 University Ave., **Toronto**



Hose as modern as the Cord Tire

Go back to the days before Goodyear undertook to produce better hose, and you will find that rubber hose was built in much the same way that most hose is to-day.

An old-fashioned product. Good enough for those times, perhaps, but inadequate to meet modern standards of efficiency.

Goodyear opened a new era in the industry. Goodyear disregarded tradition. Goodyear's engineers started from the ground up to build hose of modern efficiency to meet modern needs.

The inevitable result of such methods was the development of better materials and improved hose construction.

Old ideas and old methods were forgotten. Goodyear Hose was built as if hose had never been built before. Modern industry's hose needs was the standard built to.

Is it any wonder, then, that the quality of Goodyear Industrial Hose dominates as does the quality of Goodyear Cord Tires?

Is it any wonder that Goodyear Hose gives longer, more satisfactory service and costs less in the end?

Goodyear builds a particular hose for every industrial purpose—water, steam, pneumatic tool, air drill, railway, fire, suction, and so on.

Let a man trained by Goodyear study your hose problem. Phone, wire or write the nearest branch.

The Goodyear Tire & Rubber Company of Canada, Limited

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Calgary, Edmonton, Vancouver.

GOODYEAR
MADE IN CANADA

INDUSTRIAL HOSE

Why you get

better service from LUNKENHEIMER "VICTOR" GATE VALVES

THE disc is a solid wedge, seating on rings which are threaded into the body in exact alignment with the disc faces; the disc is guided by ribs cast in the body, and travels to practically a closed position before coming in contact with the seatring faces. "Dragging" of the disc across the seatring faces is thereby eliminated, preventing the wear so prevalent in valves employing loose parts.

When wide open the top of the disc seats directly beneath the stuffing box, relieves the packing from pressure and permits repacking while pressure is on.

The gasket between the body and bonnet flanges is an exclusive Lunkenheimer feature. It consists of a seamless copper wire partly embedded in a groove in the body flange; will not blow out and is practically indestructible.

Bearings are bronze bushed and all parts, including the seatrings, are renewable.

Inside Screw Stationary Stem and Outside Screw and Yoke Rising Stem types for working steam pressures up to 350 pounds.

Installing Lunkenheimer "Victor" Gate Valves means permanence and satisfactory service.

THE LUNKENHEIMER CO.
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

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WRITE FOR DESCRIPTIVE LITERATURE

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This Book Tells How

Here is a book that will help you to obtain actual belting economy in your Plant.
It explains Standardization as applied to Belting, tells you how to determine the right belt for the right place on the one true economical basis—the work to be done.

Write for it—we'll be glad to send it to you.

Canadian Graton & Knight, Limited
MONTREAL, CANADA
Oak Leather Tanners, Makers of Leather Belting and Leather Products
Branches and Distributors in Principal Cities.

No Pressure Loss

Full Pipe Area. No Obstruction Smooth Passage. Opened by Quarter-turn.

HOMESTEAD

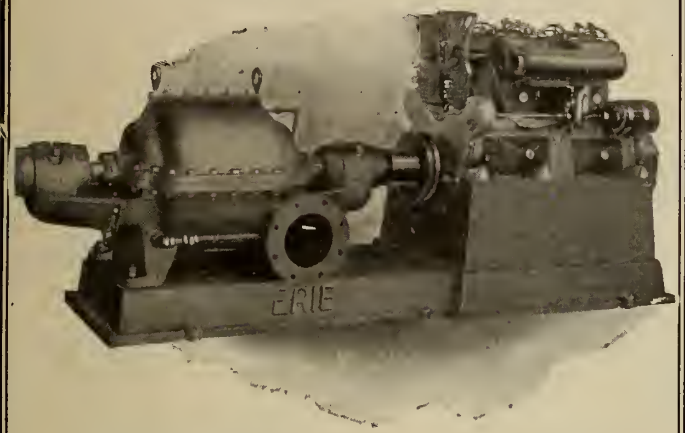
QUARTER-TURN VALVES

Free unobstructed pipe area offers practically no resistance to the flow in Homestead Quarter-Turn Valves—there is no PRESSURE DROP. Seatless Construction eliminates usual scoring and wear under pressure, insuring maintained tightness for long periods of operation. **Let us explain its several other cost-cutting features—write now.**

Homestead Valve Mfg. Company, Homestead, Pa.

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

Adequate Fire Protection

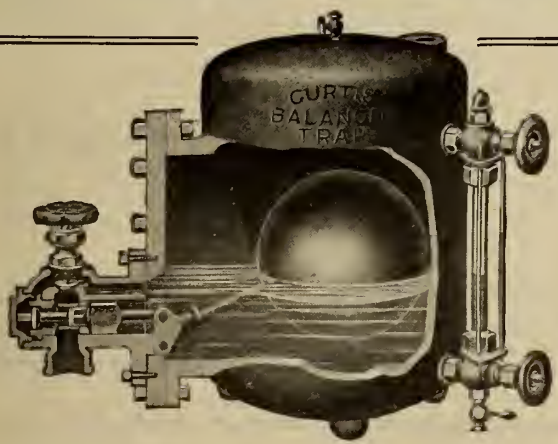


Sterling Model FC 4-cylinder engine direct connected to Erie Pump Company's centrifugal fire pump for U.S. Navy, capacity 750 gallons per minute, 3 1-⅛" streams.

The property loss in a single fire usually far exceeds the price of a Sterling powered pump.

STERLING ENGINE CO. Dept C4 **Buffalo, N.Y.**
12 to 300 H.P. Commercial and Marine

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

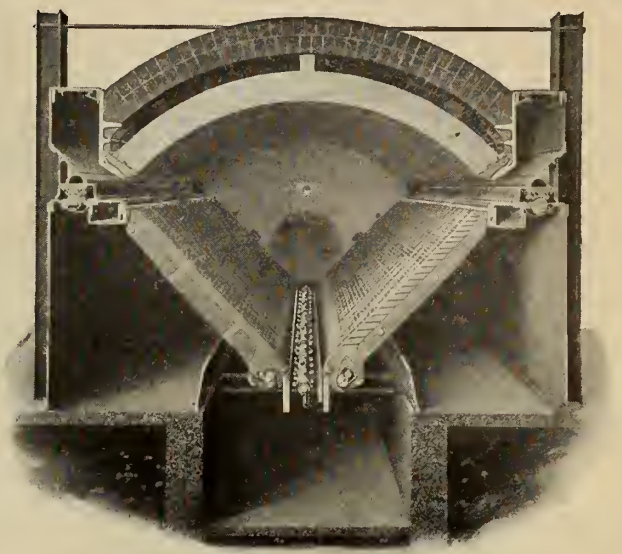
Write for 1919 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 Barclay St., New York City; 174 N. Market St., Chicago, Ill.

MURPHY AUTOMATIC FURNACES



For Any Boiler

50 h.p. and Up

Any boiler from 50 h.p. and up, can be equipped with the MURPHY FURNACE, The *smaller plant* can therefore enjoy all the economical advantages of fuel and labor savings *without resorting* to forced draft.

To-day over *6000 boilers* are fired by MURPHY FURNACES. You will find them used in nearly every branch of the industry from hospital to industrial and central station service. MURPHY FURNACES "burn any fuel that has heat in it." They double the output of the plant "without one penny for draft."

Our Catalogue "H M-11" shows how MURPHY FURNACES can be installed under any type of boiler—50 h.p. and up.

For information on RILEY UNDERFEED STOKERS for large boilers see June 5th advertisement or send for RILEY STOKER Catalogue "HR-11."

MURPHY IRON WORKS
DETROIT MICH. U. S. A.

York Refrigerating Machinery

QUALITY—SERVICE

From the very beginning we have been building **quality** and **service** into our Refrigerating Machines. This has resulted in increasing sales of our products and increasing satisfaction on the part of our customers.

With a York Refrigerating Plant you can improve the quality of **your** product as well as the measure of service **you** render to your trade.

Any firm that installs a Refrigerating Plant is looked upon by the trade it serves as a progressive firm. Give MECHANICAL REFRIGERATION a chance. In these days of keen competition it is the progressive owner who survives and profits.

Write us for information and prices.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY

YORK, PA.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard S TORONTO, 82 Chestnut St. MONTREAL, 324 Craig St. West CALGARY, 605 Second St.

Efficiency

In Power Plant Equipment
and Service—that's our Policy.

Study POWER HOUSE advertising and editorial pages—brimful of latest technical and new equipment information. Keep thoroughly up-to-date and you'll profit.

SPECIAL Send in **your** subscription to-day for any number of years at the remarkable rate of **$1.00 Per Year.**

IMPERIAL

Lubricants

For Manufacturing, Mining and Milling

CYLINDER OILS

Imperial Valve Oil
Imperial Cylinder Oil
Imperial Capitol Cylinder Oil
Imperial Beaver Cylinder Oil
Imperial 20th Century Cylinder Oil

ENGINE OILS

Imperial Kearsarge Engine Oil
Imperial Solar Red Engine Oil
Imperial Atlantic Red Engine Oil
Imperial Junior Red Engine Oil
Imperial Bayonne Engine Oil
Imperial Renown Engine and Dynamo Oil
Imperial Standard Gas Engine O I
Imperial Arlo Compressor Oil

Greater Power at Smaller Cost

REDUCE the friction load in your plant and get maximum power from every ton of fuel. Reduced friction also lengthens the life of machinery and adds to profit by reducing repairs and replacements and by a greater continuity of production.

Bigger and more dependable output from power-generating and power-using machinery is largely a matter of lubrication—*correct* lubrication, and *correct lubrication means good lubricants and the right one for each lubrication need.* Even lubricants of highest quality, like Imperial Lubricants, will not give the desired results unless they are properly applied.

Imperial Lubricants are right. They are carefully formulated from the best crudes. There is the *right* lubricant for the correct lubrication of every part and every machine under every service condition.

There are none better at any price. The use of Imperial Lubricants will make and keep your machinery efficient and capable of delivering maximum power at least cost per h. p. hour.

Consultation with Imperial Lubrication Engineers is yours for the asking. They will gladly study your lubrication problems and submit recommendations. Write to 56 Church Street, Toronto, or any of our branches.

IMPERIAL OIL LIMITED

Power · Heat · Light · Lubrication

BRANCHES IN ALL CITIES

Burn Low Grade Coal CUT FUEL COSTS Burn Refuse

This winter high-grade coal promises to be scarcer than ever, thus higher priced. Many power plants will have to substitute low-grade fuel and to many this will mean the installation of extra boilers to supply the required steam.

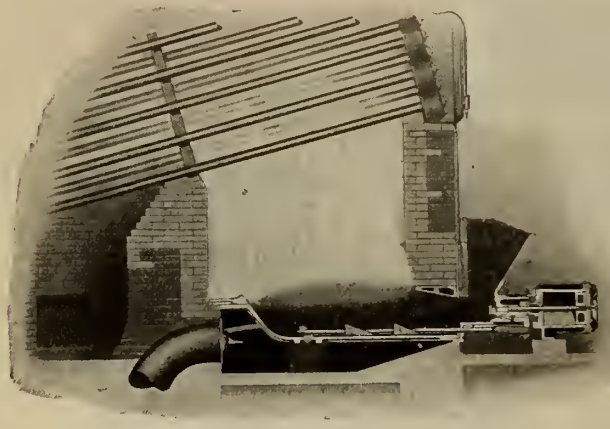
"Jones Underfeed Stokers" will burn low-grade fuel, keeping up your steam pressure and meeting your peak loads without installing extra boilers.

We furnish special stokers to burn Lignite

SMOKE ABATEMENT

The "Jones Stoker" assures proper combustion of fuel which means that the stack will be free from smoke.

The Jones simple construction means durability, no parts move in contact with the fire—no grates to burn out—no sifting of fine coal to the ash pit.



A Jones Underfeed Stoker setting under Water Tube Boiler.

The Jones Underfeed Automatic Stoker

pioneered and developed commercially the Underfeed principle of firing, which is to-day recognized as the most efficient method of stoking.

FACTS AND FIGURES ON REQUEST.

Jones Underfeed Stoker Co.
Limited
37-41 Britain St. - Toronto, Ont.

Dominion Belting Company, Limited
Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber or Balata, as well as our own make.

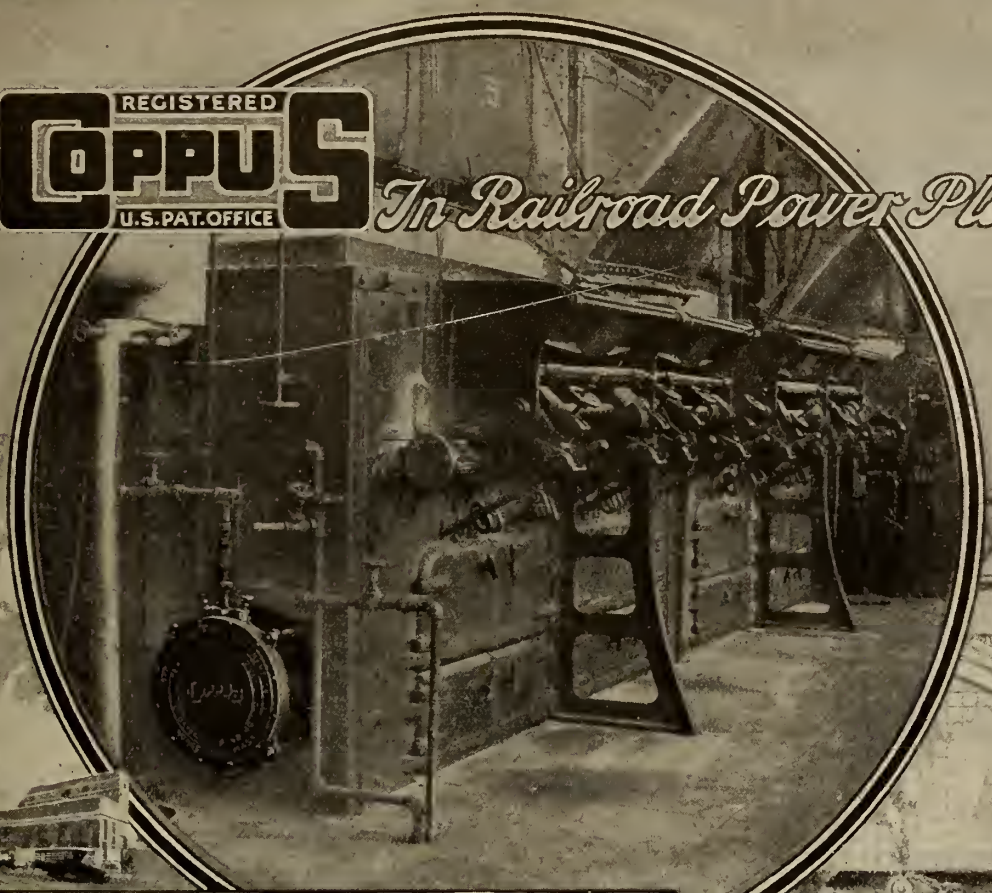
Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO. Ltd., Hamilton, Canada-Quebec Branch: 51 Duluth Bldg., Montreal

REGISTERED COPPUS U.S.PAT.OFFICE

In Railroad Power Plants

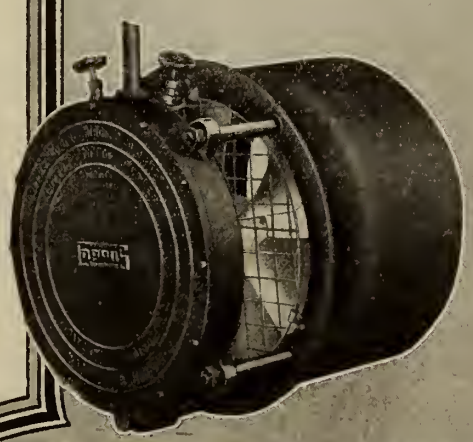


Railroads are sticklers for efficiency. Equipment approved by them must produce results — save money — earn dividends. The fact that the Central Railroad of New Jersey operates twenty-six COPPUS Turbo Blowers in their great shops at Jersey City —proves that these blowers **pay.**

Every one of this big battery of blowers—one of which is shown above—has cut coal costs—reduced labor charges—and saved dollars. In this power plant—as in thousands of others—COPPUS Blowers keep up steady steam pressure—prevent clinkering—meet peak loads quickly—and burn cheap fuel.

COPPUS Blowers **pay** a profit to the Central Railroad of New Jersey. They can do as much for you. Why not put them on the job? Catalog H-16 will show you how

"COPPUS Equipment can Save You Money"



THE COPPUS ENGINEERING & EQUIPMENT CO.

Mfgs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine

341 Park Ave., Worcester, Mass.

Agents for Montreal: Mason Regulator and Engineering Co. Agents for Winnipeg: Parkhill & Hanson, 905 Confederation Bldg. Agents for Toronto: Arthur S. Leitch Co., 1001 Kent Bldg.

COPPUS TURBO BLOWER

Jenkins Bros. Valves

They Stay Tight

When the power house superintendent makes an inspection of the pipe lines he tests the valve bearing the Jenkins Bros. Diamond trade mark with a smile of confidence. He knows from experience, that above all things it can be depended upon to STAY TIGHT. Only valves of highly scientific design and quality construction can be depended upon to stay tight under severe conditions — Jenkins Bros.' Valves are made of first-class material by workmen who know Valve requirements.

Furnished in brass or iron body, in globe, angle, cross, check, Y or blow-off, hose whistle and other patterns.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street, Montreal, Canada

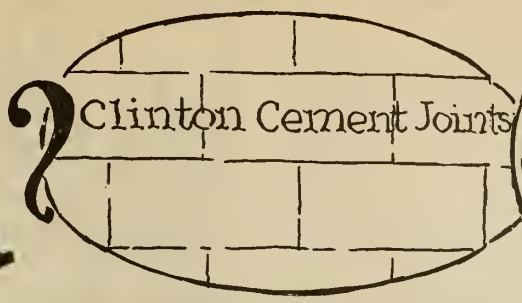
Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway London, W.C. 2, England

TRADE JENKINS MARK Jenkins Bros

Catalogue No. 8 free on request

Which ?



CLINTON CEMENT

FIRE clay dries up and sifts out from between the bricks like powder, causing the escape of hot air and interfering with proper combustion by cold air leakage.

Clinton Cement Saves Fuel and Increases Boiler Furnace Efficiency

It makes joints that stay tight. Sets and makes a surface like glass yet allowing for expansion and contraction. Stands a heat up to 3,000 degrees Fahrenheit.

Try it once and you always want it.

A five-pound tin of **Clinton Super-Heat Cement** will be sent you free and all charges prepaid, if you write the

Standard Machinery & Supplies Limited
261 Notre Dame St. West, Montreal

Does Your Storage System Save Oil?

If you have never studied the question of storing, distributing and using oils, you will be surprised to know the enormous losses that occur daily wherever oils are handled by inefficient methods. Losses that could easily be prevented by use of

BOWSER OIL STORAGE SYSTEMS

Such Conditions Are Wasteful, Dangerous, Unnecessary

Save All the Oil!

Store oils in leakproof, dirt-proof tanks. There is no loss of oils from any source, no loss of quality. Labor in handling is cut to the absolute minimum.

Write for literature describing equipment for your needs.

S. F. BOWSER CO., LIMITED
66-68 Fraser Avenue
TORONTO

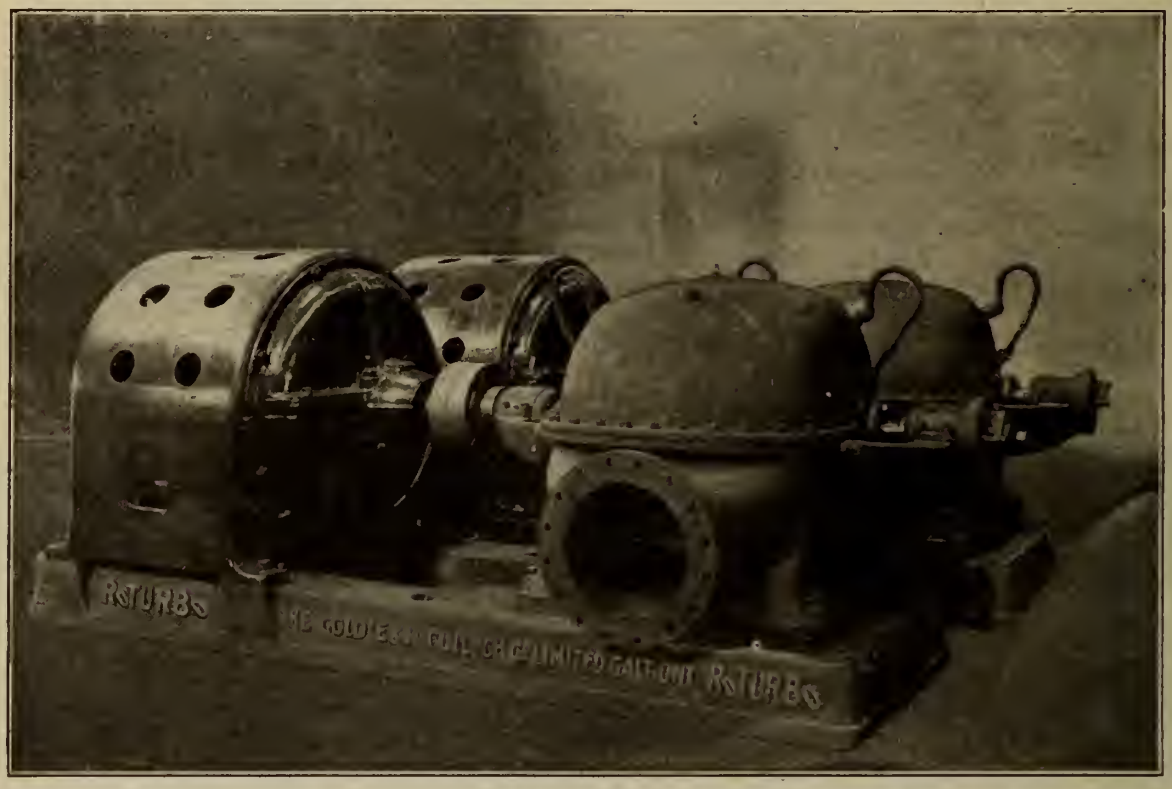
LONDON: 32 Victoria St., S.W. 1
PARIS: 5 Rue Denis-Poissons
HAVANA: Lonja del Comercio 427
SYDNEY: 6 Castlereagh St.

The Bowser Way—Safe, Loss-proof, Convenient, Clean, Systematic

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed by us for the Windsor Water Works at Windsor. Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Bank of Hamilton Bld'g.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig 400 St. James St., Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

POWER HOUSE

Established 1907 Published Semi-monthly

The Hydro-Electric Plant at Keokuk, Ia.

The Mississippi River, While Flowing Through Level Country, Has Considerable Possibilities for Power Development Owing to the Enormous Volume of Its Flow. 150,000 H.P. is Generated at the Plant Described Below

THE accompanying illustrations, Figs. 1 and 2, show the Keokuk 150,000 h.p. Hydro-Electric plant from the Iowa side of the Mississippi River and the down-stream side of the dam, while in drawings, Figs. 3 and 4, and photograph, Fig. 5, may be seen the four intakes converging into the scroll chamber around the 10,000 h.p. turbine and the 7,500 kv.a. electrical generators in the power house of the Mississippi River Power Company, which has a total capacity of over 15,000 h.p.

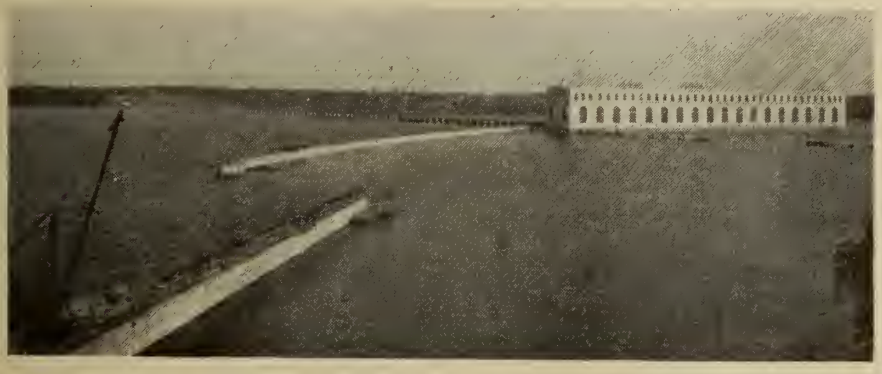


FIG. 1—POWER HOUSE AND DAM.

It will be seen from Figs. 1 and 2 that the throwing a dam across the Mississippi River, and flinging down into the centre of the great Mississippi Valley a Hydro-Electric development as large as this at Keokuk, has involved many things, direct and indirect, which are of great interest. The engineering, as it always is, was but the means to the end. The ultimate object was the production of electric current to be used for the benefit of mankind and especially of the inhabitants of the Mississippi Valley. Pains have been taken to make the effects of this water-power development, exerted through the electric generators and transmission lines, as plain as possible to everybody in the treatment of the economies. Giving this section of the country so large a quantity of the most economical power possible to use in factories has marked far-reaching effects for good upon the whole population of the country.

The object has been the development of a large quantity of water power in the centre of the Mississippi Valley, convenient to many raw materials and a large consuming population. The output is electric current chiefly for power and manufacturing. The location of the plant is in the Mississippi River between Keokuk, Iowa, and Hamilton, Ill. The stockholders live in Keokuk, Boston, New England, the East, Canada, England, Germany, France and Belgium. Chief Engineer Hugh L. Cooper has charge of the great power station.

The dam, power house, lock, dry dock, sea-wall and ice fender are all one concrete monolith, with a total linear measurement of 13,185 feet, or two-and-a-half miles. The dam has a length of 4,278 feet, plus east abutment 290 feet and west abutment 81 feet, a total of 4,649 feet, or 88-hundredths of a mile.

The dam has a width of 29 feet at top and 42 feet at bottom, the height of structure being 53 feet. It is composed of 119 arched spans, with piers 6 feet thick and span 30 feet inside. The spillway sections each measure 30 feet long and 32 feet high. The steel gates on top of spillways are 11 by 32 feet. The up-stream face is vertical and the down-stream face of spillways an ogee curve, while the dam is keyed into the limestone bottom of the river about 5 feet.

The power house has a length of 1,718 feet and a width of 132 feet 10 inches; the total height was 177 feet 6 inches, and the substructure is of monolithic concrete, with walls of reinforced concrete and steel roof trusses. It has four floors, the first containing generators and accessories, and the others containing the oil switches and electric accessories. The substructure is 70 feet high to generator floor and 78 feet high to transformer floor. The superstructure is 107 feet 6 inches from the generator floor to the pinnacle.

The installation was designed for thirty units with turbine and generator on same vertical shaft with four auxiliaries added, the first installation being fifteen power units and two auxiliaries. The turbine is of the Francois type, of special design, with a capacity of 10,000 h.p. and an overload capacity of 13,500 h.p. The efficiency is 88 per cent, at 57.7 revolutions per minute.

The diameter at buckets is 10 feet 2 inches, and the lubrication of thrust bearing is by forced pressure oil. The single thrust bearing is set above the water and carries rotating parts weighing 550,000 pounds. The turbine is direct-connected with the generator, on

FIG. 2—DOWN STREAM SIDE OF DAM.

a vertical shaft 25 inches in diameter. Sixteen buckets are on hub, the rating based on a head of 32 feet. The regulation is by guide vanes at the inner circle of the scroll chamber, actuated through a system of levers by fly-balls acting on an oil relay.

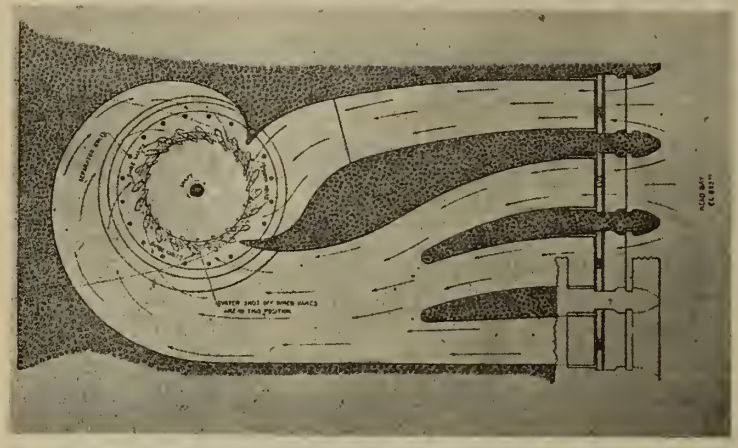


FIG. 3—FOUR INTAKES CONVERGE TO FORM THE SCROLL CHAMBER.

It will be seen in drawing, Fig. 3, that for each unit there are four intakes, converging into a scroll chamber 39 feet in diameter, with spiral floor, the whole so shaped that the water strikes every point on the circumference of the turbine with equal velocity and impulse. The draft-tubes are below the turbines, vertical, and 18 feet in diameter at the top. At the bottom, horizontal and of oblong shape, 22 feet 8 inches in vertical diameter, and 40 feet 2 inches in horizontal diameter. The bottom of the draft-tubes and bottom of the tail-race are set 25 feet below the bottom of the river. The tail-race is excavated parallel with the east wall of the power house and down to the railroad bridge.

Each electric generator has a capacity of 7,500 kilowatts. The current generated is alternating, 25 cycle, three-phase, generated at 11,000 volts, and stepped up to 110,000 volts for transmission. The field revolves at a speed of 57.7 r.p.m., and is excited by auxiliary units through a motor-generator set for each one. The diameter of the generator on the floor is 31 feet 5 inches, and the diameter of the revolving field is 25 feet 5 inches, its height at centre being 11 feet 3 inches.

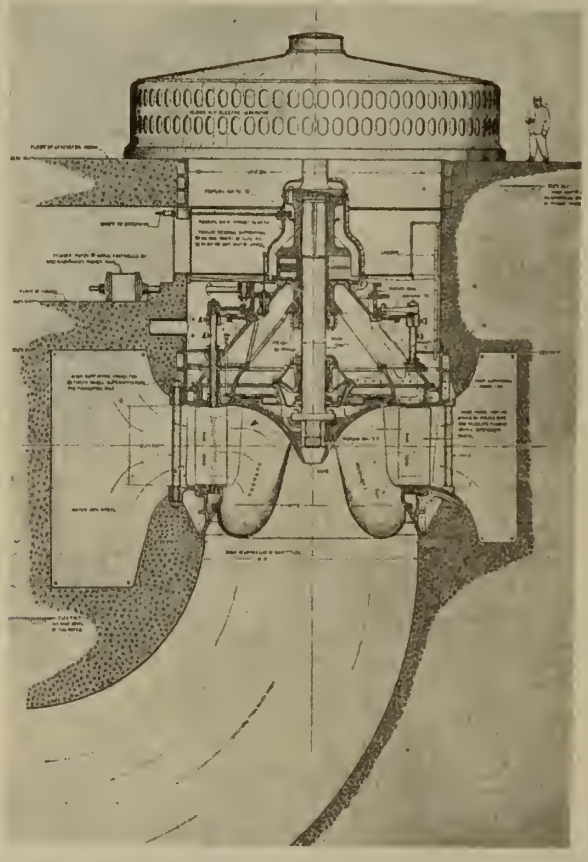


FIG. 4—DRAFT TUBE, TURBINE AND GENERATOR.

The transmission lines include one to Saint Louis, 144 miles, with a voltage of 110,000; six copper cables, five-eighths inch in diameter, each composed of 19 wires supported on steel towers set on concrete foundations in a right-of-way 100 feet wide. It crosses the Mississippi river twice and Missouri river once. The line to Burlington is 40 miles long, with voltage of 11,000, of aluminum cables on poles. Both lines are built to withstand extraordinary weather conditions and minimize accidents.

The total amount of concrete was about 650,000 cubic yards, requiring about 650,000 barrels of cement and 300,000 cubic yards of sand. The power to be developed includes a capacity at generators of over 231,500 kilowatts, and of turbines of 310,408 horsepower.

Nearly all the water-power development in the United States is on the edge of the country, from California along the Canadian border and down the Atlantic coast to Carolina, thence across Georgia and Tennessee to Alabama. This is the only very large development in the heart of the nation. This development exceeds that in any one state except three, New York, Maine and California. It is about half the total of all five companies at Niagara, on both sides of the international boundary, and it is practically all available for manufacturing. It is sold much cheaper than steam power costs, and factory sites are plentiful and being rapidly taken up.

ENGINEERING SECTION OF THE NATIONAL SAFETY COUNCIL

In accordance with the action of the annual meeting of the National Safety Council in Chicago, on October 1, the Executive Committee of the Council has approved the organization of an engineering section along the lines described below.

This plan does not contemplate a "safety engineering" section, nor does it attempt to define the term "safety engineer," which has been commonly applied to all men in responsible charge of safety work. The purpose of the new section is to bring together in closer contact the civil, mechanical, electrical, mining and chemical engineers in the council's membership, so that they may contribute more effectively towards the solution of the purely engineering problems so frequently encountered in safety work—just as the physicians among the council's membership are united in the health section.

Membership qualifications are parallel to those of the great national engineering societies, except that, for the present, associate membership (without the right to vote or hold office in the section) is open to engineers having three years experience; this will gradually be increased to six years, which is the requirement of those engineering societies

FIG. 5—INTERIOR VIEW OF POWERHOUSE SHOWING GENERATORS.

having the highest standard of membership.

The details of the plan approved by the executive committee, on the recommendation of a special committee of engineers, are as follows:

Membership

The membership of the engineering section shall be composed of individuals who are members of the National Safety council or who are employed by or affiliated with members of the council and who, in addition, have the following qualifications: Either (1) they must be members of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Chemical Engineers, or Canadian or European societies of equal standing; or (2) they shall have had at least ten year' experience in engineering work and shall have been for at least five years in responsible charge of such work—a degree from a recognized college of engineering being accepted as equivalent to two years' experience. Persons who are members of the council, or employed by or affiliated with members of the council, may become associate members of the Engineering Section if they are either (1) associated members of the American Society of Civil Engineers or the other engineering societies abovementioned, or (2) if they have had three years of experience in engineering work, a college degree being given the same credit as above. Such associated members shall have all the rights and privileges of members except the right to vote or hold office in the Section.

Organization

The Section shall have a chairman, a vice-chairman, and a secretary, the secretary being a member of the engineering staff of the National Safety Council, and an executive committee of not more than twenty-five, including the officers, and at least one member representing each of the industrial sections of the council. Among the sub-committees of the executive committee there shall be a committee on membership, with five members, which shall pass upon all applications for membership in the section. Messrs. D. S. Beyer, J. R. Brownell, A. P. Costigane, L. A. DeBlois, G. T. Fonda, H. W. Forster, E. B. Morgan, L. R. Palmer, C. E. Pettibone, C. C. Rausch, H. A. Schultz, F. P. Sinn, T. S. Stanion, C. M Talbert, B. F. Tillson, C. P. Tolman, E. B. Tolsted and J. S. Williams are constituted a temporary Executative Committee to perfect the organization of the Section.

Functions

The functions of the Engineering Section shall be:

(1) To help to meet the technical demands of the various industrial sections and furnish them technical information as desired;

(2) To perform technical services for the council on request of the executive committee of the council, such as the development of standards or participation therein; the solution by inquiry or through research, of special engineering problems arising in safety work, and helpful co-operation with the American Engineering Staandards committee, the national engineering societies, the Bureau of Standards, the casualty department of underwriters' laboratories, etc.;

(3) To conduct one or more meetings as a part of the Annual Safety Congress, at which engineering problems shall be discussed;

(4) To conduct, if considered desirable, one or more additional sectional meetings during the year, or in different localities;

(5) To carry on such other activities as will, in the opinion of the executive committee of the National Safety Council, promote the safety movement, and the best interests of the council.

The growth of the electrical industry in Japan has been chiefly due to the development of the great water power resource of the country. The first hydroelectric enterprise in Japan was established in 1891, when the Kyoto municipality utilized the water of the drainage system from Lake Biwa to the city, a distance of about seven miles, and provided four water mills, each of 120 horsepower, and two dynamos of 80 kilowatts each. Another landmark was the opening of the first electric tramway in Japan in 1895, also at Kyoto. With the increase in generating capacity the transmission of current over long distances was undertaken with such marked success, that in November, 1914, the Inawashiro Hydro-Electric Company carried out the transmission electric power at 115,000 volts over a distance of 140 miles. Taking into account power already being used or proposed to be used, it is estimated that the total water power in Japan will reach over 8,500,000 horsepower.

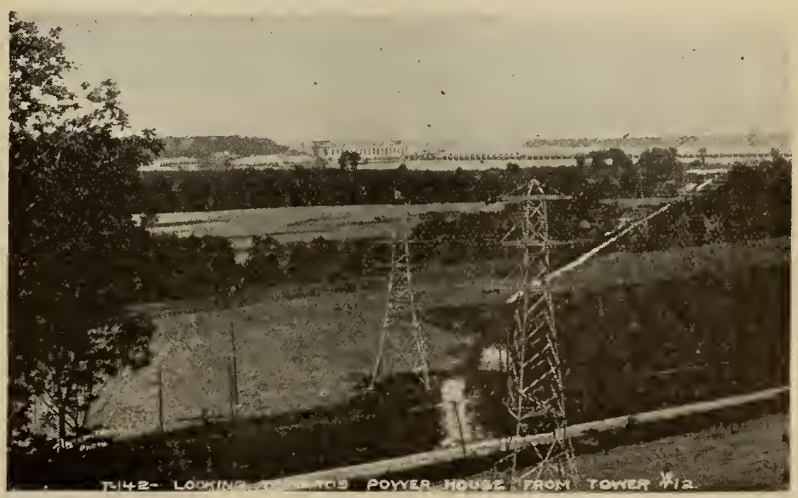


FIG. 6—TRANSMISSION LINE.

Rules for Figuring Boiler Horse-power

In View of the Coming Into Force of the Graded Certificate Act in Ontario, the Rating of Boilers is of Much Interest to the Engineer. The Following Article Gives a Resume of the Subject

By W. F. SUTHERLAND

IN connection with the grading of certificates in Ontario, the question of boiler horsepower is of much interest to the engineer and affects his interests very materially. Unlike a mechanical horsepower, brake or indicated the term boiler horsepower admits of several interpretations when speaking of performance, the term is now defined as 34.5 lbs. of water evaporated from and at 212° Fah. per hour, although at various times different figures have been adopted.

This is not taken into consideration to any great extent when speaking of the nominal rating of a boiler. The nominal rating expressed in horsepower is determined by the number of square feet of heating surface exposed to the combustion gases. Here again uniformity is not universal and various figures for the number of square feet, heating surface to the horsepower have been in use. For those interested in the Ontario regulations the figures taken in the Act may well be used.

The clause in the Act which defines horsepower is as follows:—

"B.H.P. shall mean boiler horsepower or the equivalent to the evaporation of 34 lbs. of water from and at 212° Fah., 15 square feet of heating surface for return tubular boilers, 12 square feet of heating surface for locomotive type boilers—10 square feet heating surface for water-tube boilers."

The usual rule for the determining of heating surface is to consider as heating surface, all the surfaces that are surrounded by water on one side and by flame or heated gases on the other, using the external instead of the internal diameter of the tubes for convenience in calculation; the external diameter usually being made in even inches or half inches. This method is not quite accurate since the true heating surface of a tube is that side which is exposed to the hot gases which is the inside surface in a fire-tube boiler. The resistance to the passage of heat from the hot gases on one side of a plate or tube to the water on the other, consists almost entirely of the resistance to the passage of the heat from the gases into the metal, the resistance of the metal itself and that of the wetted surfaces being practically nothing.

In finding the heating surface of vertical tubular boilers, multiply the circumference of the fire-box (in inches) by its height above the grates; multiply the combined circumference of all the tubes by their length and to these two products add the area of the lower tube sheet; from this sum subtract the area of all the tubes and divide by 144; the quotient is the number of square feet of heating surface.

Rule for finding the heating surface of horizontal tubular boilers; take all dimensions in inches. Multiply two-thirds of the circumference of the shell by its length; multiply the sum of the circumference of all the tubes by their length; to the sum of these products add two-thirds of the area of both tube-sheets; from this sum subtract twice the combined area of all the tubes; divide the remainder by 144 to obtain the result in square feet.

The heating surface in the tubes may be found by the following rule:—Multiply the number of tubes by the diameter of a tube in inches, by its length in feet, and by 0.2618.

Another rule sometimes used for determining the h.p. rating of horizontal tubular boilers is the following:—Square the diameter in feet and multiply the result by three.

It will be of interest to work out an example showing just how the heating surface and horsepower of a horizontal return tubular boiler are determined.

Take a boiler of the following dimensions, diameter 72 in., length 18 ft., 72 tubes 4 in. in diameter.

The circumference of the boiler is $72 \times 22/7 = 226$ in.

Two-thirds of the circumference multiplied by the length, also in inches—2/3 of $226 \times 18 \times 12 = 32{,}544$ sq. in.

The circumference of all the tubes is $4 \times 22/7 \times 72 = 905$ inches.

The heating surface of the tubes is accordingly $905 \times 18 \times 12 = 195{,}480$ sq. in.

Two-thirds of the area of one head less the area of the tubes is $(72 \div 2)^2 \times 22/7 - (4 \div 2)^2 \times 22/7 \times 72 = 3{,}168$ sq. in.

The net area of the two heads is, therefore, $3{,}168 \times 2 = 6{,}344$ sq. in.

The total heating surface will be $32{,}544 + 6{,}334 + 195{,}480 = 234{,}354$ sq. in. or 1,630 sq. ft.

The horsepower rating of this boiler will be $1{,}630 \div 15 = 108$.

Out of curiosity we may calculate this horsepower rating by the rule last given. The diameter of the boiler in feet is 6. Squaring this gives 36, and multiplying by 3 gives us 108 as before. This result is the same more by accident than design, for the two methods have nothing in common, and another size of boiler might give divergent results. This rule doesn't take into account the difference in length which is possible in boilers of the same diameter. Boilers of a longer length have a higher nominal rating than short ones, but the evaporative capacity is not greater in proportion for the extra length is not so effective in the absorption of heat from the gases resulting from combustion.

While the figuring out of the rating of any boiler is an easy matter it is much easier to consult a table, and for this reason one is appended giving the boiler horsepower rating of standard horizontal tubular boilers on the basis of 15 sq. ft. per boiler horsepower, which is the figure specified in the act.

BOILER HORSEPOWER RATINGS

(On the basis of 15 sq. ft. heating surface per boiler horsepower)

Size of Boiler	No. of Tubes	Heating Surface Sq. Ft.	Boiler Horsepower
36" x 10'	32-3"	305	20.3
36" x 12'	32-3"	365	25.
42" x 10'	38-3"	363	24.
42" x 12'	38-3"	434	29.
42" x 14'	38-3"	504	34.
48" x 10'	52-3"	484	32.3
48" x 12'	52-3"	578	38.5
48" x 14'	44-3"	584	39.
54" x 12'	56-3"	628	41.8
54" x 14'	56-3"	730	50.6
60" x 12'	70-3"	774	51.6
60" x 14'	70-3"	899	60.
60" x 16'	54-3½"	937	62.5
66" x 14'	92-3"	1,156	76.6
66" x 16'	72-3½"	1,217	81.
72" x 14'	108-3"	1,344	89.
72" x 16'	88-3½"	1,471	98.
72" x 18'	72-4"	1,555	104.
78" x 16'	108-3½"	1,780	118.6
78" x 20'	84-4"	1,966	131.
84" x 18'	106-4"	2,234	149.
84" x 20'	106-4"	2,478	165.

The Principles of a New Centrifugal Pump

The Rees-Ro-Turbo Type of Pump is Herein Described, and Various Illustrations Are Given of Interesting Portions of This Class of Pump

By J. H. MOORE

BEFORE going into the construction of this type of pump, let us go back quite a few years, and see where first the idea of centrifugal pumps appeared.

Something over two hundred years ago the centrifugal pump was invented by Demesne Papin in Hess, Germany. Little seems to have been done with it in a practical way for a long period. It first appeared in this country in 1818, and was known as the Massachusetts Pump. Gradual improvements were made in its design by Andrews in 1839, Bessemer in 1845, Appolod in 1848, and Gwyne in 1851. The development was slow and until within the last ten years was not considered seriously by many engineers, except for large capacities and for extremely low heads.

No doubt the delayed development was largely due to the fact that to get the best results from a centrifugal pump, impellers should be of small diameter running at high speed, but until the advent of the electric motor and steam turbine there was no means of driving centrifugal pumps at the necessary speed except through belting of gearing with their inseparable difficulties and losses in transmission, which neutralized the advantages aimed at in the pumps. With the introduction of electric motors and steam turbines high efficiencies became possible, and for high lifts the old arrangement of impellers in series was revised and the centrifugal pump became a strong competitor of the plunger pump for conditions which used to be looked upon as only suitable for reciprocating pumps.

Perhaps the defect which has been the most difficult to overcome and which has decided the buyer in many cases against this type of pump, has been the fact that it would work at its best only at the exact head for which it was designed, the reason for this being that the blades of the impeller were shaped so as to pass a certain amount of water with the minimum frictional loss, due to cavitation; but if the head against which the centrifugal pump is working reduces, a greatly increased volume of water passes and the impeller then becomes unsuitable for the increased speed of the water through it and begins to act as a water brake, thus creating an overload on the driving machine.

These conditions were well-known and until the introduction of RoTURBo by Rees of Wolverhampton, England, in 1907, it was attempted to overcome them by designing the impeller with blades bent rearwards so as to reduce the break effect. This necessitated increase in the speed of the impeller to compensate for the slip of the water, and beyond a certain amount of recurvature the capacity of the pump is very greatly reduced and the internal friction of the impeller increased with consequent loss of head at anything but a restricted range of service.

True, turbine pumps are of such comparatively recent development that the general public and, in fact, many engineers have not been sufficiently well informed upon the subject to distinguish between a high grade turbine pump and an ordinary commercial centrifugal pump.

Venturi Pipe

What is know as the Venturi principle is embodied in a specially shaped contraction in a water pipe having an abrupt nozzle where the water enters the construction, and a gradually expanding taper piece after the water has passed the contraction. The result of this is that the water under pressure in the pipe is forced through the neck at a high speed, and in doing so it loses its pressure, in the inverse ratio to which it gains velocity, so much so that the whole pressure can be annulled in the neck if the contraction is sufficient and an actual vacuum can be created. When the water enters the expanding pipe the speed of the same is slowed down again, due to the increasing diameter, and as the speed is lost the water regains its pressure. The Venturi pipe, therefore, is a hydraulic transformer, with a double transformation, converting from pressure into velocity and the velocity back again into pressure, and without much loss.

The special shape of the Venturi pipe is because a very abrupt contraction will convert pressure into velocity, but a carefully designed expanding piece of about 10 or 12 degrees expansion is necessary to attain the second conversion, because if the expansion is abrupt the water leaves the sides and the head (instead of being regained) is lost in friction and eddies.

In the ordinary centrifugal pump with an open rim impeller, the object is to pick up the water in the eye of the pump and get up a high peripheral velocity as of the water as it leaves the impeller and convert this velocity into pressure in the expanding channels of the pump casing; a very difficult and inefficient conversion.

These expanding channels are the exact counterpart of the expanding part of a Venturi transformer, but the contracting part of the Venturi transformer was not previously used in centrifugal pumps until what is known as the Rees RoTURBo Pressure Drum replaced the ordinary impeller. The pressure drum is a water chamber of large capacity, in which, by centrifugal force, a pressure is accumulated; the water being flung against the rim by the revolution of the drum and generating a hydraulic pressure inside of the drum. The water is allowed to escape through abruptly contracted openings in the rim, precisely in the same manner as the contracting part of the Venturi pipe.

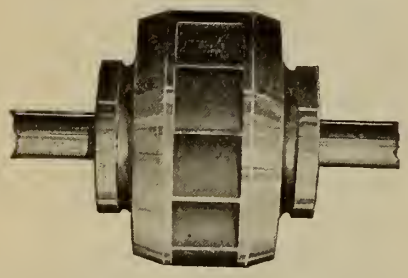
These openings, or nozzles, are pointed backward, and as the water escapes from them the jets of water have a turbine effect and give self regulation or a reduction of power when the head is reduced and a larger volume than the normal passes through the pump. The contraction of the openings is such that only 25% of the initial pressure is converted into velocity. That is to say, the water going through the nozzles at normal duty has a pressure of 75 per cent. and a velocity equivalent to 25 per cent. only. This velocity is picked up again in the expanding channels of the pump casing, so as to make the total pressure of the water being delivered from the pump equal to the 100% originally intended, but by this arrangement only 25% of the head is picked up in the expanding part, instead of the 100% as in the ordinary pump. As the expanding part of the Venturi transformer is the most difficult to design, and the efficiency of the same depends entirely upon the accurateness with which this part is designed, it will readily be seen why a pump of this type leads in the matter of efficiency.

General Principles

The design of the pump is exceedingly simple, comprising a single or a series of pressure drums (the number depending on the nature of its work), rotating inside a cast-iron casing at a moderately high speed. These revolving pressure drums are mounted on a central shaft supported in bearings. There are no moving parts in contact, except at the bearings, and the whole of the internal arrangements are such that the pump is in hydraulic balance and free from any lateral end pressure on the shaft. The main bearings are external and oil ring lubricated, and packing arrangements are exceedingly simple.

When running the water gravitates or is drawn into the eye of a revolving pressure drum where its speed is slow relative thereto, the water being carried round by the revolving partitions. A pressure is created in the revolving drum by centrifugal action of rotation, and the capacity of the chamber being large the water slowly moves towards the periphery, where there are a number of short nozzles curved in a direction op-

posite to the direction of rotation. These nozzles convert a portion of the pressure into velocity, and the water passing through them behaves as in a turbine, assisting the rotation of the revolving drum, thereby giving a self-regulating effect. The escaped water still having velocity in the direction of rotation, is passed between stationary diffusion channels which convert the remaining velocity into pressure. A considerable



SINGLE-STAGE IMPELLER.

space is left between the revolving nozzles and the stationary channels, greatly minimizing the effect of any wear and tear.

Impeller

The special feature of the pump, which (instead of being built as a flat disc runner with the main object of securing velocity of water in the expanding channels of the fixed casing), is designed in the form of a barrel or pressure chamber, the object aimed at being to secure a constant pressure inside the revolving drum or impeller, equivalent to the height of the lift. The impeller having this large capacity, the water inside as it approaches the rim becomes practically stationary relatively to the impeller, thus eliminating frictional losses and generating a pressure by centrifugal force.

Another interesting feature to note is that the highest efficiency point is when the speed of the water issuing from the impeller in a rearward direction is 50 per cent. of the peripheral speed of the impeller and this for the same reason that the Pelton wheel gives the highest efficiency when the speed of the buckets is half the speed of the water jet. In fact, the pump may be looked upon broadly as a reversed Pelton wheel in which the buckets are stationary and a series of nozzles on the rim of the impeller revolve, whilst the ordinary turbine pump with the narrow disc impeller is, of course the reversed vortex turbine.

The Effect of Self-Regulation

The self-regulating pressure chamber is the equivalent to a pump and a turbine in series, the result being that if the head varies or is reduced below the head for which the pump is designed, there is no overload possible, the turbine rim blades extracting the energy of the increased speed of the water through the impeller, which otherwise would be thrown to waste. It follows, therefore, that the margin of horse power usually allowed on the motor in the ordinary turbine pump for this emergency is unnecessary, it being absolutely impossible for the pump to overload materially the motive power so long as the speed is kept constant, regardless of the head against which the pump is working, or as in the extreme case of a pipe bursting, taking the head off the pump entirely. The value of this feature of the pump in keeping down power costs to the lowest point without the necessity of complicated arrangements for speed variation or cutting out impellers, will at once appeal to the manager or engineer.

With further reference to self-regulation and the turbine effect, it should be noted that the impeller becomes a pump and a turbine in series, with a pressure chamber between the two portions. The pump portion is, therefore, always discharging into a constant pressure, which is the ideal condition for a centrifugal pump, and the turbine is always discharging from a constant pressure, which is the ideal condition for a turbine.

The result of the combination just described is perfect self-regulation with the highest efficiency and, at any head lower than the normal duty, the power taken by the motor is prevented from rising.

Characteristics

When running under a constant speed the Rees RoTURBo Pumps are designed to deliver a certain capacity against a specified head at this speed, and will give a guaranteed efficiency at that point. If required to deliver water at a higher head (and all the following calculations are based on a constant speed), the pump will deliver against this higher head up to 115% of the designed head. The amount of water delivered will decrease as the head increases above the designed head, and the efficiency will also decrease likewise.

For instance: At 106% of the designed head the pump will deliver 83% of its capacity, and the efficiency will be 95% of its guaranteed efficiency. In a similar manner: At 108% head, delivery is 73%, efficiency 90%. At 111% head, delivery is 60%, efficiency 80%. At heads above, the capacity and efficiency are not dependable, and the characteristic curves for the pump in question will have to be referred to.

For heads lower than the designed duty, the pump is more stable. For instance: for heads from 100% of the designed head down to 82% designed head, the pump will give an efficiency of 100% of that guaranteed, and the capacity at 82% is 126% of the designed.

At 69% head, the capacity is 140% and the efficiency 93%.

At 65% head, the capacity is 145% and efficiency 90%.

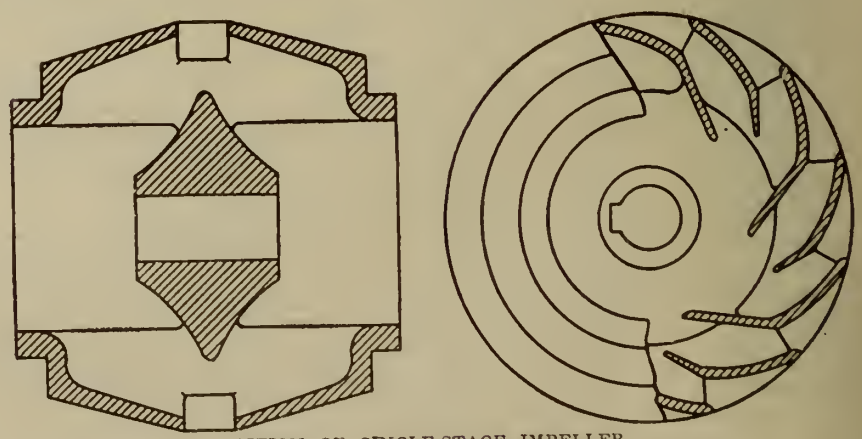
At 52% head, the capacity is 155% and efficiency 80%, etc., down to open valve or no head, at which point the pump will deliver in the neighborhood of 192% of the designed duty.

Due to this flat head and volume curve the efficiency of the pump is flat and varies over a wide range.

From the figures given you will note that it is best that the pump operate at heads lower than that for which it is designed. In fact, never, under any circumstances, would it be advisable for pump to operate under conditions where the head will be higher than that for which it was designed.

It will be noticed that the efficiency of the pump remains at the highest point until the head is reduced as low as 82% of the designed head and the capacity has increased to 125%. The pump can operate very satisfactorily down to heads as low as 40% of the designed head, and at this point the efficiency will be 60% of that guarantee, and the capacity will be approximately 160% of that for which it was designed.

A fact which should be remembered is that the volume increases directly as the speed; i.e., if the speed is doubled the volume will be doubled, and at the same time the head will vary directly as the square of the speed, and the head will be quadrupled, and likewise the power will be increased in direct proportion as the curve of the speed, or as the speed doubles the power will increase as the cube of 2 or 8.



SECTION OF SINGLE-STAGE IMPELLER.

Prof. Zowski's Report on Rees RoTURBo Pumps

The following technical report of Prof. Zowski, of the University of Michigan, sets forth clearly the principles in-

volved in the RoTURBo Pump, and will be found of interest. The accompanying curves and test cards should be of assistance in discussing the subject with consulting engineers and others.

SINGLE-STAGE DIFFUSER.

The new hydraulic principle embodied in this pump is that the impeller is used to create pressure head directly, whereas in all other centrifugal pumps the impeller imparts to the water practically speed energy only, leaving it to the diffusor to turn this speed energy into pressure head, which is always a very inefficient transformation.

A chamber of relatively large volume makes up the major part of this casing. A great volume of water is dragging along, and being exposed to the centrifugal force created by rotation is converted into a sort of accumulator which feeds the discharge nozzles and is itself fed by the suction pipe.

The speed of flow in the chamber is very small and its effect upon the pressure head which is caused by rotation is, therefore, very slight. Consequently, we may vary the discharge considerably without changing the pressure conditions in the impeller to any material extent. The variations in the discharge will only change the pressure at the entrance into the diffusor, and this produces the varying pressure differences which are, of course, necessary, if different quantities of water are to pass through the same passage area.

The fact that the speed of flow in the impeller is very small, means also that the theoretical power of the pump is practically dependent only on the pressure head created in the chamber. and therefore, equally independent of the discharge as the same.

If we now succeed in designing a pump in which also the efficiency will be independent of the discharge, then it is self-evident that the variations in the discharge will not affect much the actual power which is required to drive the pump. In this pump this condition is fulfilled for the following reasons:

1st. Because the speed of flow is very small, the hydraulic loss of the impeller will be very slight as compared with the other hydraulic losses of the whole pump, and changes of speed flow caused by varying the discharge can, therefore, not affect much the total efficiency.

2nd. The impeller nozzles act as turbine buckets, doing useful mechanical work by deviating the discharging water streams, and thus creating the S.C. force of reaction pressing against the buckets in the direction of rotation. This mechanical work increases with increasing discharge, and therefore, neutralizes to some extent the increase of hydraulic losses which takes place when the quantity discharged is increasing.

On the basis of what has been stated above, the following characteristics may, theoretically, be expected from the Rees Pump:

1st. A flat power curve with varying discharge.

2nd. A flat efficiency curve with varying discharge.

3rd. A total efficiency which must be at least as good as that of any other centrifugal pump, and which, on account of the relatively small velocities which flow through the impeller chamber, may be expected to be even better, if both are designed and built with the same amount of care and precision.

It cannot be the purpose of this report to enumerate the various instances in which this pump may be used to a greater advantage than the other centrifugal pumps, but this seems to be quite certain that the pump is ideally fitted to all services where the operation conditions are variable. Further, the peculiar construction of the impeller makes it relatively easy to use the pump as a wet compressor or as a vacuum pump, as it is a simple matter to admit the air or exhaust steam into the wide impeller chamber, and then to compress or mix it with the water in the impeller.

S. J. ZOWSKI.

On all pumps the casing is split horizontally so that the pump can be opened out and the internal parts examined by simply removing the top half of the casing.

It is very advisable to have both the branches, that is to say, the suction and discharge openings, in the bottom half of the casing, so that the top half can be removed without disturbing the branch connections. The standard arrangement is with both the suction and discharge branches horizontal and below the centre line of the pump. The suction branch can be made vertical if specially required. The horizontal suction branch is, however, preferred. The standard arrangement is with the discharge branch on the right hand side looking on the thrust end of the pump, but it is equally satisfactory to have it on the left hand side.

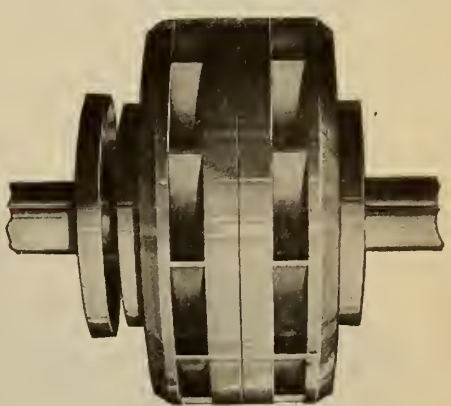
This pump may be made with either one or two main bearings. When the prime mover is supplied by another firm our practice is to fit two main bearings in all cases, but when the prime mover is supplied by ourselves, one main bearing is sufficient in the case of reciprocating engine drive and on small units with turbine drives up to moderate speeds; but in the case of high speed turbine drives (above 2200 R.P.M.) or units absorbing more than 50 H.P., two bearings should be supplied. With two main bearings a flexible coupling is used, but with only one main bearing a solid coupling is required. A brief description of the various types is given below:

MUTI-STAGE DIFFUSER.

C. W. Type

These pumps may be used for heads up to 120 feet, when the impeller is made of cast iron; double that head when it is made of bronze. It is not usually good practice to exceed 180 feet on a single-stage C. W. pump, unless it is of considerable capacity. Lubrication is by one or two oil rings, running over the shaft and dipping into a large reservoir beneath. This bracket also contains a two way ball thrust bearing, which acts as a centreing block for the impeller, keeping the nozzles in line with the diverging channel. In special cases the branches may be located at almost any position on the periphery of the casing to suit the convenience of the customer; but this should be avoided whenever possible, as it means special attention in designing and will probably entail delays in shipment.

The base plate is of cast iron, usually in one piece of the heavy boxed ribbed



MULTI-STAGE B TYPE IMPELLER.

type, extended to receive the driver. For belt drive, two pedestal bearings are furnished, thus providing a bearing on each side of the pulley. Lubrication is by ring oiling. The efficiency of this pump will range from approximately 40% on a very small pump to 80% on a large one, depending entirely on the fitness of the pump in question to the

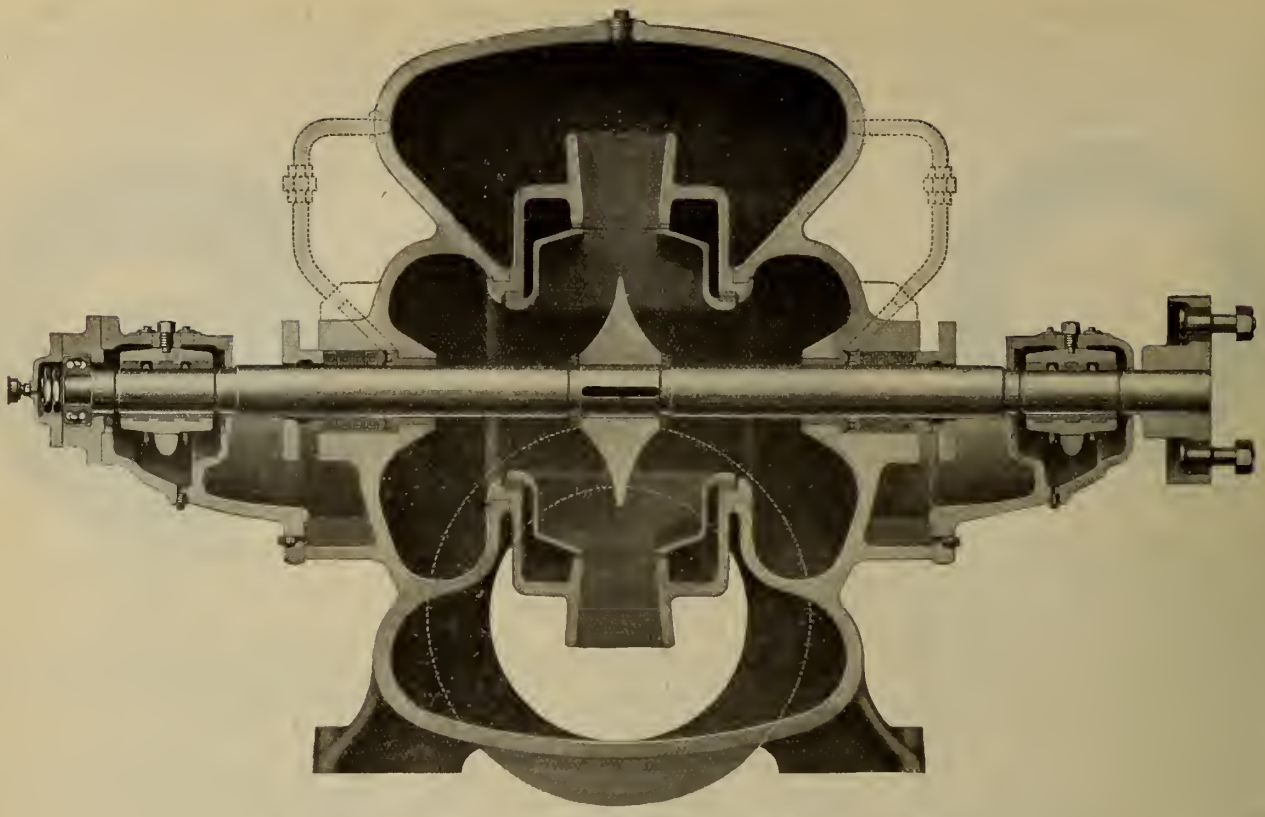


FIG. 1.—C. W. TYPE SINGLE-STAGE PATENT PRESSURE CHAMBER PUMP.—SECTIONAL VIEW.

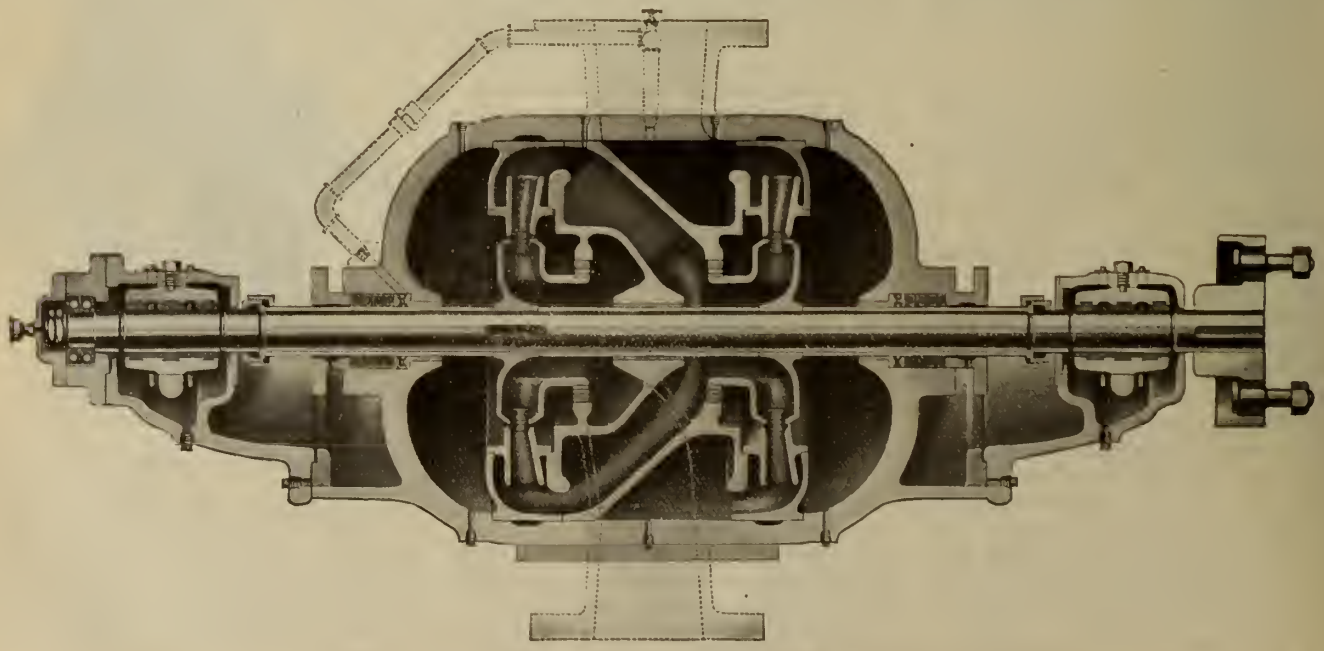
service demanded of it. Efficiencies obtainable are found for any given conditions from the efficiency charts. In practice the best efficiencies are obtained with heads varying from 40 to 140 feet.

S-2 Pump

This consists of two single stage, single impeller, single suction pumps, mounted on one shaft, and placed in one casing; in reality, this is two single stage pumps in one casing. The impeller differs from that employed in the C.W. Pump in that the water enters on one side or through one eye only, and therefore the capacity of an equivalent size S-2 impeller is only one-half that of a C.W. type of pump of the same diameter, the capacity limit of the impeller being based on the velocity of water through the eye. The impellers in these pumps, when mounted on the shaft face to face, are so arranged that water under pressure flows to the back of them, thus hydraulically balancing them with regard to end pressure. The diffusors of these pumps are two in number, and are of the straight way type similar internally to those used on the C.W Pump. What has already been said about number and type of bearings for previous pump, is also applicable to the S-2 Pump.

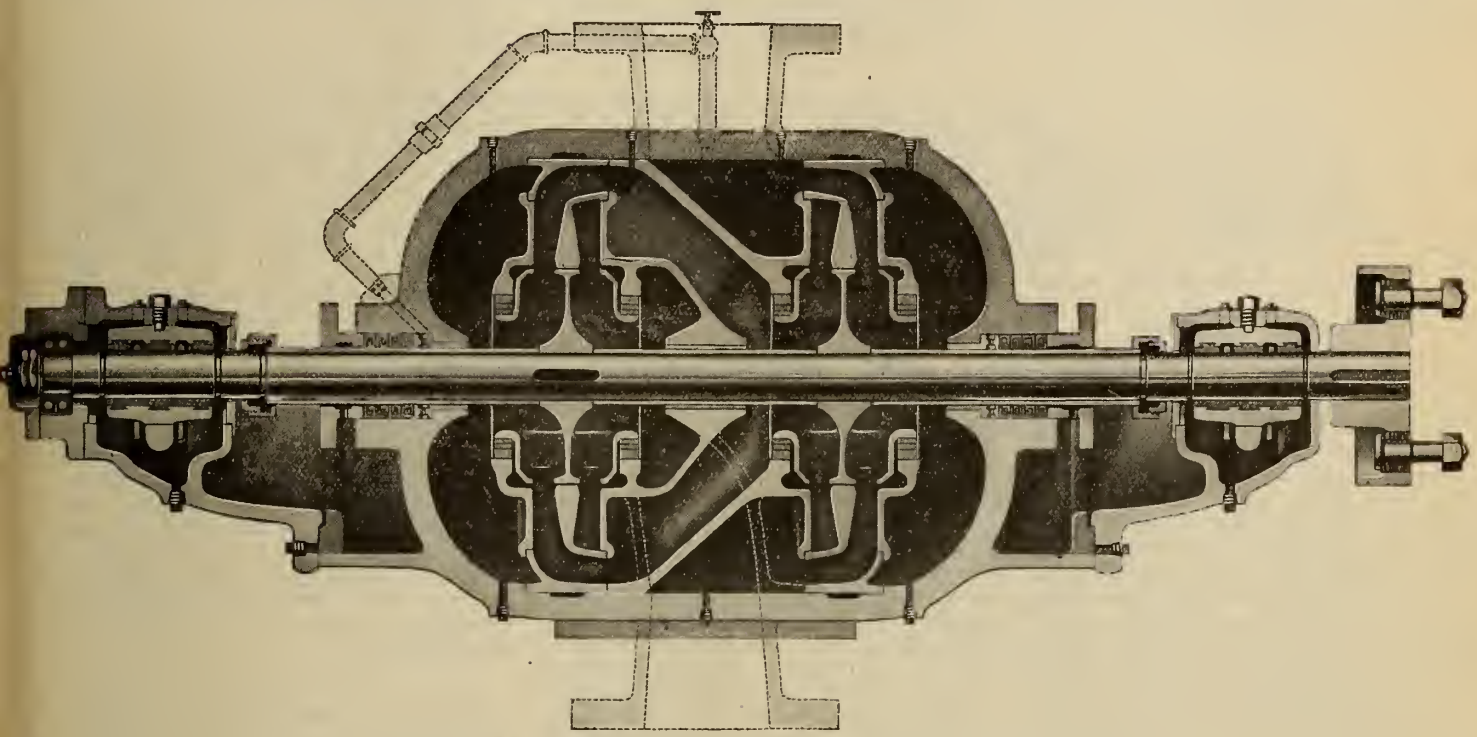
B Type Pump

This type of pump is one which is particularly well adapted for exacting service. It has many advantages over the ordinary centrifugal pump besides the special feature of the capacity chambers. It is multi-stage built in multiples of four, and not otherwise. The impeller is of the two stage type, each impeller having two stages back to back with an eye on both sides. This is a mechanical advantage in that it shortens the length



S2. TWO-STAGE PATENT PRESSURE CHAMBER PUMP.—SECTIONAL VIEW.

of the pump, and consequently the distance between bearings. The arrangement of the stages in multiples of four only, is clearly explained by reference to the method of obtaining hydraulic balance. This hydraulic balance is not only theoretically perfect but is actually so. This can easily be proven by the fact that on pumps up to 16 stages and more, a standard type of ball thrust bearing is used for the centreing block instead of the usual type of collar, water cooled marine thrust bearing, used by other pump manufacturers to take up end thrust. The end thrust experienced in RoTURBo Pumps is practically negligible. The purpose of the ball thrust used is to keep the impeller in line with the diffusors. The compactness of the pumps is further facilitated by the use of cross over diffusors. These diffusors are two combined in one, and cross the water from one stage of the pump to the next, and in this way (the water being crossed in a correct manner from one stage to the next) the pump is balanced with reference to end pressure. B types of pumps usually contain two bearings, both external to the casing, supported in brackets from each end of the pump. These are the same as those used in the other pumps, and are lubricated by means of two rings to each bearing dipping into a large reservoir of oil beneath, which has an overflow and drain. Above each stage of a B type pump is a relief or pet cock, its purpose being to relieve the entrapped air. B & S types of pumps have bronze covered shaft; the other type of pumps have steel shaft unless bronze is specified, which will be special and for which an extra charge will be made. B type pumps are used for heads from 100 to 1,600 feet. Their efficiencies are found from the efficiency charts. Given the volume and head per stage on the pump the best efficiencies are obtained with heads of from 40 to 140 feet per stage.

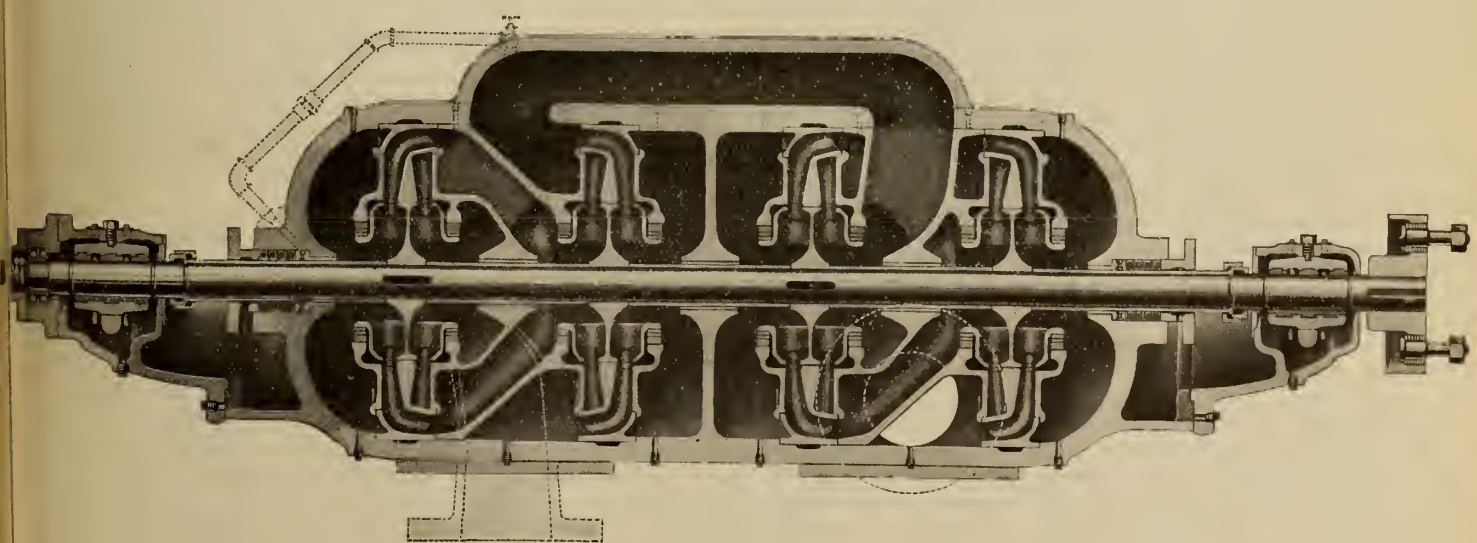


B2.—MULTI-STAGE PATENT PRESSURE CHAMBER PUMP.—SECTIONAL VIEW.

The makers of these pumps claim the following features and advantages derived from their pumps, namely that:

1. A drooping power curve, i.e., a power curve which rises not more than 10% as the volume is increased beyond the designed duty point and falls away as the volume is still further increased, thus making it impossible to impose an overload on the motor or turbine which may be used for drive.

2. High and permanent efficiency maintained over a very wide range of



B4.—EIGHT-STAGE PATENT PRESSURE CHAMBER PUMP.—SECTIONAL VIEW.

heads and volumes, i.e., a flat efficiency curve.

3. A head and volume curve which goes out to approximately 200% of the volume at the designed duty point when delivering against no head, in other words, maximum increase in volume at reduced heads. This is a great advantage for many purposes.

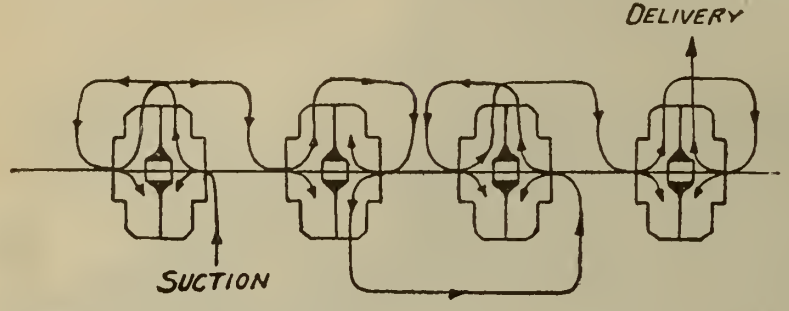


DIAGRAM SHOWING FLOW AND HYDRAULIC BALANCE OF A B4 EIGHT-STAGE PUMP.

4. Owing to the low water velocity through the impeller and stationary passages, there is almost complete freedom from wear, even when pumping gritty water. This forms a marked contrast to the ordinary centrifugal pump, where facilities have to be provided for the renewal of blade tips and other parts, due to the excessive erosion. With much wear, of course, in pumps of such construction, the efficiency falls rapidly.

5. An outstanding feature of the Rees RoTURBo Pump is that both single and multi-stage pumps are in perfect hydraulic balance, thus eliminating the expensive marine thrust bearings and balancing pistons which are always liable to wear and give trouble as soon as the clearances of same become worn through pumping gritty water. A small two-way ball thrust is usually fitted, the function of which is merely that of a centreing block to maintain alignment between the impeller and the diffusors.

6. The strong and rugged design of the impeller, diffusors and casing insures complete freedom from noise and vibration.

7. The pump is especially suitable for use with liquid of a gritty or viscous nature, owing to the low velocity through the impeller and casing, and has been largely used for pumping thick oil, sugar, liquids, etc.

8. From a mechanical point of view the pump is fully standardized and all wearing parts are easily replaceable, being made to gauge and kept in stock, thus permitting quick shipments on receipts of orders for repairs. The design of the pump is specially adapted for a wide range of duties with a given pattern by small alterations, thus reducing the number of patterns carried to a minimum and enabling us to completely standardize all parts.

From the foregoing history, and detailed description of these pumps, it will be noted that efficiency is a very strong feature. These pumps are now being built in Canada, by the Goldie McCulloch Co., Limited, of Galt, Ont., who have secured the sole rights for these pumps in the Dominion.

AUTUMN MEETING OF ELECTRICAL ENG.

Review of Work Undertaken at the Ottawa Conference—Papers Are Read

The first autumn meeting of the Toronto Section, the American Institute of Electrical Engineers, was held in the Engineers' Club, Friday, October 24. A review of the work accomplished by the National Industrial Conference held at Ottawa was presented by Mr. Frank R. Ewart, representative of the institute. The appointment of engineering delegates representing the various societies was a recognition of the engineer's status as one who, while coming into intimate contact with both the manufacturer and laborer, yet was in a position where impartial judgment and knowledge might be expected. One of the most noticeable things about the proceedings of the conference was the complete and accurate information of the labor delegates. When one of them spoke, no time was wasted in preliminary remarks, but the whole time available to the speaker was made use of in the presenting of information vital to the cause of labor. The briefs presented by those representing the manufacturing element of the community in some cases were not so well prepared, nor did they show such a familiarity with statistics and other information pertinent to labor. Mr. Ewart's further remarks had to do with the various topics of the agenda and the manner in which they were treated. In the discussion which followed, Wills McLachlan emphasized the importance of the necessity for thorough knowledge of economics on the part of both manufacturer and engineer. Both should be as familiar with the subject as was the laboring element of the community.

An interesting paper on water-turbine design was read by Mr. Adolph Eberli, hydraulic engineer, the Hydro Power Electric Commission of Ontario. Information regarding the design of this prime mover was given, and in the paper itself and in the discussion which followed, interesting facts regarding present-day developments were brought out. The Francis turbine, which is used almost universally up to high heads, is only a development, so far as its present design is concerned, of the past twenty odd years. It was formerly thought only suitable for moderate heads, but is now used everywhere, except where exceptionally high heads are encountered, as in mountainous districts. The turbines being built for the Chippewa-Queenston development are of this type.

In a recent paper presented before the American Society of Mechanical Engineers Mr. N. C. Harrison defines pulverized coal as coal that has been reduced to such fine particles that at least 95 per cent. will pass through a 100-mesh sieve having 10,000 openings to the square inch. In other words 95 per cent. must be less than one two-hundredth of an inch cube. He goes on to say that "the average person does not fully realize to what a high degree of fineness it is possible to reduce the coal to-day by pulverization. The finer coal is pulverized the more efficiently it can be burned and the more readily it will be diffused when mixed with the air for combustion and fed into the furnaces. Pulverizing certainly does not change the nature of the coal, but it does change its form to a certain extent in that the coal is changed from a solid into a fuel having liquid properties. As the coal is pulverized it is mixed with air, and when handled in the conveyor it flows like water; when fed to the furnaces it is more or less like a gas, and the furnaces must be designed to burn a gaseous mixture."

The St. Lawrence Welding Company of Montreal, have acquired a property adjoining their present plant, which they are now preparing for the installation of the equipment necessary for their tank manufacturing enterprise. Plans now under way will provide this company with adequate facilities for making any size of tank for industrial or domestic purposes. Several machine units have already been ordered and negotiations for others are in progress. The new tank shop will take care of all classes of work up to ½ inch thickness of plate. The company is continually adding to their general equipment; the machine shop has been enlarged, and by the first of the year they will be in a position to take on almost any class of repair work—welding or machine, or both. Their portable electric welding outfit is so mounted that it can be taken to any section of the country where local apparatus is not available for this purpose. The company are now accepting tank orders for delivery after the first of December.

A. W. Swan, who has been associated with the Canadian Ingersoll-Rand Company, of Sherbrooke, for the last two years, has resigned to take over the position of assistant-secretary for the Engineering Institute of Canada, in the head office at Montreal. Mr. Swan graduated from the University of Toronto, with a B.A.Sc. in 1917 and entered the production department of the Can. Ingersoll-Rand Co. Since March, 1918, he has been assistant in the publicity department, in charge of technical journal advertising.

Handy Tools for the Maintenance Man--II.

A Compilation of Various Devices and Methods Used by the Maintenance Man, Facilitating Wiring and Electrical Installations

By JAMES A. PERRY

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EVERY wireman knows how to make a drill for forming holes in brick work, from a piece of conduit or pipe. Most of them, however, do not appear to understand how the teeth of the drill can be formed so that the drill will clear itself, that is, that it can be withdrawn from the hole without binding.

The teeth in a conduit brick drill are cut, as shown at Fig. 15B, with a three-coronered or half-round file. Although it appears inconsistent, the work can be done better and quicker with a half-round file than with a three-cornered one. Where files are not available, a hacksaw can be used for cutting the teeth, but this tool is not as good as a file, because of the liability of breaking the hacksaw blades. After the teeth have been cut, the end of the drill can be held projecting about ¼ in. over some solid object, and the ends of the teeth should be spread out, possibly 1/16 in. beyond the normal surface of the conduit with the ball end of a ball-peen hammer.

It is always a good scheme to thread the end of a conduit brick drill and run a coupling on it as shown at A, Fig. 15, to protect the thread. In spite of all precautions, these drills will sometimes bind in a hole. If one does, and its end is threaded, the protective coupling can be removed and a pipe T run on as shown in Fig. 16. Then a length of pipe of a smaller diameter is pushed through the open hole of the T. This short pipe can be used as a lever, whereby the drill can be turned in the hole and loosened, or one can pound against the short pipe and thereby force the drill from the hole.

For drilling in concrete or masonry harder than brick, a drill of the type suggested in Fig. 17 is best fitted. This is forged from hexagonal tool-steel stock. The cutting edge of the drill is formed somewhat like that on a cold chisel, except that it should be rounding, and that clearance should be provided as suggested. In using this drill, its head is pounded with a heavy hammer and the drill is turned a portion of a revolution between each blow. This will tend to make a cylindrical hole and prevent the drill from wedging in it.

Wherever many holes are to be drilled in concrete, either an air or electric drill should be purchased. The justification for such an investment can be readily shown if one figures the cost of labor for drilling with a machine, and then the cost for hand drilling.

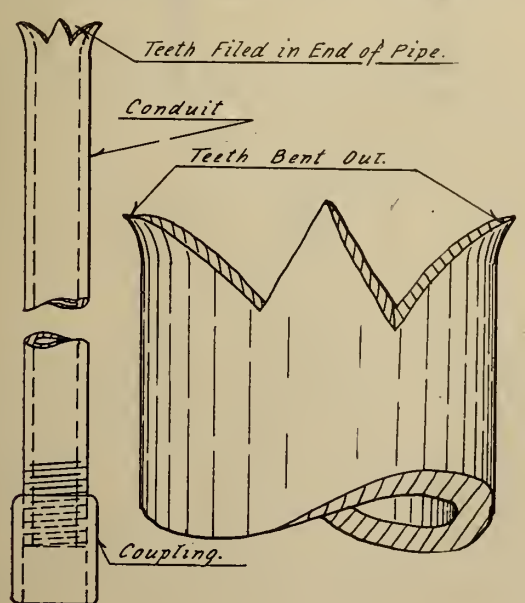

FIG. 15—DETAILS OF A BRICK DRILL

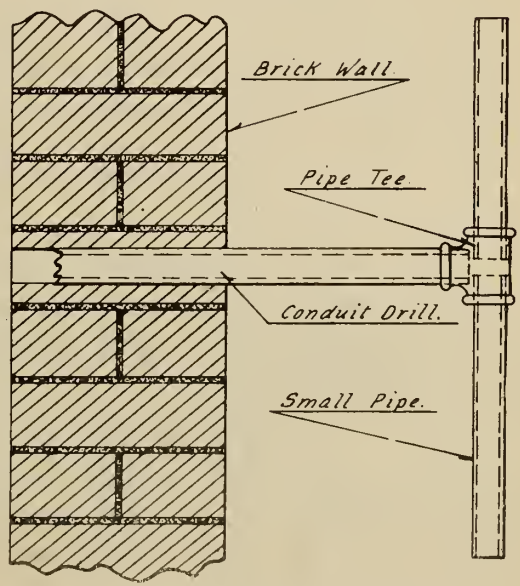

FIG. 16—REMOVING BRICK DRILL FROM WALL.

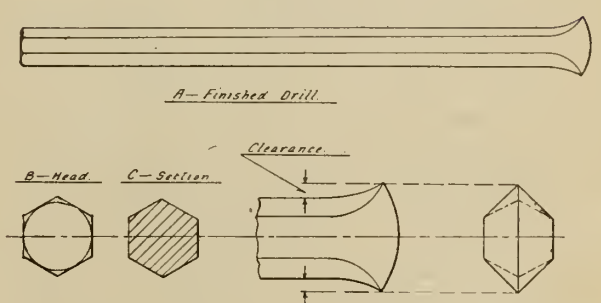

FIG. 17—DRILL FOR CONCRETE OR STONE.

It is often necessary to bore holes in locations where the ordinary brace cannot be used. Examples are the holes that must be bored in pockets in finished building wiring through joists or floor plates. If the wireman will carry in his kit a door knob or valve wheel (Fig. 18) he can turn an ordinary bit with one of these handles, and so cut holes in these restricted places. For a permanent tool, probably a door knob, Fig. 18 H, is best. Its rounding smooth surface fits the palm of the hand, and the bit can be firmly held in it by the screw that is always provided in the metal part of the knob. A V-shaped groove should be filed in the shank of the bit, into which the end of this tightening screw can engage. For a satisfactory operation with one of these handles the bit should be kept very sharp.

An operation that is usually very tedious is the fishing of electric fixtures. This is particularly true when wires must be drawn through small-diameter arms that are formed into right-angle curves. A splendid home-made device for getting a pulling-in wire through these irregular arms can be made as shown in Fig. 19. A piece of fishing line is tied to the end of a length of bead chain, such as that used for pull-chain sockets. It will be found that when the chain is inserted into the tube that it will

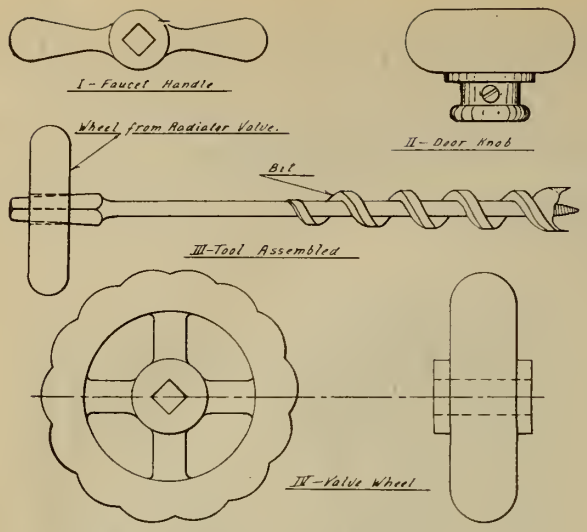

FIG. 18—HOME-MADE BORING TOOL.

follow all of the curves very readily, and draw in the fishing line. The fixture wires can be easily attached to this line and then pulled into place. The bead chain will even pass around a right-angle curve.

Another method that can be used for fishing fixture arms if bead chain is not available, is as follows:—The end of a length of strong thread is rolled with the fingers into a little ball. This ball is placed, with the end of the thread extending, into the fixture arm. Then by blowing into the arm the ball will be forced through, and the thread can be fed in after it. With the thread a stronger piece of twine or a small wire to serve as a pulling-in line can be drawn in.

When a wireman has a great many fixtures to install, the quickest way of handling the job is to scrape and twist connections for possibly fifty of them, and then solder and tape them later. This procedure saves time, and hence, money. Furthermore, if the ladle method later described, is used, splotches of solder on the floors can be avoided, and there will be no blackening of the ceilings that occurs when joints are soldered with a blow torch.

The soldering of the fixture connections in a job like that above referred to can be most readily affected by using a small ladle such as that indicated in Figs. 20 and 21. Either of these ladles can be heated by the ordinary blow torch. In soldering, it is only necessary to dip the twisted and fluxed ends of the fixture connections into the little pot of molten solder, and then strike the connection a tap or two with the hand to knock off the surplus solder.

The ladle of Fig. 20 is made by screwing a part of a steel armored cable bushing into a ½-in. gas cap. This

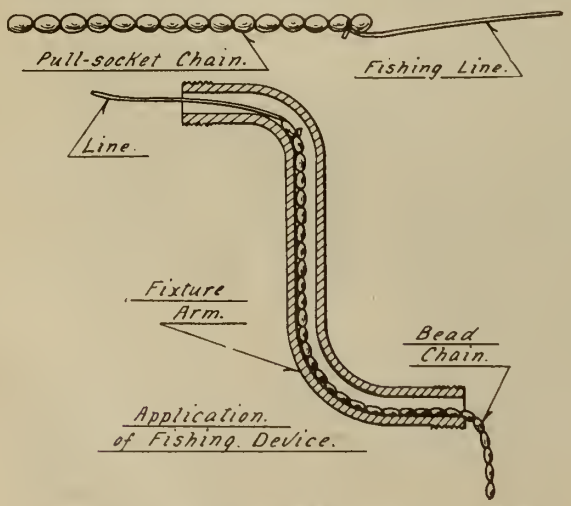

FIG. 19—BEAD CHAIN FOR FISHING FIXTURES.

provides a holder in which the wire of the handle can engage.

Another method of making a soldering ladle of a little larger capacity is shown in Fig. 21. In this, four holes are bored in a ½-in. or ¾-in. pipe cap, and the wire for the handle is threaded through them as shown. The cap cannot turn in the wires, hence, the threading provides a very substantial attachment. A wood handle (Fig. 21)

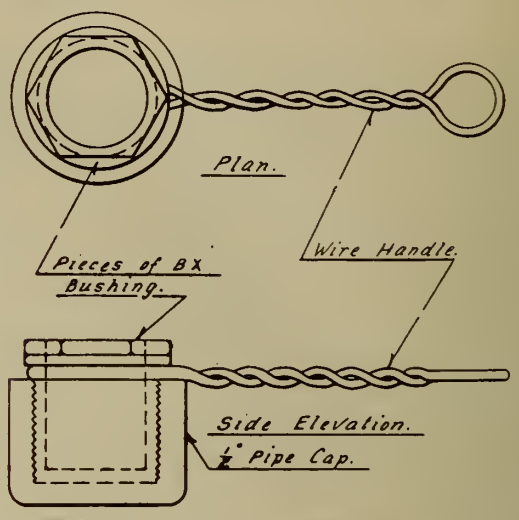

FIG. 20—LADLE FOR SOLDERING LEADS.

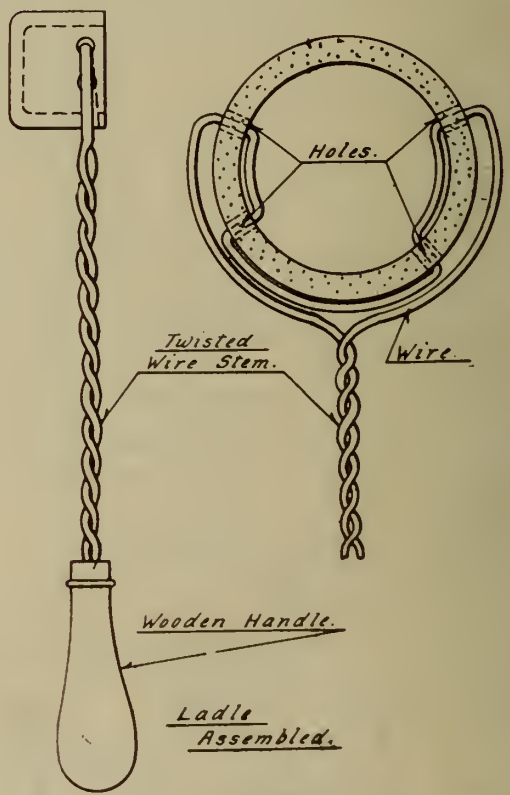

FIG. 21—LONG-HANDLED LADLE.

will be found very convenient, because if the handle is made of wire only, it is apt to become uncomfortably hot.

How to best carry his soldering paste is usually somewhat of a problem to the average wireman. It is supplied by the manufacturers in cylindrical tin or pasteboard containers, which are of rather inconvenient size to carry to the points where the soldering is being done. One scheme that has worked out very well in practice, is to transfer to a grease cup some of the paste and to use the grease cup in feeding it to the joint to be soldered. Fig. 22 shows grease cups of two types used for this

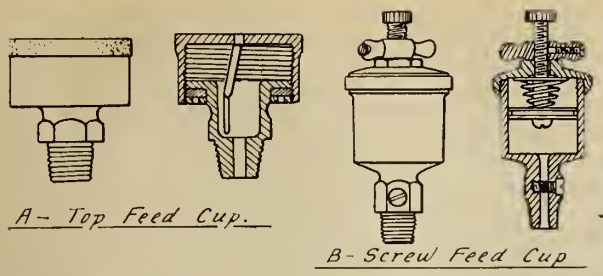

FIG. 22.—GREASE CUPS FOR CARRYING SOLDERING PASTE.

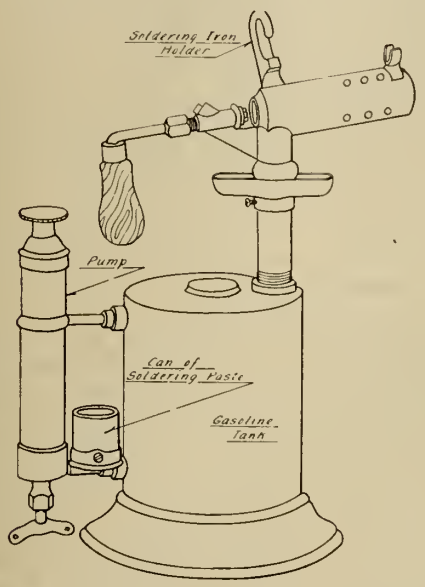

FIG. 23—PASTE CAN ON BLOW TORCH.

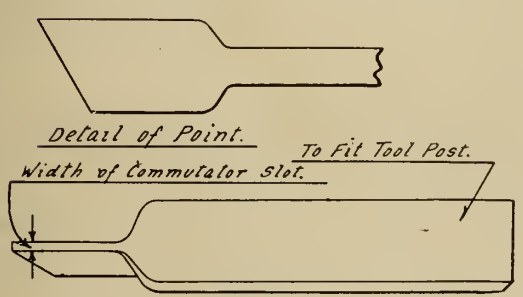

FIG. 24—TOOL FOR SLOTTING COMMUTATORS.

purpose. In that of A, which is the cheaper, the paste is fed through the orifice by turning the top. A steel retarding spring, which will fit into a groove at each revolution, prevents the cap from unscrewing easily. The grease cup at B is the most convenient because the paste can be fed either by a direct push on the feed plunger or by turning the feed handle. Furthermore, the valve screw provides a means whereby the cap can be entirely closed before it is placed in the wireman's kit for the night, or for transportation.

Another method of carrying paste that has been used by some wiremen is that shown in Fig. 23. In this, a small can to contain the paste can be directly attached to the blow torch by using a piece of a shade holder. This makes a very convenient arrangement for certain kinds of work. By loosening the set screw in the holder the can can be easily removed for re-filling.

Sometimes the electrician finds it necessary to re-slot commutators that were formerly slotted, but that have worn down, or to cut mica from those that were not, but which should have been, slotted by their manufacturers. For a makeshift arrangement, the mica can be scraped out with the edge of a hacksaw blade, but a much better and more accurate tool is that shown in Fig. 24. It is forged from a piece of tool steel, and in use is held in the tool post of a lathe. The armature that carries the commutator to be slotted is maintained between the centres of the lathe. Then the slide rest with the tool described and its tool post is worked back and forth. Each time it goes forward, the tool should be set to cut some of the mica from between two commutator segments. The action is, in a general way, similar to that of a planer or shaper. After one slot has been cut to a sufficient depth, the armature is rotated and the next one cut, and so on, until the entire armature has been re-slotted.

Screw-drivers especially designed for starting screws, that is, to hold the screw in the end of the driver for insertion in inaccessible places, are regularly made by the manufacturers. Their prices are very reasonable, hence, if one requires a screw starter, he will probably find it most economical to purchase the commercial article. However, if such for some reason or other is not available, he can make one for himself as shown in Fig. 25. The end of an old screw-driver is cut off square, as shown at A. A slot is sawed in the end. Into this slot, two pieces of clock spring, possibly 1 in. long x ¼ in. wide, are soldered. The pieces to be soldered should all be filed bright, and tinned with sal-ammoniac as a flux before they are inserted in the slot. After they have been thus prepared and inserted, additional solder should be sweated on. In using the tool, the two clock-spring levers are pressed together and inserted in the slot of the screw. When the pressure on them is released, they will grip the screw and hold it while it is being started.

Every man that does much knob-and-tube work must have thought at some time or another of the time that is required to string leather heads, that is, to insert the nails in the leather washers that are used with porcelain

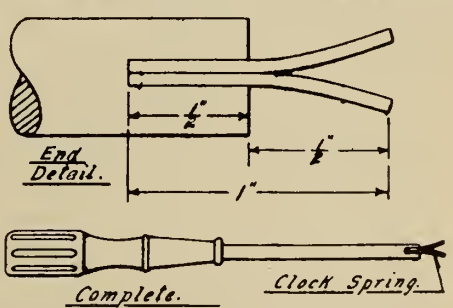

FIG. 25—SCREW-HOLDER FOR SCREW DRIVER

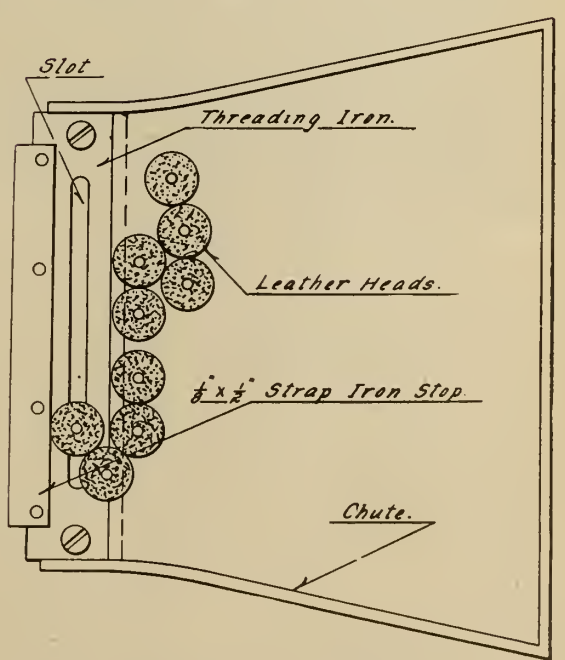

FIG. 26—PLAN VIEW OF STRINGING DEVICE.

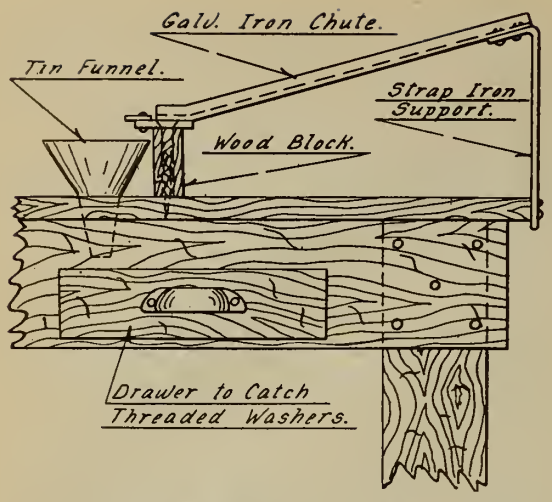

FIG. 27—STRINGING DEVICE MOUNTED ON BENCH.

knobs and cleats to prevent the breaking of the porcelain. Figs. 26 and 27 show a simple device, whereby this threading can be accomplished quickly and with minimum labor. In a large shop the threading device should be installed in the stock room. Then the stock-boy can use his spare time in putting nails in the leather heads. When the nails are drawn out of stock for a job, the leather heads will be in place on them, already for insertion in the knobs. The arrangement consists (Figs. 26 and 27) of a galvanized-iron inclined chute into which a supply of leather heads is dumped. The heads slide down against a stop of ⅛ in. x ½ in. strap iron. When they are in this position, the holes in the heads lie directly over a slot in the threading iron, and a nail is driven into each leather head and into the slot. Then the nail and the leather head are taken up and dropped through the funnel into the drawer prepared for their eception. The constant pounding causes the heads to continuously slide down the chute, hence, as soon as a nail is driven into one head and it is removed, another head slides down to take its place.

The "Natural Law" of Steam Boiler Performance

IF a steam boiler is recognized as an apparatus for converting heat energy in fuel into heat energy in steam with atmospheric air as the medium of conversion, then it can naturally be expected that the process of conversion will take place in accordance with the laws governing the medium in the same way as it is governed in other analogous processes. As a matter of fact, the expectation is entirely fulfilled. In order that the readers of the *Engineer* may have no doubts on the matter, and also that they may be in a position to verify the fact for themselves, the writer gives the two cases of internal combustion engines and steam boilers in such a form that a glance will almost be sufficient to convince them.

If T E = thermal efficiency of boiler expressed as a fraction,

R = rate of combustion in B.Th.U. per cubic foot of air used,

and Q = quantity of air in cubic feet per pound of water evaporated from and at 212 deg. Fah.

$$\text{then } Q = \frac{966}{T\,E \times R}$$

That is to say, quite independent of their size or type, quite independent of the soot or scale on their surfaces, and quite independent of the class or calorific value to the fuel they use, all steam boilers that realize the same standard of thermal efficiency use the same quantity of air per pound of water evaporated from and at 212 deg. Fah. With regard to evaporation per square foot of heating surface, different types of boilers present their heating surfaces in different positions towards the heated air passing over the surfaces, and as a consequence each type of boiler has a characteristic factor of its own. Also the ratio of heating surface to flue area is different in different size boilers of similar type, as well as in boilers of different type. Taking these factors into account, the reader will be in a position to predict the performance of any boiler.

Finally, all the fuel fired is not burnt, and a factor that expresses the proportion actually burnt in proportion to ashes and to cinders carried away by forced draught must be used, or the rate of combustion would not be accurately or even approximately known.

JAMES DUNLOP, in the *Engineer*.

Internal Combustion Engines

P = any higher pressure in pounds per square inch absolute.
p = any lower pressure in pounds per square inch absolute.
S = stroke volume of cylinder expressed as unity.
V = clearance volume of cylinder expressed as a fraction.
S* = stroke volume expressed as a fraction for scavenging pumps and air compressors.

$$\sqrt[4]{\frac{P}{p}} = \sqrt[3]{\frac{V+S}{V}}$$

$$\frac{P}{p} = \sqrt[4]{\left\{\frac{V+S}{V}\right\}^3} \qquad \frac{V+S}{V} = \sqrt[3]{\left\{\frac{P}{p}\right\}^4}$$

$$P = p\sqrt[4]{\left\{\frac{V+S}{V}\right\}^3} \qquad S^* = \frac{\sqrt[3]{\left\{\frac{P}{p}\right\}^4} - 1}{\sqrt[3]{\left\{\frac{P}{p}\right\}^4} - 1}$$

$$p = \frac{P}{\sqrt[4]{\left\{\frac{V+S}{V}\right\}^3}} \qquad V = \frac{S}{\sqrt[3]{\left\{\frac{P}{p}\right\}^4} - 1}$$

Steam Boilers

F = any higher rate of firing in pounds per square foot of grate area.
f = any lower rate of firing in pounds per square foot of grate area.
E = any higher rate of evaporation in pounds per square foot of heating surface.
e = any lower rate of evaporation in pounds per square foot of heating surface.

$$\sqrt[4]{\frac{F}{f}} = \sqrt[3]{\frac{E}{e}}$$

$$\frac{F}{f} = \sqrt[3]{\left\{\frac{E}{e}\right\}^4} \qquad \frac{E}{e} = \sqrt[4]{\left\{\frac{F}{f}\right\}^3}$$

$$F = f\sqrt[3]{\left\{\frac{E}{e}\right\}^4} \qquad E = e\sqrt[4]{\left\{\frac{F}{f}\right\}^3}$$

$$f = \frac{F}{\sqrt[3]{\left\{\frac{E}{e}\right\}^4}} \qquad e = \frac{E}{\sqrt[4]{\left\{\frac{F}{f}\right\}^3}}$$

SELECTING AND TESTING SHOP SUPPLIES

By F. E. Merriman

So many and rapid are the changes taking place even in quite staple goods that an article best suited to a specific purpose to-day may not fairly lay claim to that distinction a few months later. New styles, kinds and varieties of goods are constantly developed and placed on the market and so demand the continual attention of the manufacturer who would exercise maximum economy in the purchase of his supplies. Furthermore, "quality" is becoming more and more the slogan of the manufacturer and this makes many articles available for use though, heretofore, found unsuitable. This, of course, raises the question of how best to make the selection and how to keep apace with changes, for some knowledge of all improvements is essential to those purchasing.

Manufacturers and buyers are taking note of improvements and developments in their supplies and checking them against their requirements in various ways. The large manufacturer has his testing laboratories and corps to keep him informed of the value of these things, others ignore them and stick to past practice; but many cannot afford the first and are unwilling to follow the other policy. To the manufacturer unable to have a laboratory there are other less expensive, and often equally as efficient, methods open. It is the purpose of this article to discuss a few practical instances of simple, inexpensive, but reliable comparisons of articles and goods of common use in manufacturing plants.

Belting is a material in common use in factories; but concerning the merits of the various kinds there is much prejudice, diversity of opinion and experience. There is, first of all, leather of various makes, tannages and methods of manufacture. Again there are belts which are of woven material and impregnated with various substances, also rubber belts, all having their uses and successful installations. Regarding their relative merits for a particular plant no general conclusion can be drawn, for every plant has a variety of drives and operating conditions to which certain kinds of belting are much better suited than others. The fallacy of expecting to use one kind of belting throughout a factory needs much emphasis, for it is a very common error. Many can be found who will say and believe that leather, or some other particular kind of belting, is the best for all purposes. It is well known high speed steel is better than carbon tool steel for certain places and conditions, but no one would think of recommending it as the best for every purpose. The same is true of beltings, they will have their application. This short discussion has shown that to properly select belting we must first of all understand the general characteristics of the various kinds available. This, of course, calls originally for some kind of a trial and there is none better than a practical application to the various types of drives about the factory. To determine what these types are, requires some knowledge of the factory and some analysis. To illustrate the idea, there are drives where rubbing occurs, due to belt shifters, drives where the belts run over small pulleys, belts with idlers and tighteners, high or low speed belts, vertical belts, horizontal belts, long and short centre distances between driver and driver pulleys, high and low powered belts, wet surroundings, greasy drives, etc., all common to nearly every factory. All these conditions call for certain common characteristics in belts and qualities necessary for a certain drive may not be at all essential to others. A little study shows what the most important characteristics are. For example, a belt where a shifter is used must successfully resist rubbing on the edges, small pulleys are more destructive than large, because they bend the belt to a greater extent. Excessive moisture or oil, when present, increase the tractive difficulty as do short drives. The horizontal drive is easier than the vertical drive. A practical belt test under such conditions discloses its characteristics in these particulars. It shows that leather resists rubbing on the edges better than belts from woven materials. Also under certain greasy conditions leather will not always do as well as certain other materials.

To obtain a reasonable idea of the value of various kinds of belting need be neither expensive nor yet long drawn out. Drives selected for test should be of sufficient difficulty to disclose the merits of the tested material in a short time. Such a test, when the material fails, often discloses characteristics valuable and sometimes superior for other applications. A brief trial or two of this kind usually furnishes the information necessary to determine where further tests can advantageously be made. Drives where trouble is found often furnish suitable places for a trial. In this connection a warning may well be sounded against too severe a test, for really good material has sometimes been condemned by senseless and unreasonable tests. Common sense is as necessary here as elsewhere.

An illustration of the knowledge gained from a test of this character will be of interest. The drive was from a main line to a countershaft. Considerable power was transmitted and, due to the presence of a clutch, considerable oil was present. It was considered a difficult drive. Oak leather was the initial belt and afterward two woven belts were used on two similar drives with very close to the same conditions. One of the trial belts was of woven material folded to make several plies and finally stitched together and impregnated with a waterproofing substance. The other was woven to the desired thickness in one ply. The results were as follows: The leather belt became saturated with oil and then lost its tractive capacity; the folded and stitched belt ran successfully until the outer ply wore out, including the stitching, the plies then separated and the destruction of the belt soon followed. The third belt was still running in good condition long after the others were useless. It was found that the second belt carried the drive as long as three leather belts and not as long as the third trial belt. The leather belt, however, had a reclaim value not possessed by the woven belts.

Cost of 3 leather belts	$24.62
Reclaim value	14.77
Belting cost	9.85
Cost of folded belt	4.78
Saving over leather belt	5.07
Cost of single ply belt	3.51
Saving over leather belt	6.34

The lesser risk of shut down in the case either of the two belts tested was of considerable value and a still larger balance in their favor could readily be shown.

The success of the institched belt in this trial suggested its use for a spindle drive on the radial arm of a large drill press where, due to a poorly arranged oiling system, much oil was present. This made it a difficult drive for leather belting. The trial belt here was a success, though the life was not great, due to the destructive effect of the small pulleys used.

Another installation, a wet grinder, proved a leather belt of special tannage, superior to anything else, for it had long life and excellent driving power, notwithstanding the large amount of water present. The other belts were less successful under these circumstances.

These tests all required some time and attention, but most of this was furnished by the millwright foreman, who was easily interested in making the tests. In fact it was the interest on the part of this foreman which was instrumental in carrying the test to a successful conclusion in each case. The point of greatest interest is, however, the fact that the tests were made with no interruption of regular factory operation and at practically no expense. The results were worth many dollars to the firm.

One of the much-mooted questions in many factories is the question of a proper cutting lubricant. Many hold there is nothing equal to a good grade lard oil. Others, however, find an advantage in the use of other fluids. Due to the many variable conditions present such as the operator's opinion, the quality of the cutting tools, the grade and condition of the material worked, etc., definite comparisons of performance are not readily set up. However, an analysis of these conditions will point out what may be called a typical job on which the cutting fluid may be given a trial. The result of such a trial will demonstrate in many instances the value of the goods not only for the job, but also for the usual run of work.

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The Isolated Plant

PRESENT tendencies in power plant engineering point to the elimination of the small plant. The power salesman plays up the resulting saving in labor, cleanliness and general economy effected. All of this may be true of the summer months but in a manufacturing plant of any size the heating question is one of considerable magnitude and steam is required for a not inconsiderable part of every year. This is apart from the fact that many industries require heat the year round for process work.

Where a boiler plant is installed for any purpose whatever, the most logical method would seem to require the installation of engine or turbine and the generation of power to whatever extent possible. Little extra fuel would be necessary and the power made would be so much velvet, consideration being given to operating and capital charges. Furthermore, the isolated plant using exhaust steam for heating or process work is a direct aid to conservation.

The difficulty with the isolated plant operating under these conditions and a talking point, used by the power salesman is the costliness of summer power when heating is no longer required and the suggestion has been advanced to the effect that the small plant be hooked up with the central station. This would result in the central station supplying the summer load, while the isolated plant carried the winter one and fed power in a reverse direction if too much for private needs were generated.

This sounds quite attractive, but the actual working out of the problem is not so easy with direct current or alternating current generators of the usual type. Experienced operators would seem to be necessary, and metering and billing would be complicated.

It has been suggested of late that the many small water-powers not now developed be utilized and tied up with the transmission lines of large power companies. The induction generator has been advanced as suitable equipment and the small plant made automatic in operation. This same type of generator might find use in the isolated plant tied in with the larger power company. Electrical operating problems would be reduced to the vanishing point and great flexibility would result.

The relieving of the central station load during the winter months would be of advantage to them in the smoothing out of the yearly load curve.

Harnessing the Wind

COINCIDENTAL with the growing interest manifest in fuel conservation in various forms, an increasing interest is evident in the utilization of, at present, waste forms of energy. The power of the tides is a fertile field for inventors, and many and varied have been the schemes proposed for its harnessing. Wave motors, too, have received their share of attention, but, like the extracting of gold from sea water, the capital cost of development greatly outweighs any resultant revenue.

The harnessing of the wind, while practiced on a small scale in the familiar farm windmill, has never been seriously attempted, and there are many who anticipate great things when this is accomplished. The other side of the question also has its adherents, and these hold to the opinion that little or nothing will come of attempts to utilize this power.

The truth of the matter probably lies between the two extremes, and the windmill in moderate sizes will find a useful service to perform where the power required is not of large volume. Large size is not economical whether from the standpoint of efficiency or from economy in cost and operation, two twelve-foot mills giving better results than one sixteen-foot mill.

While the windmill has one considerable advantage in that the cost of the energy used is nothing, interest and depreciation have to be taken into account, and the cost of the power rendered available is thus appreciable. With due allowance for this fact and considering the variable nature of the power available due to fluctuating winds, the windmill should find a definite sphere of utility for irrigation and agricultural purposes and other fields of like nature where the power required is small and requirements can be met by units of small horsepower.

The development of the induction type generator as an auxiliary supply of power feeding a general transmission system may here also solve some of the problems connected with the use of wind power.

Are You a Figure Fiend?

AT an early stage in our lives, most of us, possessed of any imagination whatever, wondered just how much we saved by cutting across lots instead of going around. A little later on another problem intrigued us; we wondered as to just what the relation between the diameter and circumference of a circle was. Fortunately, we had teachers, more or less accomplished, to enlighten us, but in the early stages of the development of mathematics and general science those of a philosophic mind were not so happily situated and perforce, they had to go it blind.

All problems having to do with the mensuration of the circle have to do with the ratio of the circumference to the diameter. To those not conversant with mathematics, it would appear that this should be comparatively simple and so it is of no absolute value required. The ratio commonly denoted as π is in its nature an incommensurable number, that is no fraction can be found which will give its exact value. The commonly accepted approximation of 22/7 is not strictly accurate, for when it is changed into a decimal fraction its value will be 3.142857°, whereas the true value to the same number of decimal places is 3.141592. A closer approximation than the fraction 22/7 is given by another fraction 355/113.

Perhaps the best proof of the fact that no vulgar fraction can be found which exactly represents the value of π is seen in a characteristic of all vulgar fractions. When reduced to decimals it will be found that after a certain number of divisions they repeat themselves thus: 22/7= 3.142857142857, etc. On the other hand, the number π never repeats, but runs on and on as far as one cares to figure it.

The earliest idea of the number which represented the ratio between the diameter and circumference was probably the number 3. It was so at least among the Jews (1 Kings vii:23, 26), the Babylonians, the Chinese and probably also the Greeks. Archimedes made a notable advance over former knowledge of this subject, and by geometrical means which he originated determined the fact that the true ratio lay between 3 1/7 and 310/71. His method consisted essentially of calculating the length of the sides of regular polygons inscribed in and escribed around the circle.

With the renaissance in Europe more powerful means became available and the use of formulae, in themselves an algebraic shorthand, greatly simplified the labor involved in computation. One Rudolph Van Ceulen (a.d. 1610), busied himself with the problem for the greater portion of his life and the results of his labors were not interred with him but inscribed on his tomb. He gave the result correct to 20 decimal places and as a curiosity it may be given here:

π=3.141,592,653,589,793,238,462,643,383,279,502,88.

Since his time has arisen a class of workers known as π-hunters, π-computers, or circle squarers. Their labors, fruitless though they may be, are interesting from the length to which they have carried the number. A decimal number with several hundred places is common in their results and one figure of 707 places has been reached. When compared with the modest figure given above, this number seems enormous.

Various methods have been used by these investigators for the solving of their problem and much effort has been wasted by some of them in trying to reach the end of their never-ending labors. It has been definitely proved that no such end is possible, and we must be content with approximations, of whatever degree of exactness desired.

Are You Wasting Your Time?

NOW that the winter months are almost here, what are you doing in the long winter evenings? You say you get enough of the grind all day without continuing it at night. Quite right. But did you ever stop to think that the way to get away from the grind was to grind harder?

The manner in which manufacturing is carried on now, the speed with which operations must be performed, the way in which material must be routed, all mean that the man who is going to master the situation must be a student. What was considered a job for a standard machine yesterday is moved to a special-purpose tool to-day.

What do you read? The papers? Very well, read them. Keep informed, but make certain that your information is going to be worth something to you. You read three columns of stuff about the gruesome details of a murder or a suicide or a divorce case. What better off are you? Absolutely none.

Get a direct drive in your reading. Make it a point to be well informed about some subject. People find it a pleasure to talk to you. There are successful men on the road who do this thing continuously. They enter into a conversation and turn it to a subject on which they have gathered a lot of information. They are able to talk intelligently and they get a good hearing.

You can do the same thing in your own line, no matter what it is.

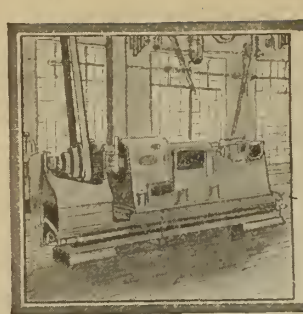
You can largely make yourself what you want to be.

Water Powers of British Columbia

THE Commission of Conservation, Ottawa, have issued to the press advance copies of an unusually complete report on the water powers of British Columbia. The report of some 650 pages is a compendium of data relating to the water power resources of the province and as such, is of much value from an engineering and reference standpoint. The opening chapters comprise a statement of the guiding principles which should govern in the conservation and utilization of inland waters, and a description of certain important features which should characterize reliable water power data. There follows a comprehensive, historical survey of water legislation in the province, together with discussions of subjects cognate thereto.

In the portion of the report which relates more particularly to physical data, will be found tabular lists of the estimated possibilities of water power sites throughout the province, which lists are based chiefly upon results obtained chiefly from the special field investigations conducted by the Commission of Conservation — Digests of stream flow, meteorological and other hydrometric records.

The Commission commenced its own reconnaissance field work in the Eastern provinces, in connection with the water power resources of the country, and in 1911 published "Water Powers of Canada," which presented in summary form the information then available for the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Ontario. In 1916 the report on the water powers of Manitoba, Saskatchewan and Alberta was issued. The present volume on "Water Powers of British Columbia" completes the series of reports on this subject. Owing to the recent war the publication of this concluding volume of the series has been delayed.



NEW POWER PLANT EQUIPMENT

"VOLYUM" CENTRIFUGAL PUMP

The Volyum Pump Co., 419 West Liberty St., Cincinnati, Ohio, have brought out a new vertical centrifugal pump, known by the trade name of "Volyum" and intended especially for supplying the coolant for machine or cutting tools. Fig. 1 shows an outside view of the device, while Fig. 2 is a sectional view showing the construction. The impeller is of the open type, mounted on the lower end of the vertical shaft and extending the full depth of the semi-spherical body, there being no contact between the impeller and the body casting. The bearings for the impeller shaft are both above the water line; one of these bearings is formed by the stuffing-box gland that is located just above the impeller, while the second one is in the cap. The drive from the pulley is through two spiral gears, placed at right angles and having a 3 to 1 ratio. The large gear is mounted on the driving shaft and runs in oil in the chamber formed by the cover, this oil serving to lubricate both the shafts and the thrust bearings, as well as the gear teeth themselves. A 3-in. flanged pulley is standard equipment, although a gear or sprocket wheel can be substituted if desired. The pump can be mounted on either the side or end of a machine, as desired, various angles of drive being obtained by swiveling the cover in relation to the body and by reversing the position of the pulley. In order to eliminate the loss of the liquid necessary for priming, the suction pipe is located above the delivery box and the body thus retains a full supply of liquid. The pump is at present made for ¾-in. pipe connections, and has a capacity of from 5 to 22 gal. per minute, depending upon the speed.

In the United States the great reserves of shales that contain oil are still untouched. These shales are found in many parts of the country, and tremendous reserves are known to exist in Colorado, Utah, and Wyoming. Some of the American shales are much richer in oil than are the Scotch shades, and are conservatively estimated to contain many times the amount of oil that has been or will be produced from all the porous formations in the country. The recovery of oil from shale has never been followed in America because of the lack of necessity, for the oil reserves are great, and it would not be commercially economical to invest money in retorts for distilling oil from shale that would have to compete with the crude oil obtained by other methods. But this condition will not last for ever. In fact, it is thought that it will be only a very short time before the oil shale industry will be of considerable magnitude.

The world's two deepest wells, penetrating to depths of 7,579 feet and 7,386 feet respectively, are, according to the "Engineering News Record," the Lake, near Fairmont, W. Va., and the Goff, near Clarksburg. These wells were sunk by the Hope Natural Gas Company, of Pittsburgh, in an endeavor to reach the rich oil-bearing Clinton sand of Ohio, which it was hoped to encounter at depths between 7,000 feet and 8,000 feet. Another well, the Geary, was sunk near McDonald, Penn., to a depth of 7.248 feet by the People's Natural Gas Company. It is the fourth deepest, a well at Czuchow, Germany, according to the United States Geological Survey, exceeding the depth of the Geary by 100 feet.

Ask Government Control of Ferries —A delegation from Windsor has gone to Ottawa to try and secure Government control for the Detroit-Windsor ferries. Parliament will be asked to amend the customs act under which ferry companies operate in Canadian waters The company can at present charge any fare it likes, as it is operating without license from the Dominion authorities.

FIG. 1—OUTSIDE APPEARANCE OF PUMP.

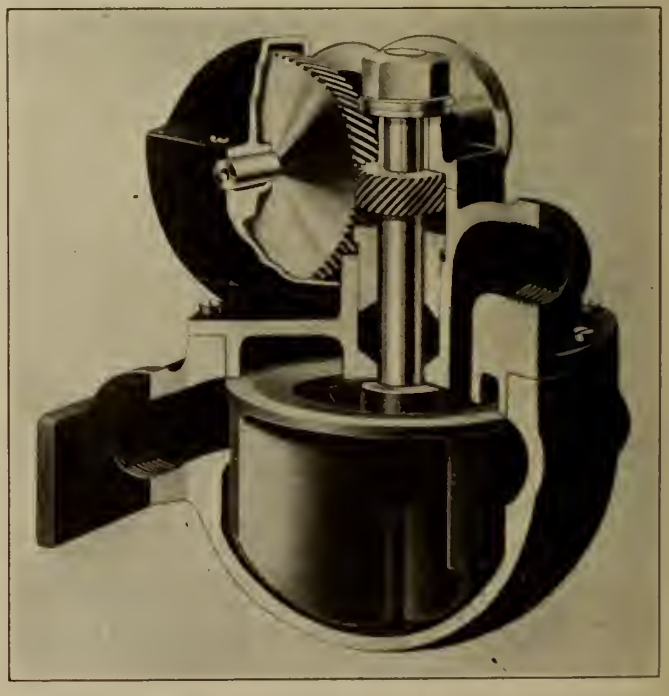


FIG. 2—SECTIONAL VIEW OF PUMP

The Operators' Point of View

MAXIMUM PITCH OF RIVETED JOINTS

By John S. Watts

The following rule for finding the maximum pitch of rivets to be allowed in the riveted joints of a boiler is found in the regulations of all of the following authorities: British Board of Trade; Dominion of Canada—for marine boilers. All the Provincial Governments in Canada have enacted regulations for the construction and inspection of boilers.

The formula is:

$$Pm = (C \times T) + 1\frac{5}{8} \text{ in.}$$

When Pm = Maximum pitch of rivets in inches (not to exceed 10 inches) immediately inside the caulking edge or edges.

C = Constant applicable from the following table.

T = Thickness of plate in inches.

Number of rivets in one pitch	Constant for lap joints	Constant for double butt strap joints
1	1.31	1.75
2	2.62	3.50
3	3.47	4.63
4	4.14	5.52
5	...	6.00

To save the time necessary to work out this formula, the accompanying chart has been drawn, from which, by measuring on the vertical line corresponding to the thickness of the plate in question, the distance from the base line to the intersection of the aforesaid vertical line, with the diagonal line marked to correspond with the type of joint under consideration, will give the length of the maximum pitch allowed.

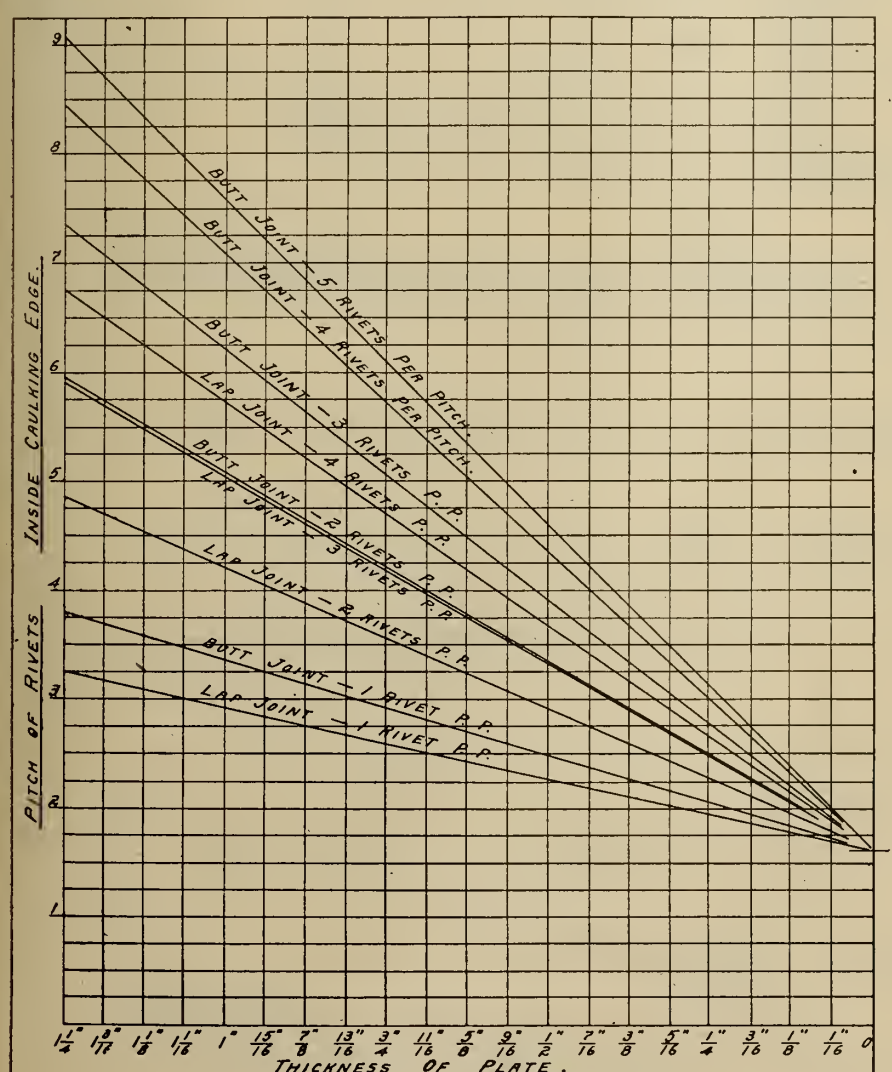

PITCH OF RIVETS
INSIDE CAULKING EDGE.
BUTT JOINT — 5 RIVETS PER PITCH.
BUTT JOINT — 4 RIVETS PER PITCH.
BUTT JOINT — 3 RIVETS P. P.
LAP JOINT — 4 RIVETS P. P.
BUTT JOINT — 2 RIVETS P. P.
LAP JOINT — 3 RIVETS P. P.
LAP JOINT — 2 RIVETS P. P.
BUTT JOINT — 1 RIVET P. P.
LAP JOINT — 1 RIVET P. P.
THICKNESS OF PLATE.

CHART FOR MAXIMUM PITCH OF RIVETED JOINTS.

For example, take a ½ inch plate with a butt joint having three rivets per pitch, the maximum pitch according to the chart is slightly over 3 15-16 in. According to the formulae it is $(4.63 \times \frac{1}{2}) + 1\frac{5}{8}$ in. = 3.94 in.

For the benefit of those draftsmen who have not had the advantage of shop experience, it may be added that the reason for this rule is that it is difficult to caulk a boiler so as to be permanently steam tight with wider pitches than allowed by the rule, as the plate, when being caulked, tends to spring up between the rivets when they are too widely spaced.

Another point in connection with this rule as regards the butt strapped joints, is that it assumes that the butt straps are ⅝ of the thickness of the plate. As the thickness of the butt strap is what decides the ability of the joint to stand caulking, it would appear logical that if a thicker butt strap is used, the maximum pitch of the rivets could be increased to that allowed for a plate whose thickness is 8-5 of the thickness of the butt strap. The writer does not recommend doing this as a standard practice, and there is nothing in the rules to cover this point, either for or against, but some inspectors allow it to be done, and in special cases the point may be worth remembering.

A REPLY TO JUSTICE

The Editor:—

I have been greatly amused reading the letter of one who calls himself Justice, Grade Certificates. Now, sir, to my way of thinking, this upstart—this would-be engineer—would be more in keeping with his name if he had signed it Bolshevik. He finds fault with the act for allowing an engineer, who has had charge of a plant of 150 h.p., to remain in charge of his plant. According to this man the older engineers—men who have come up from the ranks and distinguished themselves, showing to their employers by their ability that they were efficient and worthy of a position of trust—this man who signs his name Justice would throw these men into the discard, and by the tone of his letter he would like to step into one of the jobs left vacant.

Now, sir, as an engineer, who, through the working of this act, may be placed after the first of January in charge of a plant of unlimited capacity—I would like to register a kick. The agitation in this province for the grading of engineers' certificates has been of some

years' duration. The writer of this letter has been down to the Legislature on several occasions, as one of a body of engineers asking the Government to give us graded certificates. Sufficient opposition to offset our demands came through an organization in one of our large cities, and the consequence was that we have been unable to secure any legislation until quite recently. Many of the engineers who have been influential in the securing of this act are placed in an embarrassing position by the wording of the act.

I refer to those engineers who will be left in charge of plants of unlimited capacities. These men, who are to-day handling efficiently large plants and who know the ins and outs of engineering from A to Z, may not be able to sit down at a desk and figure out the intricate problems in higher mathematics and so forth, as required to secure a first-class certificate; yet, they have the confidence of their employers and are able to direct a body of men in the economical operation of large steam plants. I claim that an injustice will be perpetrated on these engineers if they are not granted a certificate in keeping with the position they hold. When a man reaches the age of 50 or thereabouts, his mental abilities are not as easily exercised as they would be at 20 or 30, and a man who has the care and responsibility of a large plant on his mind cannot find time to devote his attention to learning the highly technical end without dropping something else. These men should be taken care of in our new legislation and granted first-class certificates. Any old loophole was good enough to let a man qualify when the Government first granted certificates. Now our Bolshevik friend would give us a year to prepare for an examination, and if we fail why let him have the job. He does not tell us why, with all of his qualifications, that he is not in charge of a large plant. Surely, with all the ability that he is making claim to, he could have persuaded some of our large plant owners to have given him a position. He forgets that the chiefs in charge of large plants have proven their ability; they have also studied hard and improved their knowledge, and have demonstrated to those in authority that they are responsible, too, that they are masters of their profession. The leaving of these men alone does not do them justice. The day may come when a better position opens up. They cannot accept another position of unlimited capacity without passing this highly technical examination. This, I claim, is an injustice. It also puts these engineers in a humiliating position; they are placed at the mercy of their employers. They cannot make demands of their employer, because they are not independent.

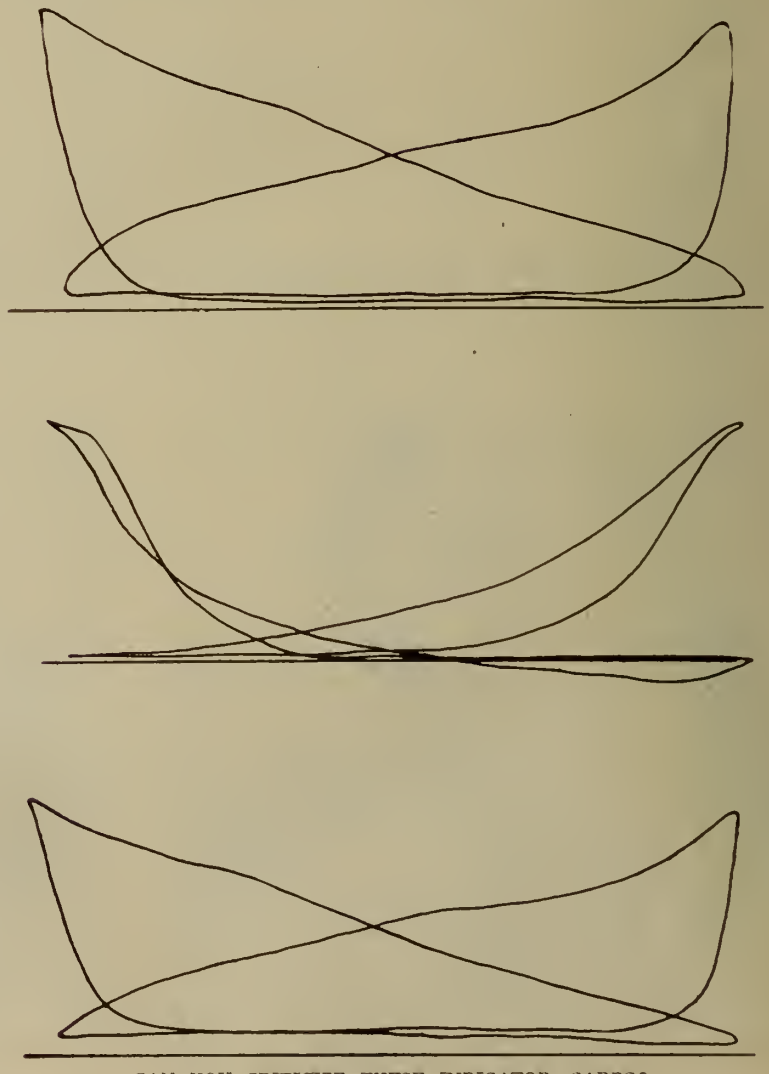
In our city one of the men who has been employed by the Government to arrange the different examinations of the different grades, told an assembly of engineers that it was not essential for a man to have all the different formulaes necessary to pass these examinations in his mind. But this is not borne out in the act. This is what it says: "In the event of any candidate being discovered referring to any book or paper, or copying, etc., he subjects himself to the penalty of failure." Now, I have set the ball rolling, let us hear from some more of the engineers.

CHIEF.

INDICATOR DIAGRAMS FOR CRITICISM

The accompanying diagrams are submitted for the criticism of POWER HOUSE readers. I would like to have some reader tell me just what trouble is present in the setting of the valves. One is taken before noon with a fair load, another is taken just before quitting with a light load, and the other one after disconnecting the clutch from the jack shaft, thus with only friction load.

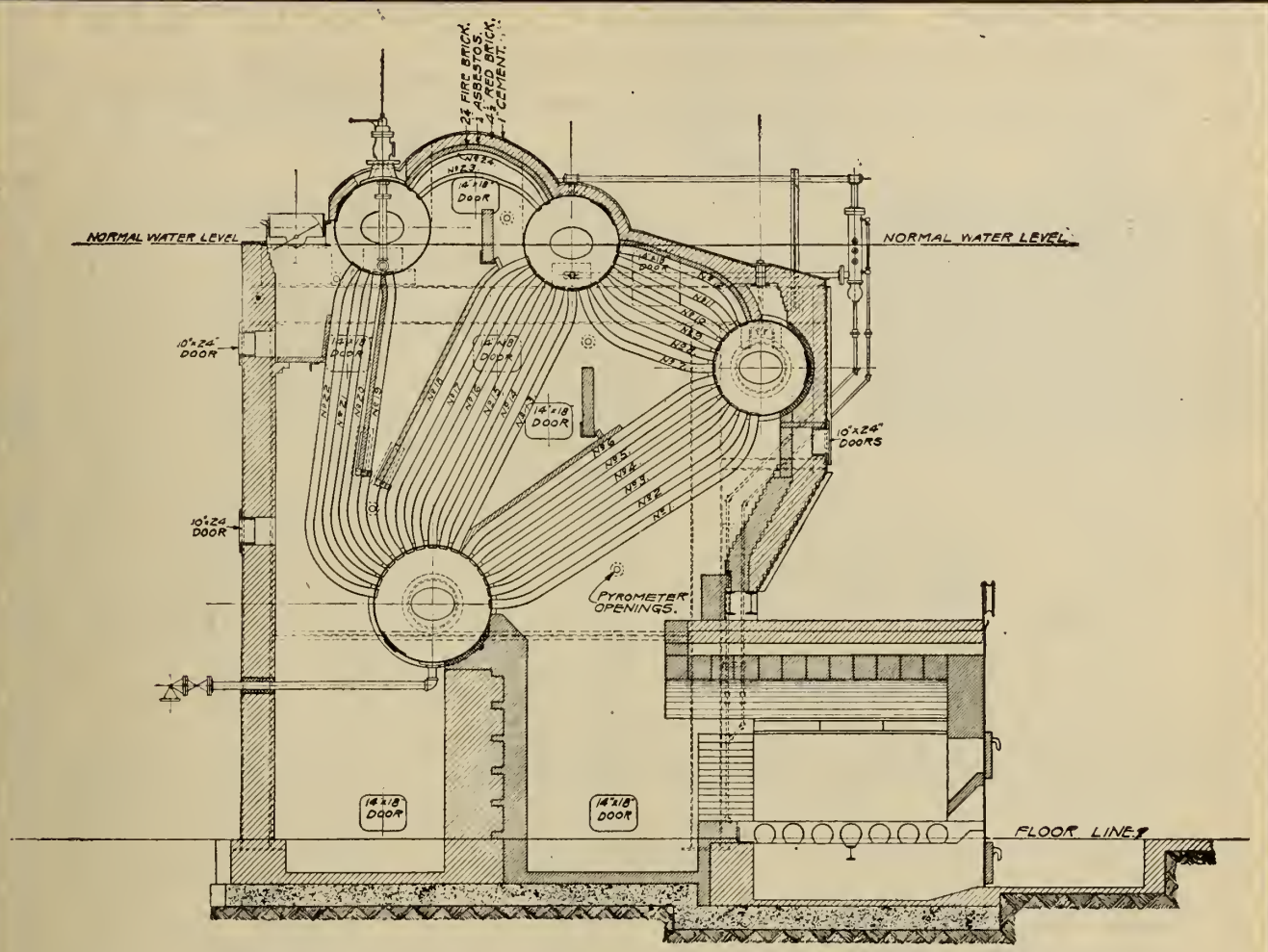
Editor's note.—We are desirous of obtaining from our readers, representative indicator diagrams for analysis and criticism. The interchange of information concerning the feature of power plant engineering is valuable in the extreme and we urge our readers to respond.



CAN YOU CRITICIZE THESE INDICATOR CARDS?

The Oil Engine Works of Canada, 29 Prince St., Montreal, will shortly move their plant to Iberville, Que., where they will occupy a portion of the plant of the Rapid Tool and Machine Company. When in Montreal the bulk of the machine work on the engines was performed in outside shops, and the assembling of the units was not all that could be desired. In their new location nearly all of the work will be carried on at the assembly plant. There is a steadily increasing demand for these engines.

R. M. Rook, who for the past five years has been associated with the Metal Thermit Corporation of New York, has been appointed general foreman of the St. Lawrence Welding Company. Mr. Rook has had a wide experience in welding work of every description, and was directly responsible for the successful repairs on what is considered the largest job yet accomplished by the thermit process. This was on the frame of a large stone machine, the weight of which was approximately 75 tons, requiring about 4 tons of thermit. Nearly seven weeks were required in preparing the mould.



Connelly (Patented) Water Tube Boilers

Made in Canada by

E. Leonard & Sons, Limited

Are of the four drum type and have 100% tube area directly in the path of circulation which not only delivers steam in abundance, but dry steam that is superheated for use at 200% to 300% with perfect safety.

A few of their good points—

Simple in design. Have no flat surfaces. Free from hundreds of joints. No hand holes at end of tubes.

Contain a tremendous volume of water, in proportion to their size. All stress due to expansion and contraction is well taken care of. Boiler tubes are so spaced that any one may be removed without moving the rest.

Designed to get the maximum horsepower in the smallest cubical space.

Can be built in units up to 4,000 horsepower.

E. LEONARD & SONS
LIMITED

London **Ontario**

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$25 00	$.....
1¼ in.	27 00	.....
1½ in.	28 00	26 00
1¾ in.	30 00	26 00
2 in.	30 00	26 00
2¼ in.	33 00	28 00
2½ in.	40 00	32 00
3 in.	46 00	38 00
3¼ in.	.....	45 00
3½ in	56 00	42 00
4 in.	70 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$4 50	$4 50
Tank plates, 3-16 in.	4 90	4 90

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 57	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill ..... list plus 5%
At warehouse ..... list plus 25%
Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto.....	4 25
Steel bars, base, Toronto.....	4 25
Steel bars, 2" to 4" base....	5 50
Steel bars, base, Montreal...	3 75
Best grades	16%
Iron bars, base, Montreal....	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..		7 50
Premier, 10¾ oz.....		7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain.....	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American ...	50
Kearney & Foot, Arcade ...	50
J. Barton Smith, Eagle	50
McClelland, Globe	60
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	19½
Palacine	22½
Machine oil, per gal.	27½
Black oil, per gal.	16
Cylinder oil, Capital	58
Cylinder oil, Acme	39½
Standard cutting compound per lb.	06
Lard oil, per gal. 2	60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard 30,	10%
Cut leather lacing, No. 1....	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke ..	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers .....list plus	20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less ..	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. bd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. bd., brass	net
Nuts, square, blank .....add	$0 75
Nuts, square, tapped.....add	1 00
Nuts, hex., blank .....add	1 00
Nuts, hex., tapped .....add	1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs ...40c	05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above..	8 40
Wood screws, flat, brigbt....	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass.....	55
Wood screws, O.&R., brass...	55½
Wood screws, flat, bronze....	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums.....	6 75
White lead, pure, cwt.....	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk.....	0 30½
Pure turpentine, single bbls., gal.	1 03
Linseed oil, raw, single bbls.	1 95
Linseed oil, boiled, single bbls.	1 98
Lead wool, per lb.	0 15
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A...list plus	20
Emery Cloth .....list plus	20
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granula.	0 14
Wood alcohol, per gallon....	1 80
Whiting, plain, per 100 lbs..	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in....$42 50		$43 00
Plain sheets, base 16 oz. and heavier...	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz...	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in..	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd..	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base.....	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING.

Standard	10%

extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	16½
Ideal	16
X press	14
Colored	
Lion	15
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	60
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.....	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.....	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws....list plus	20
Collar screws....list plus 20,	80
Thumb screws	40
Thumb nuts	75
Patch bolts .....add	20
Cold pressed nuts to 1½ in. add	1 00
Cold pressed nuts over 1½ in. .....add	2 00

METALS

	Montreal	Toronto
Lake copper $22 00		$21 00
Electro copper 21 00		20 75
Castings, copper 21 00		18 00
Tin 55 00		55 00
Spelter 9 25		8 50
Lead 7 25		6 50
Antimony 9 50		9 50
Aluminum 36 00		35 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided $0	39
Packing, No. 1 Italian 0	44
Packing, No. 2 Italian 0	36
Pure Manila rope 0	37
Transmission rope, Manila.... 0	43
Drilling cables, Manila 0	39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb. $12 00		$13 25
Sheets, 3½ lbs..... 12 00		13 25
Sheets, 4 to 6 lbs.... 13 00		12 50

Cut sheets, ¾c per lb. extra.
Cuts sheets to size, 1c per lb.

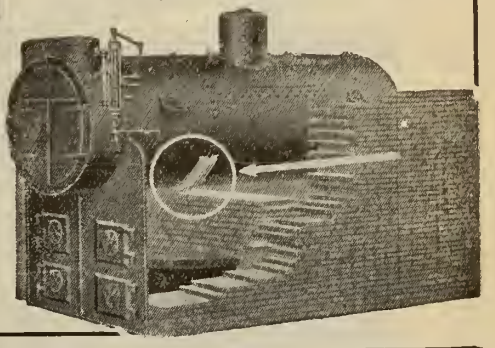
Power House

Advertisements will give you up-to-date information regarding new equipment. Read the ads.

NATIONAL Boiler Girth Seam Protector

Protection means longer life and greater efficiency

If your Boiler is not Fire-cracked it eventually will be. Prevent this by putting on a National Boiler Protector. You will save cost in repairs and prolong life of the boiler. All new boilers should be protected. If your girth seam is giving you trouble at the present time, have the seam caulked up, attach one of these protectors and the seam will remain absolutely dry thereafter.



Guaranteed for one year. We make protectors for patches and all styles of boilers. For full particulars, write—

National Boiler Protector Co.
Room 24
Lombard Building
TORONTO
Main 2623

As a consequence of the large demand for electrolytic copper during the war, the price advanced very greatly and many concerns for manufacturing this product were opened in Japan. The raw material for this industry was obtained from the Chinese bronze coin, which was imported into the country in large quantities until the Chinese Government prohibited its exportation. At present the prices of electroytic and ordinary copper vary so slightly that it does not pay to manufacture the former. Copper sheet manufacturers are also hard hit by the decline in prices and some of the large concerns are suspending operations or giving up this branch of business.

C.P.O.S. and Furness Withy.—Sir Frederick Lewis, of Furness, Withy & Co., has announced the completion of an arrangement with the Canadian Pacific to supply half the tonnage required in the services to Montreal and London, and Montreal and Antwerp. These lines are known as the Canadian Pacific Joint Services. The Furness-Withy Co. have also taken over the New York and Bermuda service of the Quebec Steamship Company, and have bought the steamer "Bermudian." In St. John, N.B., they have acquired the business of William Thomson & Company, who for many years acted as the company's agents in that port.

Plate Next Year.—After completing a tour of inspection of his company's properties, President Mark Workman of the Dominion Steel Corporation has returned to Montreal. Mr. Workman states that some of the furnaces at Sydney have resumed operations. With the completion of the new ship plate mill, which will probably become a producer early in the new year, an additional demand will be made on the furnaces. "The demand for steel products," said Mr. Workman, "is improving. There is, also, an urgent need for coal the world over, and it is this branch of our operations on which we are now concentrating our attention. With our unequalled loading facilities at four ports on the Atlantic seaboard, we are in an exceptionally advantageous position to take care of export and bunker coal requirements, and we are bending every effort toward raising our output to its normal level, in order that we may meet the conditions to the largest possible extent."

SALE OF MILITARY STORES, ETC.

DRY GOODS, HOSPITAL FURNITURE, BEDDING, HARDWARE, LEATHER GOODS, JUNK, ETC.

SALES WILL BE MADE BY SEALED TENDER

Persons desiring to tender are requested to register their names and addresses with the

SECRETARY OF THE WAR PURCHASING COMMISSION, BOOTH BUILDING, OTTAWA

stating the class of goods in which they are interested, whether new or second-hand or both.

Tender forms with full details of the goods and places at which samples may be seen, will be mailed when ready to those who have registered as requested above.

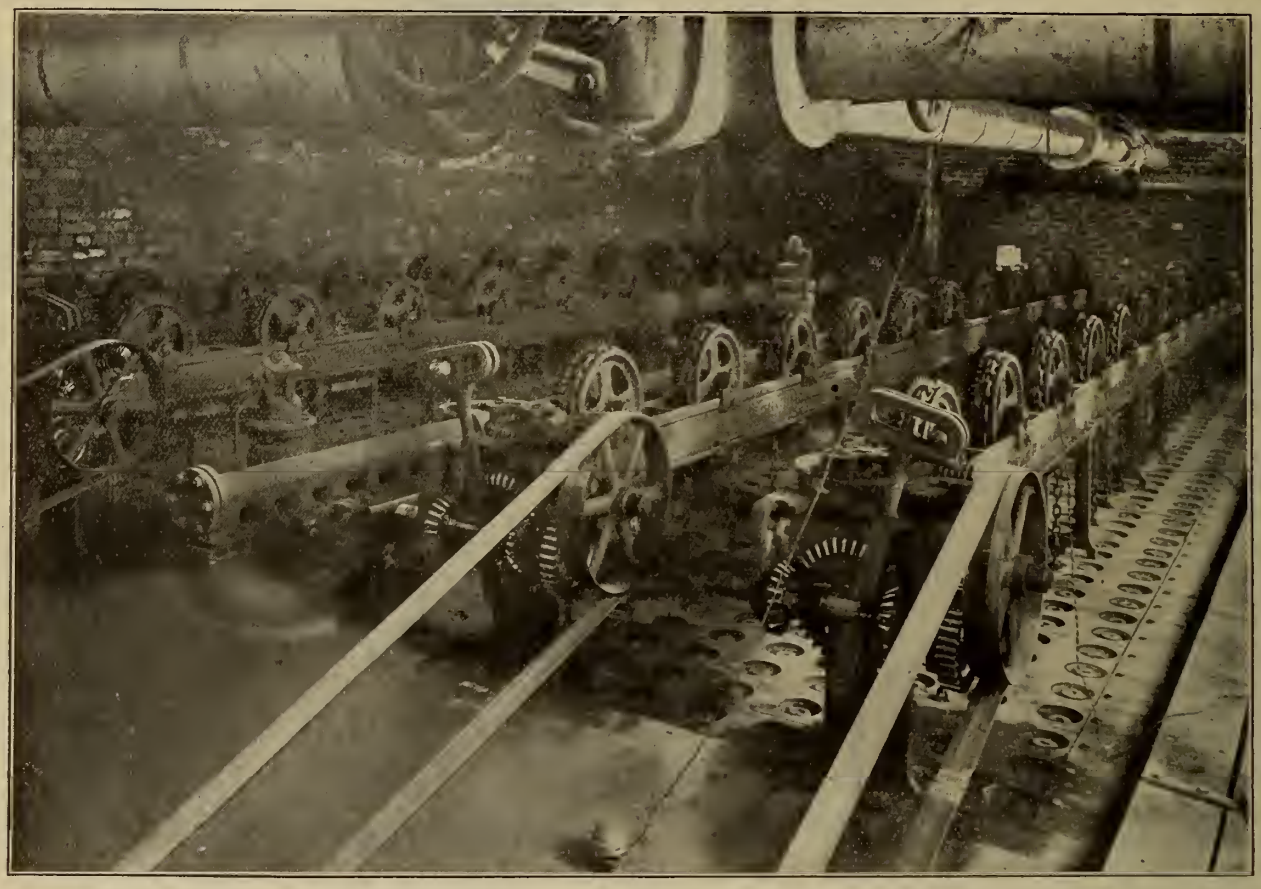
Special Terms to Hospitals, Etc.

Dominion, Provincial, and Municipal departments, hospitals, charitable, philanthropic, and similar institutions which are conducted for the benefit of the public and not for profit may purchase goods without tender at prices established by the War Purchasing Commission.

Returned Soldiers and Sailors and Widows and Dependents of Soldiers and Sailors killed in the War may obtain supplies for their own personal use and not for re-sale, through the nearest branch of the Great War Veterans' Association, who will combine individual orders and forward to the War Purchasing Commission through the Dominion Command of the Great War Veterans' Association. These services are rendered by the Great War Veterans' Association to all parties in the classes named, whether members of the Great War Veterans' Association or not.

All communications should be addressed to the Secretary, War Purchasing Commission, Booth Building, Ottawa, who will be glad to supply lists and further details to those interested.

Fuel Economy in Paper Industry



S. D. WARREN & COMPANY, CUMBERLAND MILLS, MAINE

Two of the four Green's Economizers in the above paper mill showing the scraper drive mechanism

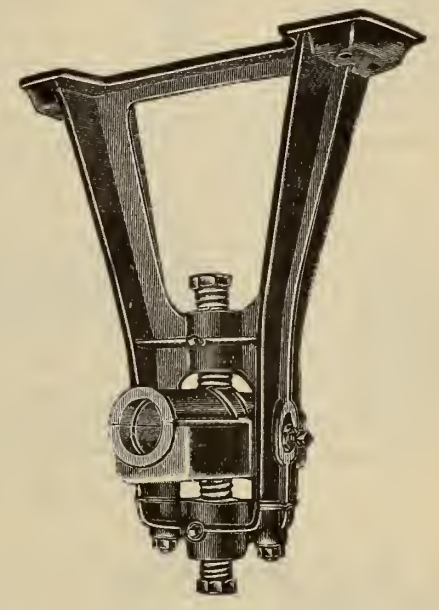
GREEN'S FUEL ECONOMIZERS

are saving coal in every industry, not only in the United States and Canada, but wherever steam is generated by stationary boilers.

The above installation, totaling 1264 twelve-foot tubes, has just been made to replace the old Green's Economizers which have been giving satisfactory service since 1899.

Also Green's Hi-Speed Hi-Efficiency Radial Flow Fans furnish the draft for this plant.

GREEN'S ECONOMISER, LIMITED.
TORONTO



Fairbanks-Morse Transmission

Fairbanks-Morse transmission has long been recognized through its high Standard of quality, its permanence and economy.

We are prepared to help you solve many of your transmission problems by means of Fairbanks-Morse transmission and the benefit of the experience of our transmission experts.

Fairbanks - Morse transmission equipment includes shafting, hangers, pulleys, belt, couplings, friction clutches, shifters, dynamos and engines.

The largest stock in Canada guarantees you the best selection.

The Canadian Fairbanks-Morse Co., Limited

"Canada's Departmental House for Mechanical Goods"

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

STEEL MAKING IS GOING AHEAD NOW

Work at Sydney Commences After a Shut-Down Lasting for Some Weeks

Sydney.—Steel making is once more in progress at Sydney Mines. After a shut-down of three and a half months, a portion of the open hearth furnaces of the Nova Scotia Steel and Coal Company are once again producing ingots. The re-lining of the blast furnace has just been completed, and steel officials expect to have the furnace blown in within the next few days. Under the most favorable conditions it takes several days to relight a furnace and produce a cast, but it is not the intention of the officials to force a quick cast, as the new lining is to be given every chance to become gradually accustomed to the increasing heat pressure. The blast furnace and open hearth furnaces were closed down about the first of July and have been under repairs ever since then. The first ingots since that date were produced a few days ago. As far as could be learned winter prospects at the Scotia plant during the coming winter are fairly bright. This seems to be particularly true as regards the steel industry. The company, it is understood, have some fairly large orders in view, but have not yet closed with them. Negotiations are in progress, and unless some unforeseen obstacle arises, the contracts will shortly be completed. The situation at the collieries of this company seems to be somewhat uncertain at present. Just now three of the four collieries of the company are working every day, while the other, the Jubilee, operates from three to four days per week. Whether this situation will continue indefinitely will depend largely on market conditions.

Paul O. Abbe, 30 Broad St., New York City, have issued a condensed catalogue (F), listing specialties such as ball and pebble mills, rotary cutters, mead mills, hammer mills, bolting reels and mixers. Bolting cloth, grinders and vacuum pumps are also listed.

The Marconi Wireless Company of Canada have removed their main offices from 173 William Street (the plant location), to 11 St. Sacrament St., Montreal, in the heart of the business district.

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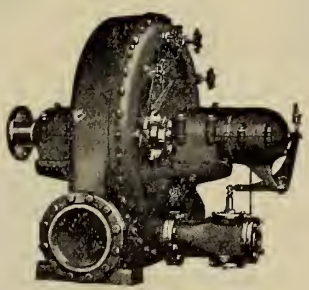

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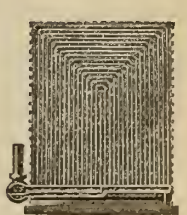
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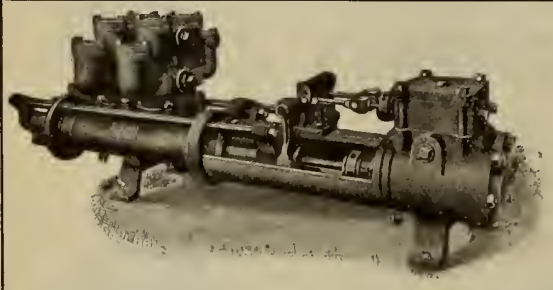

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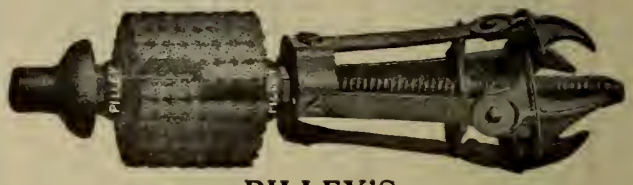

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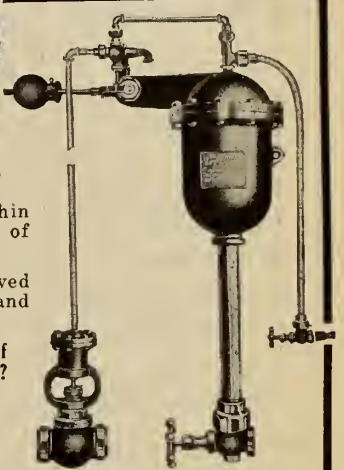

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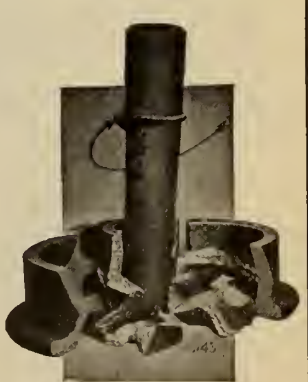

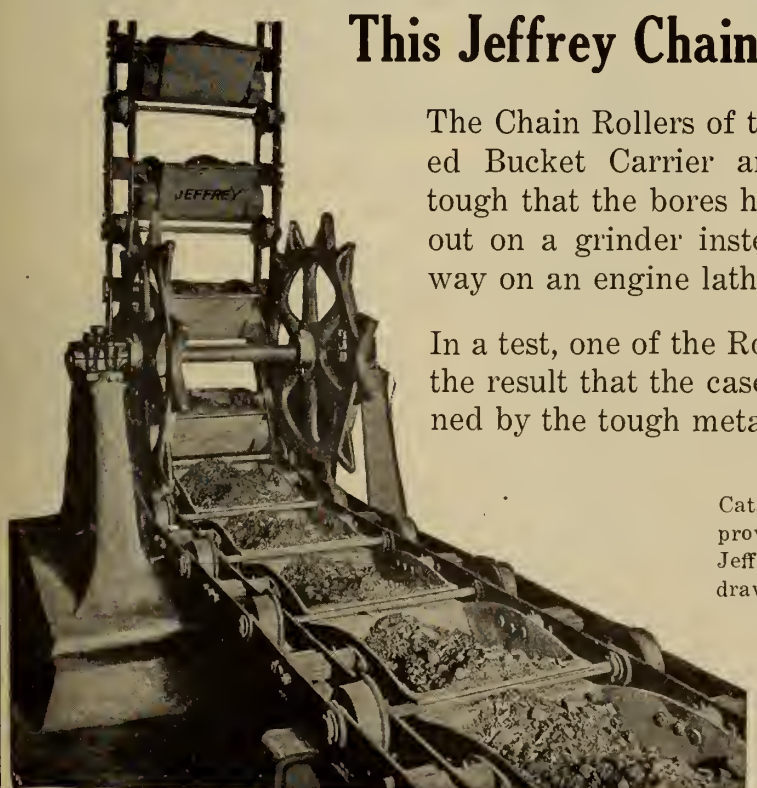

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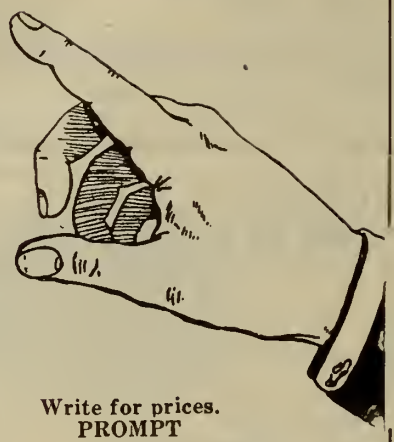

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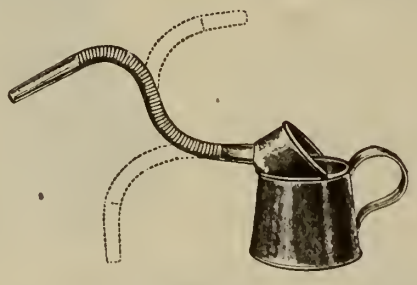

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D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

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Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.
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Can. Link-Belt Co., Toronto, Ont.
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RALPH CONNOR

On "The New Canada and Its Needs"

RALPH CONNOR, the famous Canadian novelist, who served for several years at the front and saw the war from many angles, is convinced that Canada must be prepared to make important changes if she is to profit by the lessons of the war. He has written a series of articles embodying his views and calling vigorously on patriotic Canadians to awake to the needs of the hour. The articles, which deal with economic, social and Imperial topics, were written for MACLEAN'S MAGAZINE and the first appears in the November issue, under the title: "The New Canada and Its Needs."

Every Mother Who Lost a Son at the Front

will read with deepest feeling Nellie McClung's wonderful story, "Men and Money," which also appears in November MACLEAN'S. Mrs. McClung wrote this story with a purpose—to show the ease with which the world forgets the contribution these mothers made. But it is also a very fine story—real, human and gripping.

"The Idle Hands at Ottawa"

By J. K. MUNRO

The recent session of the Dominion House was in many respects an idle one. There was not a great deal done, so the members had a lot of time to stir up things, and the result was some hugely interesting political situations. All of which J. K. Munro tells about in his usual unsparing and tersely humorous way.

Remarkable Features of a Remarkable Number

The November MACLEAN'S is cram full of other big features—famous writers on vital subjects and everything **Canadian.** Look over this list:

Baroness Orczy.—The author of "The Scarlet Pimpernel," best seller of best sellers, is represented by a serial story, "His Majesty's Well Beloved."

Robert W. Service.—The great poet of the Yukon and the battlefront contributes a strong poem, "The Outlaw."

Basil King.—This great novelist who lives abroad contributes an interesting discussion on "Why I Remain a Canadian."

Janey Canuck.—An article on Mrs. Murphy's experiences as the first woman magistrate in the whole of Canada.

Camilla Kenyon.—A new novelist who promises to become a great favorite, tells a humorous story of adventure, and treasure, "Spanish Doubloons."

Stephen Leacock.—A humorous sketch entitled, "My Memories and Miseries as a School Master."

"Two Men and an Idea That Grew and Grew and Grew."—By Charles Christopher Jenkins.—A sketch of two remarkable and practically unknown Western Millionaires.

"A Little Bit of Chicken Feed."—By Allen C. Shore. A bright story combining love and business themes.

"The Rainbow Death,"—By Madge Macbeth. An intensely interesting detective story.

"The Search for Missing Men."—By Gertrude Arnold. An article on hospital experiences at the front by a young Canadian V.A.D.

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Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

FLUES, GAS AND SMOKE
Green's Economiser, Ltd., Toronto.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Wilson Mfg. Co., J. C., Belleville.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
Bowser Co., S. F., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

FURNACE LINING
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, BOILER
Ernest Bernetz, Inc., Boston.
Gates Refractories, Limited, Montreal.
Green's Economiser, Ltd., Toronto.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE GRATE BARS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont
Economy Fuse & Mfg. Co. of Canada, Montreal
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y
Uehling Instrument Co., New York, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal, Que
Shell Bar Boico Supply Co., Toronto, Ont.
Sarco Co., Inc., New York, N.Y.

GAS ANALZERS CO-2
The Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE METERS
S. F. Bowser Company, Limited, Toronto, Ont.

GASOLINE PUMPS, SELF MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont

GASOLINE TANKS
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Wilson Mfg. Co., J. C., Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co. Brantford.
Williams Machinery Co., A. R., Toronto.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto, Ont
Goldie & McCulloch Co., Galt.
Leonard & Sons., E., London, Ont.
Mason Regulator & Engineering Co., Montreal
Shell-Bar Boico Supply, Ltd Toronto, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
The Mason Regulator & Eng. Co., Ltd., Montreal
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co. Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
The Mason Regulator & Eng. Co., Ltd., Montreal
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T. St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
The Mason Regulator & Eng. Co., Ltd. Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

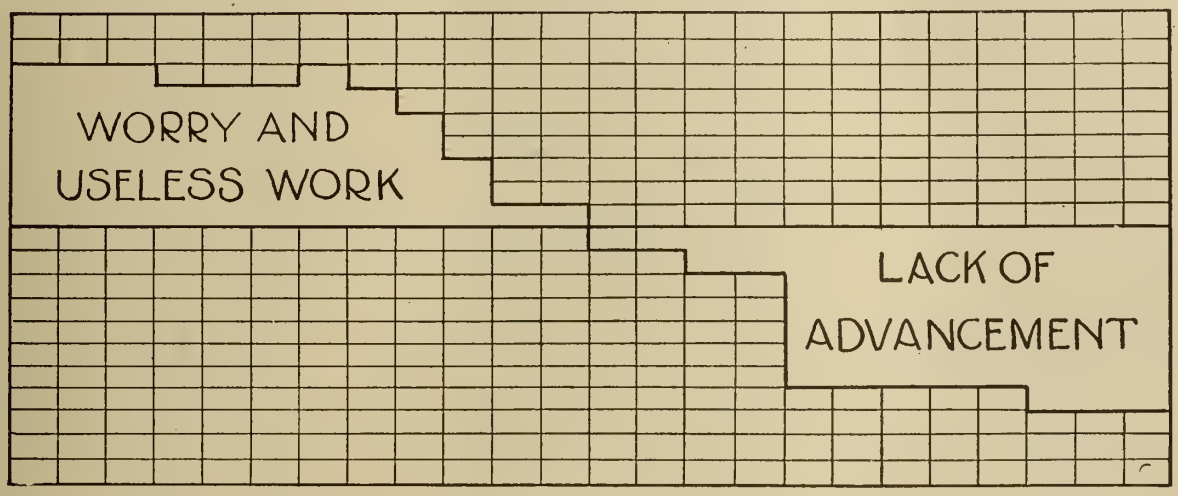
HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont
Gutta Percha & Rubber Limited, Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

If interested tear out this page and place with letters to be answered.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.
HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.
HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.
HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
HYDRAULIC POWER EQUIPMENT
Hamilton Co., Wm., Peterboro, Ont.
ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Norwalk Iron Works, South Norwalk, Conn.
York Mfg. Co., York, Pa.
INGOTS
Empire Mfg. Co., Ltd., London, Ont.
INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.
INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York, N.Y.
INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.
INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.
INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.
INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.
INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.
INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.
KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, England.
KEROSENE PUMPS (SELF MEASURING)
S. F. Bowser Company, Limited, Toronto, Ont.
KEROSENE TANKS
S. F. Bowser Company, Limited, Toronto, Ont.
Green's Economiser, Ltd., Toronto.
KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.
LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
D. K. MacLaren, Ltd., Montreal, Que.
LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.
LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.
LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.
LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.
LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, South Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, AIR
E. J. Philip & Sons, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
METERS, FLOW
Republic Flow Meters Co., Toronto.
METERS, GAS
E. J. Philip & Sons, Toronto, Ont.
METERS, STEAM
American District Steam Co., North Tonawanda, N.Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.
MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Company, Limited, Toronto, Ont.
MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OIL METERS
S. F. Bowser Company, Limited, Toronto, Ont.
OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.
OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.
OIL PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
OIL TANKS
S. F. Bowser Company, Limited, Toronto, Ont.
OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton
OILS, QUENCHING
Imperial Oil, Ltd., Toronto.
OILING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.
OILS, ENGINE
Imperial Oil, Ltd., Toronto.
ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo.
OVERALLS
R. G. Long & Co., Toronto, Ont.
PACKING, ASBESTOS
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
PACKING, ALL KINDS
Garlock Packing Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.
PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The Hartford, Conn.
PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.
PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.
PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited, Toronto.
PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
PAINT, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto.
PAPER, INSULATING, ETC.
Beveridge Paper Co., Ltd., Montreal, Que.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
PIPE COILS
Frick Co., Waynesboro, Pa.
York Mfg. Co., York, Pa.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.
PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.
PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wilson Mfg. Co., J. C., Belleville.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.
Williams Machinery Co., A. R., Toronto.
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
PLATE WORK
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.
PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
POWER, TRANSMISSION MACHINERY
Boyd Engineering Works, Toronto, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Engineering and Machine Works of Canada, Ltd. St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.
PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.
J. C. Wilson Mfg. Co., Belleville, Ont.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipment Co., Worcester, Mass.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Works, South Norwalk, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, CONTRACTORS'
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, BOILER FEED
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, CENTRIFUGAL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester, Mass.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GAS
Norwalk Iron Works, South Norwalk, Conn.

PUMP GOVERNORS AND REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

PUMP STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich.
S. F. Bowser Company, Limited, Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co. Hamilton, Ont.

PUMPS, STEAM TURBO
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.

PUMP TANK, RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek, Mich.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

PYROMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
The Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

PUMPS, CENTRIFUGAL
Escher, Wyss & Co., Montreal.
Uehling Instrument Co., New York. N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Brothers, Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RECORDERS, DRAFT
Jas. W. Hayes Corp., Michigan City, Ind.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.

RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Limited, Toronto, Ont.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

REGISTERING MEASURES
S. F. Bowser Company, Limited, Toronto, Ont.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.

RECORDING INSTRUMENTS
Defender Automatic Regulator Co., St. Louis, Mo.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
The Jos. W. Hays Corp., Michigan City, Ind.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Norwalk Iron Works, South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, PRESSURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

ROTARY COMPRESSORS
Escher, Wyss & Co., Montreal.

ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal
MacGovern & Co., Inc., Montreal, Que.

RUBBER HOSE
Can. H. W. Johns-Manville Co. Toronto, Ont.
Garlock Packing Co., Hamilton Ont.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Frank Gilman, Birmingham, Eng.
Green's Ecouomiser, Ltd., Toronto, Ont.

SELF-MEASURING PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.

SHAFTING
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Belleville, Ont.

SHAKING AND DUMPING GRATES
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTER LININGS
Beveridge Paper Co., Montreal, Que.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Hamilton Co., Wm., Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke, Que.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Watson & McDaniel Co., Philadelphia.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia. Pa.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St., Montreal, Que.
Mason Regulator & Engineering Co., Montreal.

Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford, Ont.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Dertoit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Canadian Allis-Chalmers, Ltd., Toronto.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOTWATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Can. H. W. Johns-Manville Co., Toronto, Ont
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

TANKS, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Mfg. Co., York, Pa.

TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
S. F. Bowser Company, Limited, Toronto, Ont.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
St. Catharines, Ont.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS (UNDERGROUND STORAGE)
S. F. Bowser Company, Limited, Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION, SILENT CHAIN
Morse Chain Co., Ithica, N.Y.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

TRAPS, STEAM AND WATER-LINE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que
Canadian Fairbanks-Morse Co., Montreal.
Victoria Foundry Co, Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester, Mass.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (Vacuum and Gas Filled Types)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York, N.Y.

TURBINE WATER WHEELS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg. Co., Belleville, Ont.

TURBINES, STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Engr. & Equip. Co., Worcester, Mass.
Escher Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Canadian Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNDERGROUND TANKS
S. F. Bowser Company, Limited, Toronto, Ont.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VACUUM GOVERNORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Canadian Steam Boiler Equipment Co., Toronto
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

VACUUM REGULATING VALVES
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

VACUUM TRAPS
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

VALVE DISCS
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVE LEATHER
Beveridge Paper Co., Ltd., Montreal, Que.
Graton & Knight Mfg. Co., Montreal.

VALVE RESEATING MACHINES
Darling Bros., Montreal.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Montreal.
Can. Steam Boiler Equipment Co., Toronto, Ont
Empire Mfg. Co., Ltd., London, Ont.
Darling Brothers, Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Victoria Foundry Co, Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Mfg. Co., York, Pa.

AIR VALVES
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Engineering Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
York Mfg. Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, BRASS
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, BLOW-OFF
The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa

VALVE CHAIN WHEEL
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babbitt Steam Specialty Co., New Bedford, Mass.

VALVES, FOOT
Shell Bar Boico Supply, Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Smart-Turner Machine Co., Ltd., Hamilton.

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Lunkenheimer Co., Cincinnati, O.
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Jas. Morrison Brass Mfg. Co., Toronto.
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H. Mueller Mfg. Co., Ltd., Sarnia.
McAvity & Sons, T., St. John, N.B.
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VALVES, REDUCING
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Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Mason Regulator Co., Boston, Mass.
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VALVES, STANDARD, GLOBE ANGLE AND CHECKS
Kerr Engine Co., Walkerville, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
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VALVES, POP
The Mason Regulator & Eng. Co., Ltd., Montreal
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
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Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
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Smart-Turner Machine Co., Ltd., Hamilton

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
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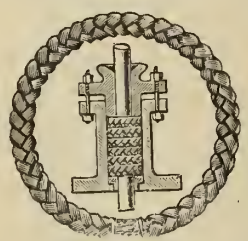

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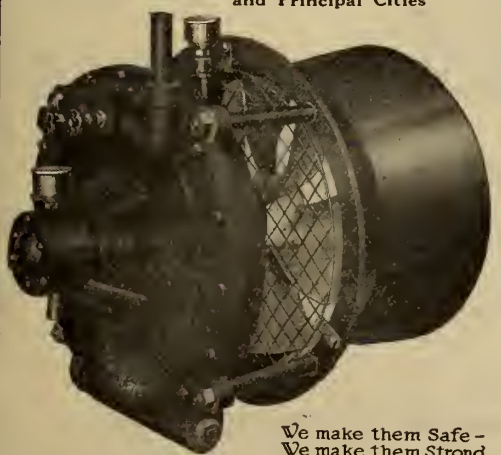

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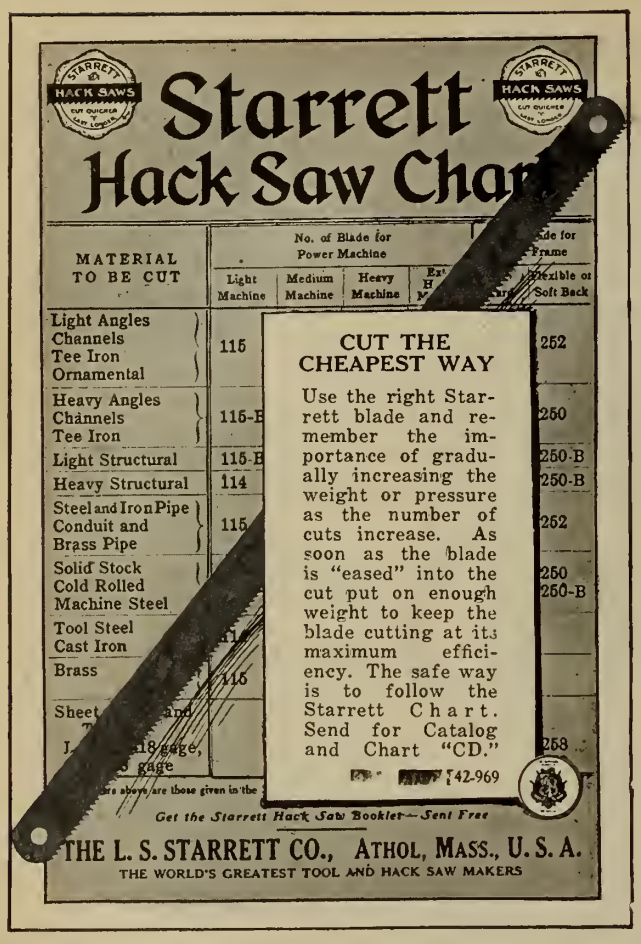
Starrett
Hack Saw Chart
MATERIAL TO BE CUT
No. of Blade for Power Machine
Light Machine
Medium Machine
Heavy Machine
Light Angles Channels Tee Iron Ornamental
Heavy Angles Channels Tee Iron
Light Structural
Heavy Structural
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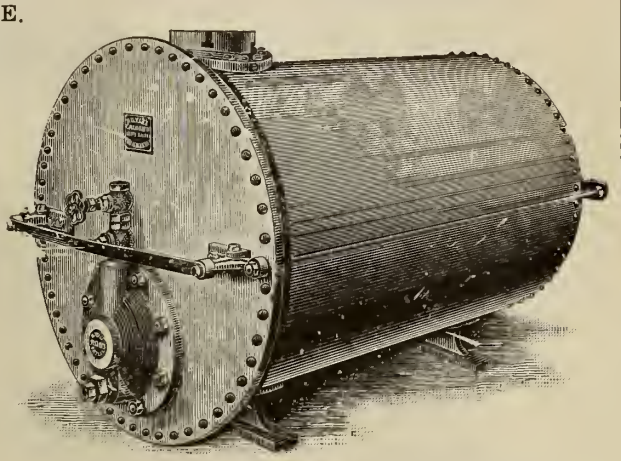
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"Beaver" Check Valve.
Bronze.

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"Beaver" Globe Valve
Bronze.

"Beaver" Check Valve.
Iron body, bronze mounted.

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Iron body, bronze mounted.

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Iron body, bronze mounted.

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MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1103 Union Trust Bldg.

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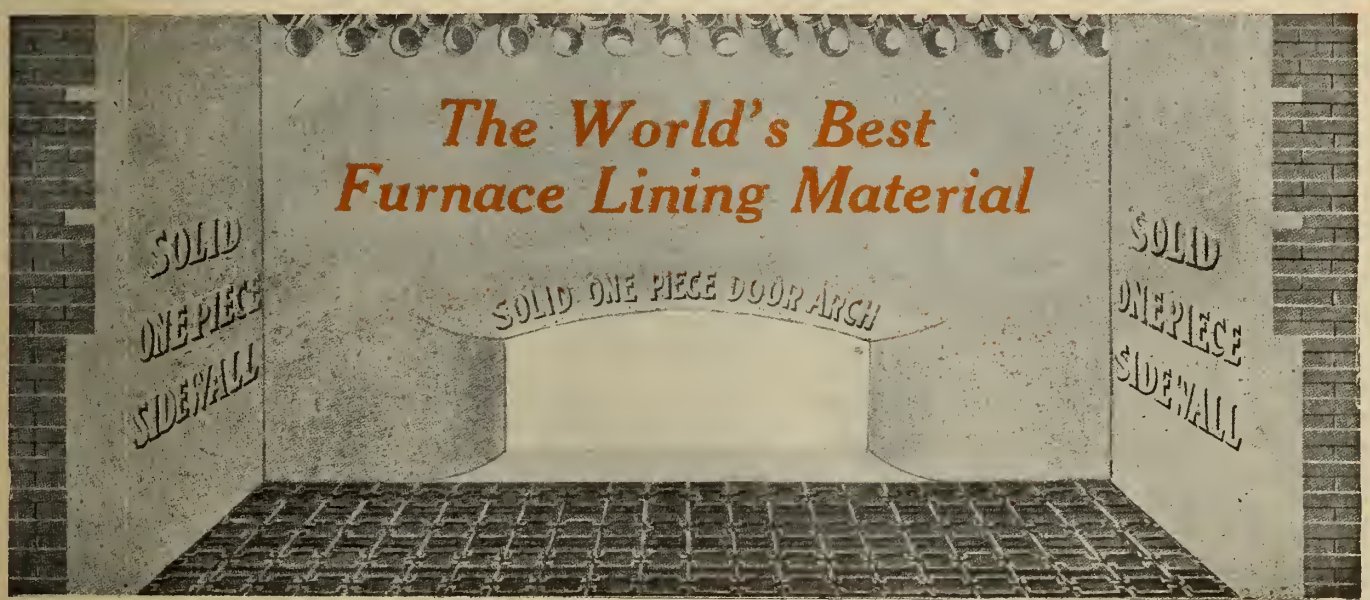

Sketch above represents the fire box of a water tube boiler lined with PYRO PUTTY.

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FIRE BRICK IN PUTTY FORM

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Minimizes Upkeep Expense. No Joints to Cause Air Leaks.

PYRO PUTTY comes to you in a stiff, moist, pliable, "ready-to-use" condition.

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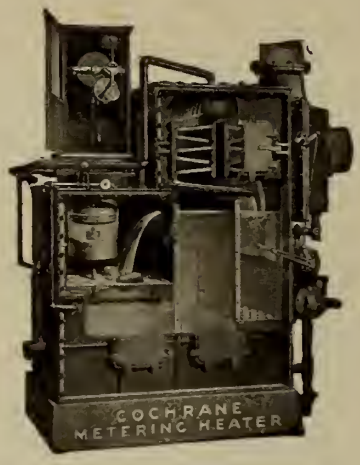
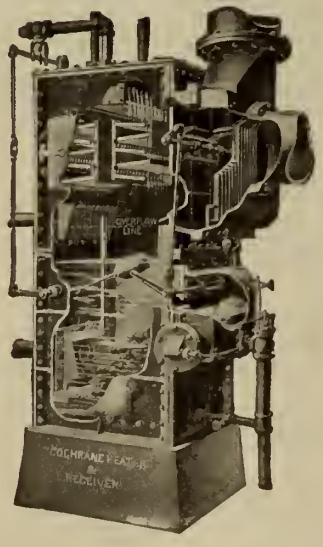
COAL SAVERS

The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Metering Heater saves coal by heating the feed water and helps save coal by telling whether or not the plant is being operated economically.

The Cochrane Multiport Back Pressure Valve saves coal by preventing leakage of exhaust steam and by making it easy to adjust the back pressure whenever desired. The Cochrane Oil Separator saves coal by rendering the exhaust steam useful for heating, drying and other purposes.



The Cochrane Open Feed Water Heater saves coal by utilizing exhaust steam to heat the feed water; 1% saving for each 11° F. rise.

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of Coal Per Year by Using Cochrane Heaters

Here are the figures:

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The corresponding amount of coal burned is 35,000,000 lb. per hour.

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The saving due to the use of Cochrane Heaters is 1% to each 11° F. rise in temperature. On the average, the water is raised from 100° F. to 210° F. using steam at atmospheric pressure, 10% or a saving of 10%. Cochrane Heaters are thus saving about $25,000,000 per year, which is vastly more than the heaters cost.

In addition, Cochrane Oil Separators are saving millions of tons of coal by purifying exhaust steam so that it can take the place of live steam in heating and drying coils, low pressure turbines and industrial processes.

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3—40 H. P.
3—60 H.P.

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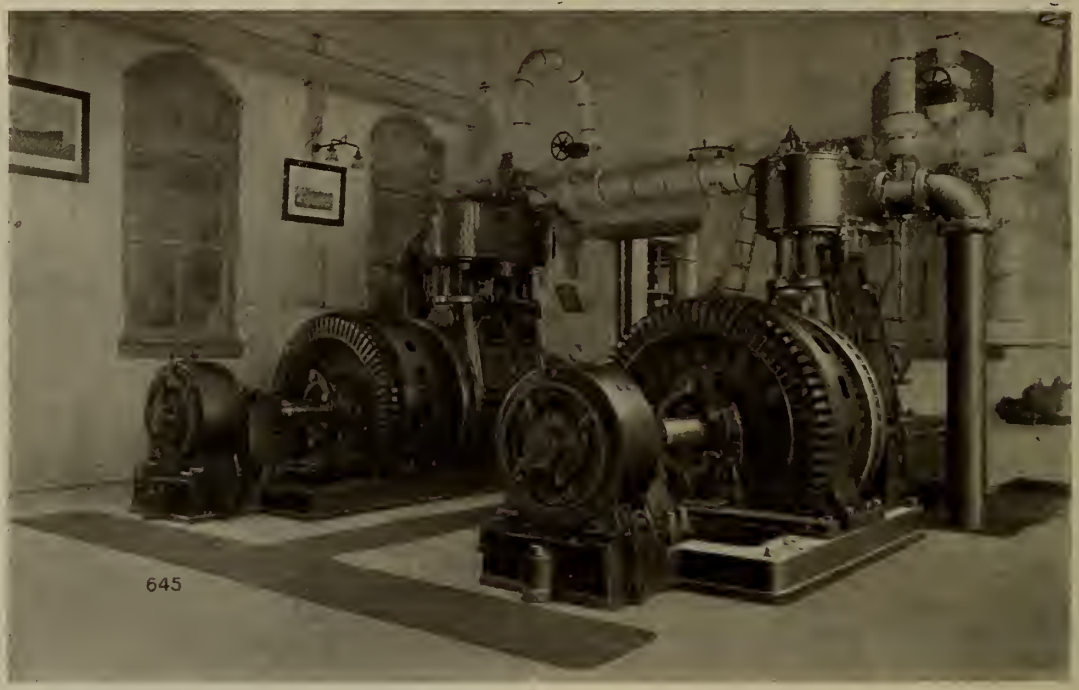

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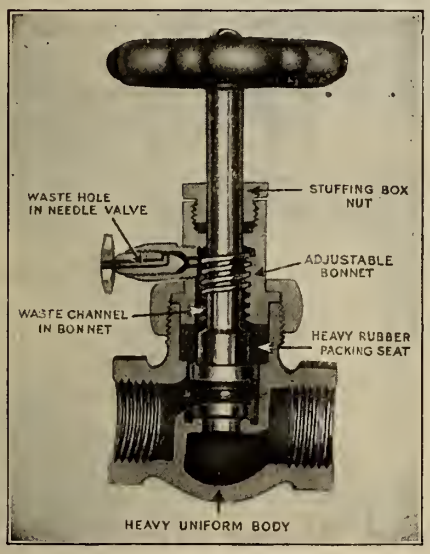

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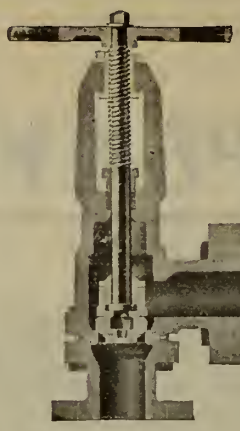

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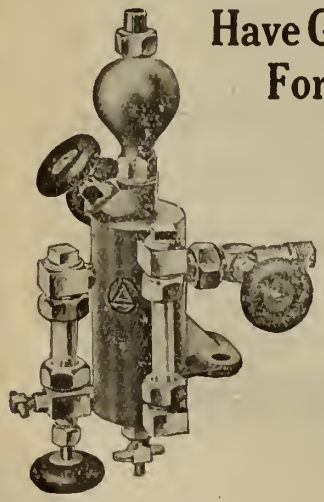

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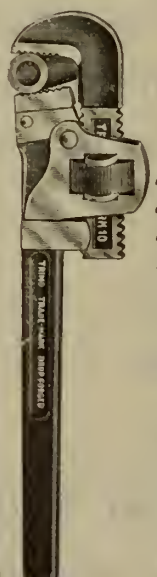
TRIMO

THE WORD TRIMO



Stands for good tools made by the Trimont Mfg. Co., which are the following:—

The Trimo Pipe Wrench
The Trimo Chain Pipe-Wrench
The Trimo Monkey Wrench
The Trimo Pipe Cutter (Hand)

The four good points that make **Trimo Pipe Wrenches** superior are the **Spiral Spring** always in place—**Steel Frames** that will not break—**Nut Guards** that protect adjustment nut—and the **Inserted Jaw** in handle that can be replaced when worn—**Save Money** and buy Trimo goods, made by

Trimont Mfg. Company

xbury (Boston), Mass.

Planing Mill Fan

No. 2 Vacuum Cleaner

Sturtevant (TRADE MARK)

SYSTEMS

Autoforce Ventilator

Steam Turbine

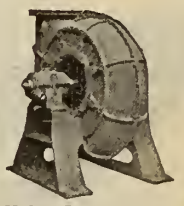
Sturtevant

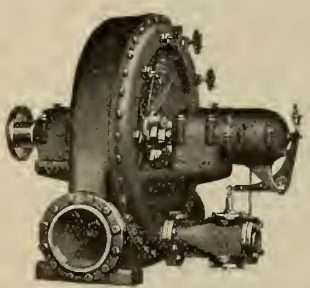
(TRADE MARK)

QUALITY STEAM TURBINES

For Dependability---For Economy

Electric Propeller Fan


Medium Pressure Blower



Low Pressure Blower

High Pressure Blower

The Product of 12 Years' Development and Refinement

THE supreme quality and rugged construction of the improved Type 6 Turbines are typically Sturtevant. They work well because they are made well. Particularly adapted to driving Sturtevant Fans, Blowers, Generators, Pumps and other auxiliaries, with the minimum in steam consumption, attention, and repairs. Built with solid rotors, having buckets milled into the rim by our own patented process. Have individually controlled nozzles with integral reverse buckets to insure the most efficient absorption of the steam velocity. Unsurpassed in close speed regulation and in protection against overspeed. Our new three-part catalog covers in detail the construction, parts, care, operation, uses, and merits of Sturtevant Turbines. *We'd like to send yours. Where?*

Volume Blower and Exhauster

Gasolene Generating Set

B. F. Sturtevant Co., of Canada, Limited

Head Office and Works:
GALT, ONTARIO

Sales Offices:
TORONTO AND MONTREAL

Turbo-Blower

Direct Current Motor

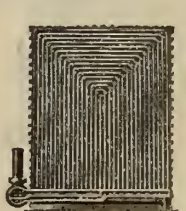
Type H Air Washer

Fuel Economizers

Sturtevant (TRADE MARK)

PRODUCTS

VS-7 Steam Engine


Heater

Garlock Packings

Have you ever considered the loss in engine efficiency due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

A horse power easily can be absorbed at the stuffing box and, when considered in dollars and cents at the coal pile, the loss would pay for a high class packing many times over.

Garlock packings are designed to meet every condition of service.

Write for catalog.

The Garlock Packing Company

Hamilton, Ontario

BRANCHES

Montreal, Quebec
Toronto, Ontario
Winnipeg, Manitoba
Calgary, Alberta

Asbestos—

the only rock on which plants thrive

INDUSTRY thrives most where waste is least. And since the development of Asbestos has gone hand in hand with the saving of heat, power and friction, this mineral of wonderful qualities has played an important part in Industrial Conservation.

It is the base of all efficient heat insulation—the necessary *other* 15% in 85% magnesia.

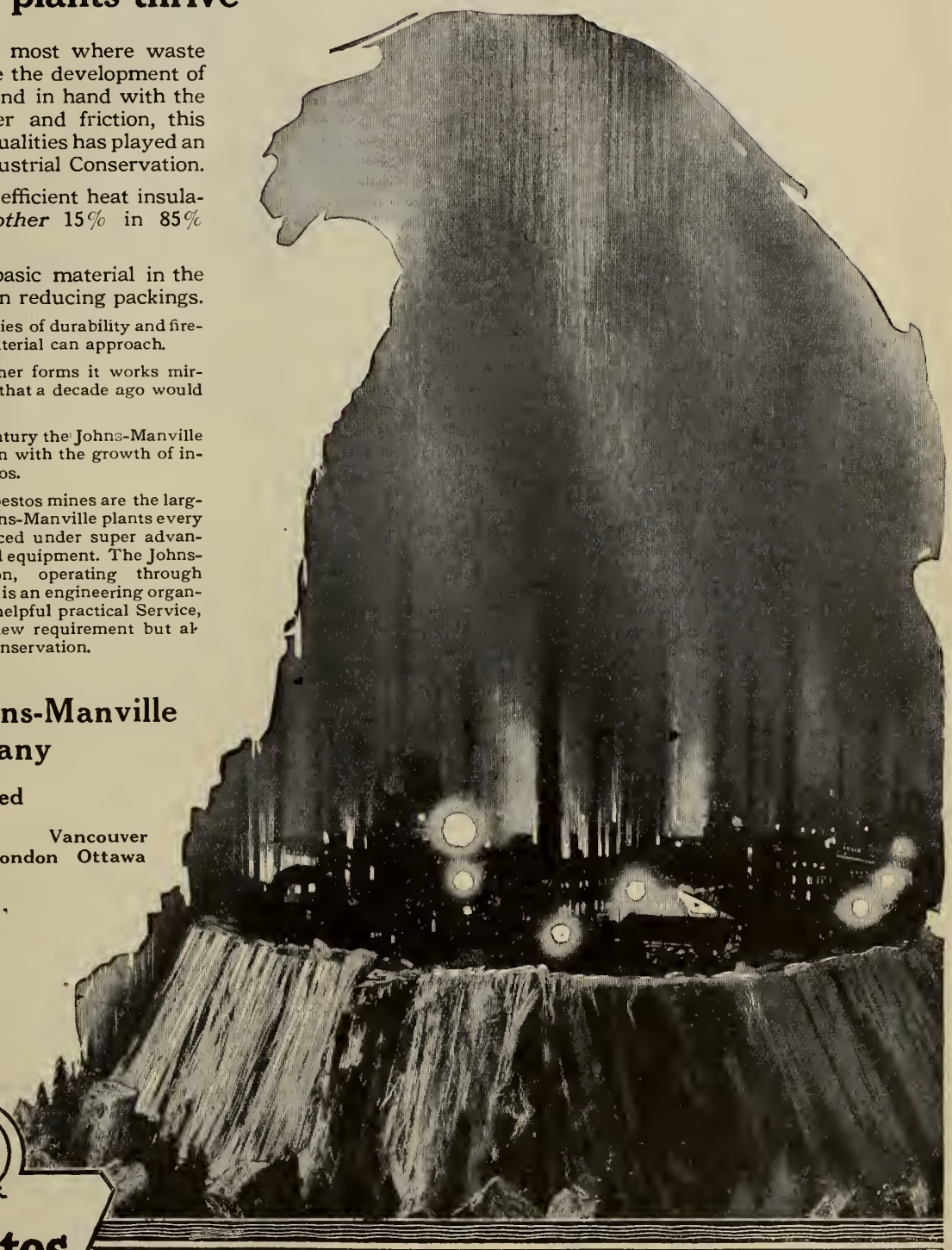
It is, as well, the basic material in the most efficient of friction reducing packings.

As roofings it has qualities of durability and fire-resistance that no other material can approach.

And in innumerable other forms it works miracles of industrial economy that a decade ago would have seemed impossible.

For more than half a century the Johns-Manville Company has steadily grown with the growth of industrial demand for Asbestos.

The Johns-Manville asbestos mines are the largest in the world. In the Johns-Manville plants every Asbestos product is produced under super advantages both of experience and equipment. The Johns-Manville sales-organization, operating through branches in all large cities, is an engineering organization as well, carrying a helpful practical Service, that varies to meet each new requirement but always has for its object—Conservation.



Canadian Johns-Manville Company

Limited

Montreal Toronto Vancouver
Winnipeg Hamilton London Ottawa

Johns-Manville Asbestos Products include: Brake Linings and Blocks, Insulations, Cements, Packings, Electrical Devices, Tapes, Clothes, Yarns—hundreds of products that enter every avenue of science and the useful arts.

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

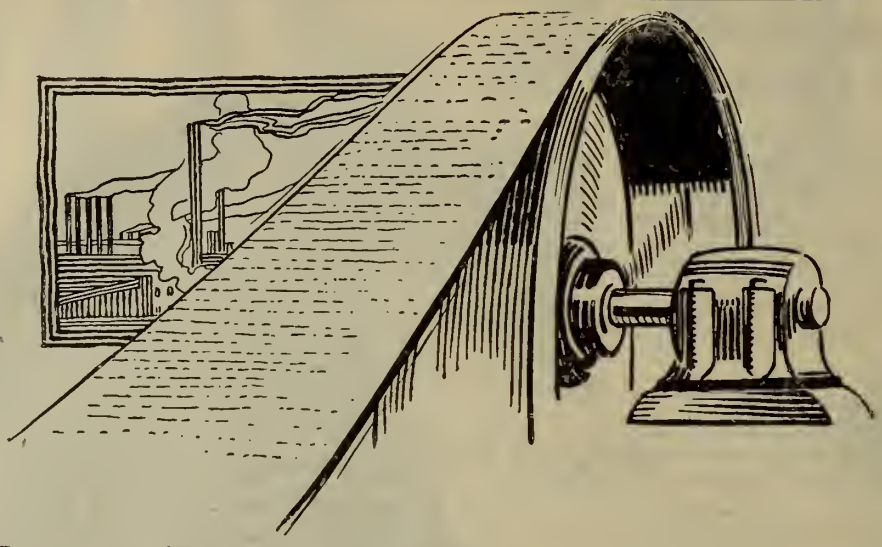
Through—

Asbestos

and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS - MANVILLE
Serves in Conservation



A Short Route to Increased Production

Efficiency of equipment is the shortest route through which you can increase production, and offset the high cost of material and labor.

Your first consideration should be to get the most out of the power that you are paying for.

Dominion Friction Surface Belting

will transmit as near one hundred per cent. of each power unit as can be transmitted by a belt.

During more than fifty years of experience in belt building for power transmission, we have perfected a special friction compound that acts not only as a water-proofing, as a vulcanizer to the fabric plies of the belt, but enables Dominion Friction Surface Belting to take a grip on the pulleys that practically eliminates all power waste.

Our engineers will be glad to show you, without charge, how Dominion Friction Surface Belting shortens the route to increased production, thereby lowering *your* manufacturing cost. Their services are available through our nearest Service Branch.

CANADIAN CONSOLIDATED RUBBER CO. LIMITED
DOMINION RUBBER SYSTEM
AND ASSOCIATED COMPANIES

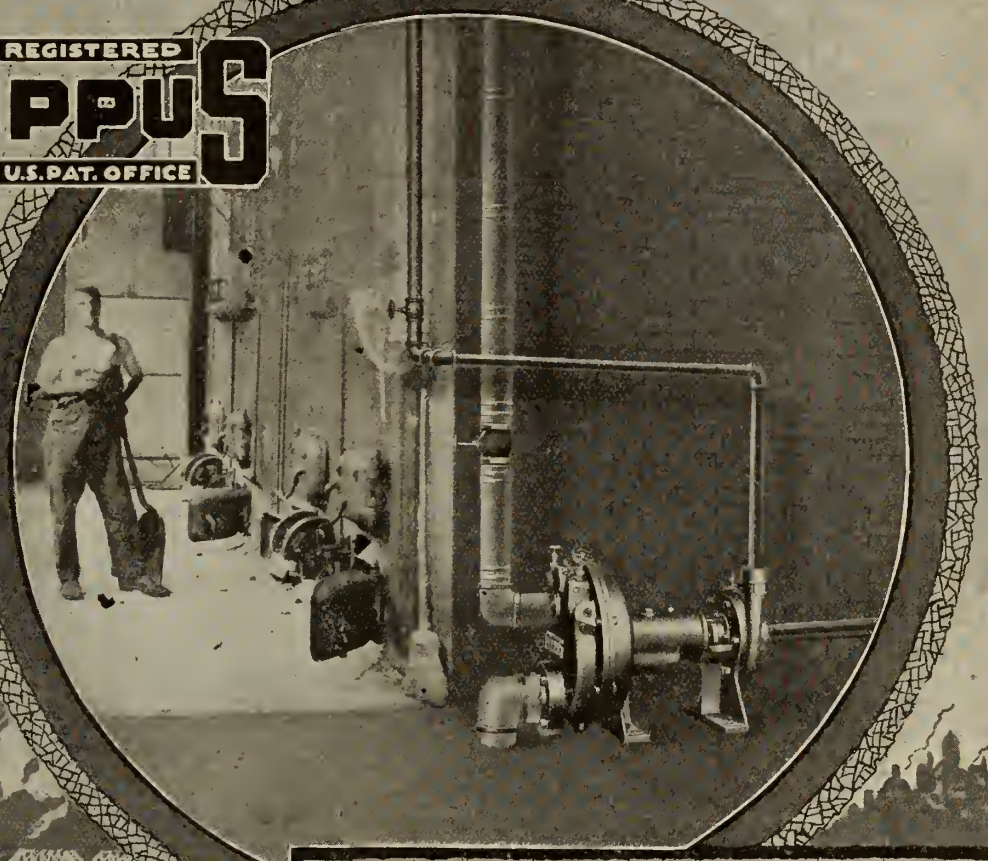
Makers of Dominion Hose, Packing and Industrial Rubber Goods and Dominion Tires, the GOOD Tires for every purpose.

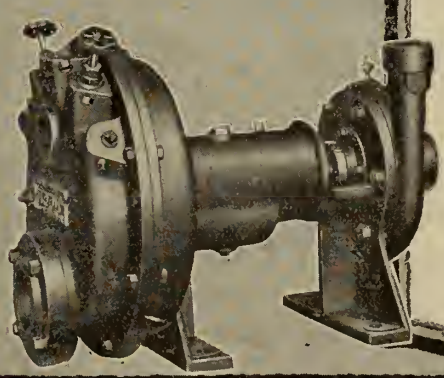
Service Branches:

Halifax
St. John,
Quebec,
Montreal,
Ottawa,
Toronto,
Hamilton,
London,
Kitchener,
North Bay,
Fort William,
Winnipeg,
Brandon,
Regina,
Saskatoon,
Edmonton,
Calgary,
Lethbridge,
Vancouver,
Victoria

57

REGISTERED
COPPUS
U.S. PAT. OFFICE





This Dependable Boiler Feeder for Your Power Plant

Possesses These Distinct Advantages:—

Simplicity of construction.
Steady feed without pulsation.
Easily controlled feed capacity.
Exhaust steam free from oil.
Less floor space required.
Lower upkeep—less attention required.
Higher Steam Economy.
Longer life—less depreciation.
Single unit construction.
Completely built in our plant.
Especially designed for the purpose.

Our Engineering Department will gladly recommend the size best suited to your particular requirements. Write to-day for Catalog H-20, and let us show you how —*"COPPUS Equipment can save you money."*

THE COPPUS ENGINEERING AND EQUIPMENT COMPANY

341 PARK AVENUE WORCESTER, MASS.

AGENTS: Montreal, Mason Reg. & Engr. Co., 135 Dagenais St. Toronto, Arthur S. Leitch Co., 1001 Kent Bldg. Winnipeg, Parkhill & Hanson, Confederation Bldg.

COPPUS Centrifugal Turbo FEED PUMP

LINDE

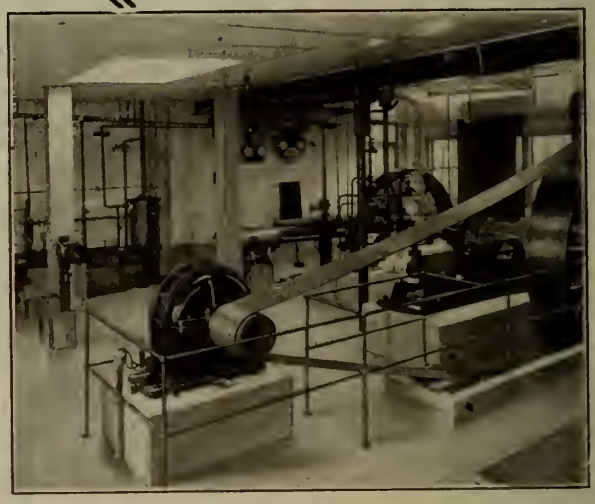
REFRIGERATING AND
ICE MAKING MACHINERY

Everything for Refrigerating and Ice Plants, large or small

Mechanical refrigeration scientifically applied means increased returns to the user. Increase your profits by installing LINDE system in place of unsanitary methods. LINDE (New) Vertical Enclosed Type Machines offer the most modern improvement and convenience for small plants from 1 to 30 tons. The large horizontal frame type guarantees unequalled service to users whose heavy demands call for loads up to 300 tons.

LINDE machines represent Quality and Service!

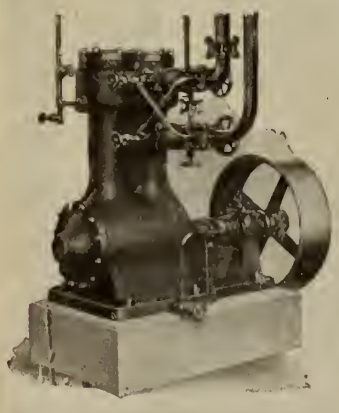
100-ton plant in operation.



Our engineering staff is at your service. Designs, specifications and estimates on request.

The Linde Canadian Refrigeration Co., Limited
37 St. Peter Street, Montreal, Que.
Toronto Winnipeg Vancouver

Makers of Quality Refrigerating Machinery Since 1896



Ice-making and Refrigerating **Machinery**

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin

Every Part of Every FRICK INSTALLATION Must Be Perfect in order to maintain

FRICK SUPERIORITY

That is why Frick Refrigerating and Ice Making Equipment proves a profitable investment wherever installed.

The entire Frick line, from the smallest to the largest plant, from the smallest part to the largest part in each plant, is designed to meet our strict standard of Durability—Efficiency—Economy. Every part must be perfect in order to maintain the well-known FRICK Superiority.

Therefore, when you purchase FRICK Equipment you are assured of perfect service regardless of the unforeseen overload demand that might be placed on it sometime—assured of continued operation without danger of breakdowns in the midst of a busy season—assured of economical operation at all times—and a long life. Frick Equipment has been standing up under the above conditions for nearly a half-century, day after day, year after year, under the most severe conditions.

You can't go wrong when you specify "Frick Equipment." **Catalog on request.**

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

Corkboard that Is *All* Cork

One important thing to be observed in the manufacture of superior corkboard is the use of **clean cork only.** Nonpareil Corkboard, known to refrigerating men everywhere for its unique service records, is made of the best cork waste available, practically all of which is obtained from the plants operated by the Armstrong Cork Company in this country and abroad. By thus going back to the sources of supply, control over the quality of the raw material is assured.

Pile to the left, cork before being cleaned. Centre pile, screenings removed in the cleaning process. Pile to the right, clean cork—the only kind used in Nonpareil Corkboard.

There are two reasons why dirt should be scrupulously guarded against in the manufacture of corkboard. First: Foreign matter reduces the insulating efficiency of the finished board. Second: If the natural gum binder gets impregnated with dirt, it cannot perform its function properly, and the result is impaired durability.

Examine a sample of Nonpareil Corkboard critically. Break it in two and look at the fractured surface. You will find it to be clean and of uniform quality throughout. For all dirt, dust and fine particles were removed from the raw material before it was baked.

If you want corkboard that is **all cork** and **good cork,** insist on "Nonpareil."

Nonpareil Corkboard Insulation

For Cold Storage Rooms

Many owners, managers and superintendents of refrigerating plants have found answers to difficult questions in the 152-page book "Nonpareil Corkboard Insulation." Do you own a copy? If not, let us send you one. There is no charge for it.

Armstrong Cork & Insulation Company, 504 McGill Building, Montreal, Quebec, Canada

MECHANICAL REFRIGERATION

SAVES MONEY ∴ HELPS BUSINESS

"We wish to express our satisfaction with your plant, which in the past several years has saved not only money and labor, but proved a business asset as well," writes one of our customers.

Here is the whole story in a few words. No addition to your business offers more certain returns on the investment than MECHANICAL REFRIGERATION.

If your business is lagging, it can be improved by the use of MECHANICAL REFRIGERATION. If your business is good, it can be made better by installing a YORK REFRIGERATING PLANT.

Write to-day for information and prices.

York Manufacturing Company

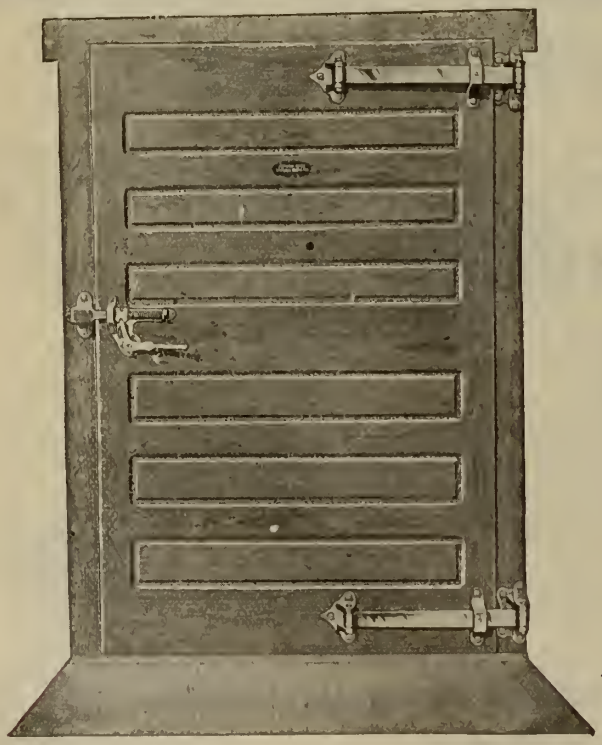
(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representatives:

Canadian Ice Machine Company

WINNIPEG, 85 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.



In the LARGEST and MOST MODERN PLANT in the WORLD, building Insulated DOORS and allied products exclusively, we are building what we KNOW to be THE BEST INVESTMENT FOR THE USER and the universally recognized WORLD'S STANDARD DOORS. In verification:

THE HARRIS ABATTOIR CO., Ltd., Canada.

"Our Coolers and Freezers are mostly equipped with your doors. In fact we adopted it as Standard throughout our plant, as we find them substantially made and the insulation perfect. We also find the Hardware stands up better than on any other door we have seen or tried."

LOUISVILLE SOAP CO., Louisville, Ky.

"Coolers at one of our plants are equipped with your doors, which have given us such satisfaction we wish to improve the doors at our old plant. We would not be warranted in throwing out the doors but would like the type hardware you supply."

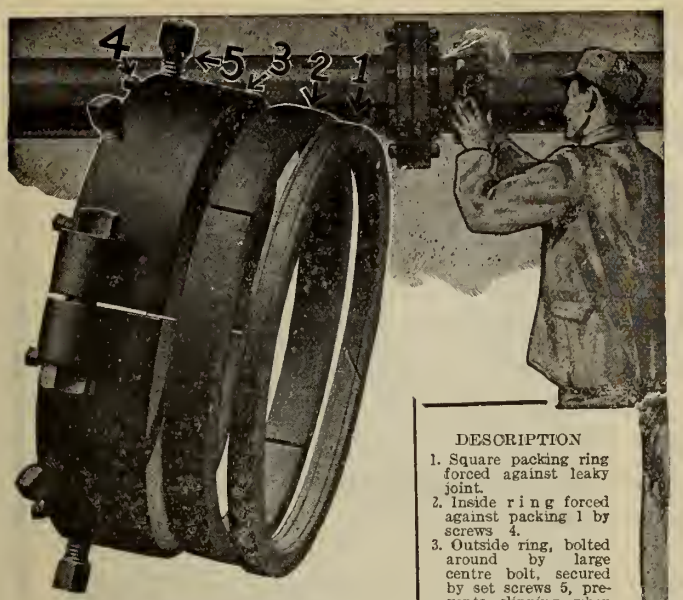
THE WASHINGTON MARKET, Washington, D.C.

"The doors supplied by you, in use at both plants, have been in every way satisfactory, and we think the Jamison door is the best on the market."

Read 'em again, men—analyze them! Acquaint yourself fully with our method of construction through latest catalog No. 9—just off the press.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.



DESCRIPTION

1. Square packing ring forced against leaky joint.
2. Inside ring forced against packing 1 by screws 4.
3. Outside ring, bolted around by large centre bolt, secured by set screws 5, prevents slipping when adjusting screws 4.

Learn the Good Points of Other Yarway Products

Yarway Seatless Blow Off Valve (formerly the Simplex).
Yarway Lea V-Notch Meter.
Yarway Automatic Boiler Skimmer.
Yarway Hydraulic Valve (Caskey Patents).
Yarway Adjustable Spray Heads (C. C. Thomas Patents).
Yarway Starting and Pressure unloader (Richards Patents).

A Quick, Sure Remedy For the Leaky Pipe Joint

The Yarway (formerly the Simplex) Pipe-Joint Clamp makes a leaky joint the tightest place in the line.

Big leak or little leak, high pressure or low, the Yarway clamp will seal it up permanently.

And the attachment can be made in a few minutes' time by any intelligent workman.

If desired the clamp may be employed as a temporary repair and used over and over again for emergencies.

In either case the Yarway will quickly pay for itself in the power that will be saved. Thousands in use.

Try one for 30 days subject to return. Write to-day.

Yarnall-Waring Company
7604-20 Queen Street
Chestnut Hill **Philadelphia, Pa.**

A. McLellan, 103 St. Francis Xavier St., Montreal.
James Robertson Company, Montreal.
Gorman, Clancey & Grindley, Ltd., Calgary.
Cunningham Hardware Company, New Westminster, B.C.

YARWAY PIPE-JOINT CLAMP
Formerly the SIMPLEX

There Is Only One Plastic Fire Brick

COMES IN THE YELLOW-TOP BARREL

Besides new work or complete remodeling, Betson's Plastic Fire Brick has found wide favor for use in temporary repairs to ordinary brick linings on water tube and horizontal return tubular boilers. Repairs with Betson's frequently make it possible to operate furnaces for long periods till there is opportunity to shut down the boiler, when the separate bricks can be completely replaced with a one-piece furnace lining that has no joints.

CATALOG ON REQUEST

Canadian Distributors

International Chemical Co.
44-46 Lombard Street
TORONTO, ONT., CANADA

49

PUT YOUR OIL STORAGE PROBLEMS UP TO BOWSER ENGINEERS

ESTABLISHED 1885

Photographs of Oil Room Before and After Installing Bowser Equipment.

Photographs of Paint Room Before and After Installing Bowser Equipment.

Planning an Oil Storage System involves important details, easily overlooked by the inexperienced. Bowser service will suggest the proper system for your oils which when in operation, will bring almost unbelievable improvements in shop conditions, safety and saving.

The illustrations shown here give a fair example of what a Bowser Oil Storage and Distributing System does for the average business, large or small. There is some type of Bowser Storage Equipment suitable for your oil handling requirements.

Ask us to make a survey of your present needs. It will show you what you can expect a Bowser Oil Storage System to save you in floor space, oils, time, labor and money. This does not obligate you to buy Bowser equipment, and you will receive valuable information from such a survey.

WRITE US AT ONCE.

S. F. BOWSER COMPANY, LIMITED

66-68 FRASER AVE., TORONTO, ONT.

LONDON
32 Victoria St. S. W. 1
HAVANA
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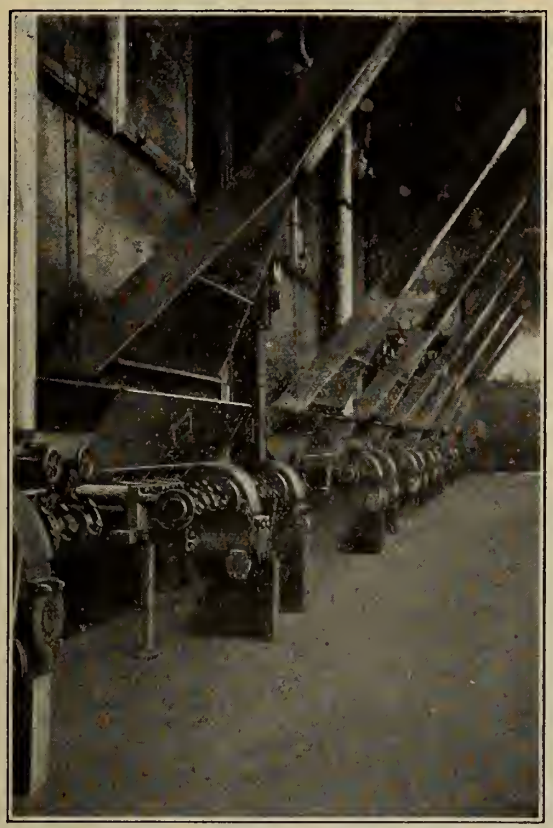
PARIS
5 Rue Denis-Poissons
SYDNEY
6 Castlereagh St.

Wasteful and a Constant Fire Hazard

Bowser Equipment—Convenient, Clean, Saving, Safe.



Eight seven-retort Riley Underfeed Stokers as installed under 600 horsepower B. & W. Boilers. Note the cleanliness of the boiler room and the absence of all operating mechanism underneath the stoker.

Riley Stokers Give
You Higher Efficiency and Lower Maintenance

The average efficiency the first year after installing Riley Stokers at this industrial plant was 72%—the maintenance $0.0035 per ton of coal fired.

RILEY UNDERFEED STOKERS

Such results have a meaning so significant that no engineer can safely disregard them.

The results are not unusual but are typical of Riley Service. They are directly traceable to the three unique Riley features—***the moving grates—the continuous automatic ash discharge—the safety connecting rod.***

These valuable features are fully described in our catalogue HR-12.

For information on the Murphy Furnace for smaller boilers, see our advertisement in the last issue or send for catalogue HM-12.

Sanford Riley Stoker Co.

Worcester, Mass.

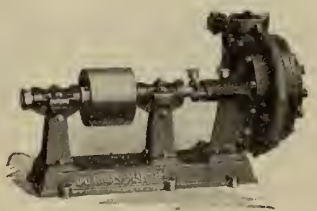
British Licensee: Erith's Engineering Co., Ltd., London. French Licensee: Erith, Leroy & Cie., Paris, France.

AMERICAN-MARSH PUMPS

SIMPLE RELIABLE EFFICIENT

The American-Marsh steam pump is an improved form of the famous Marsh Pump which has been on the market for over thirty years, during which time over 150,000 have been manufactured and sold.

The American-Marsh Pump has no internal stuffing boxes, no tappets and no slide valves. The auxiliary valve is of the semi-rotative disc type of an improved design. The main steam valve is of the balanced piston pattern, assuring highest efficiency. The water ends have large valve areas and are fully bronze fitted, including solid bronze piston rods and bronze removable water cylinder bushings.

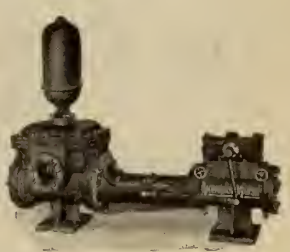


American-Marsh Centrifugal Pumps are made with the same high grade of material and workmanship which characterizes the construction of the steam pumps. They are made in all sizes up to 12 inch, both single and two stage for heads up to 250 feet.

The line also includes—

Power Pumps
Deep Well Engines
Air Compressors
Jet Condensers
Dry Vacuum Pumps
Boiler Feed Pumps

Ask for General Catalog



AMERICAN STEAM PUMP COMPANY

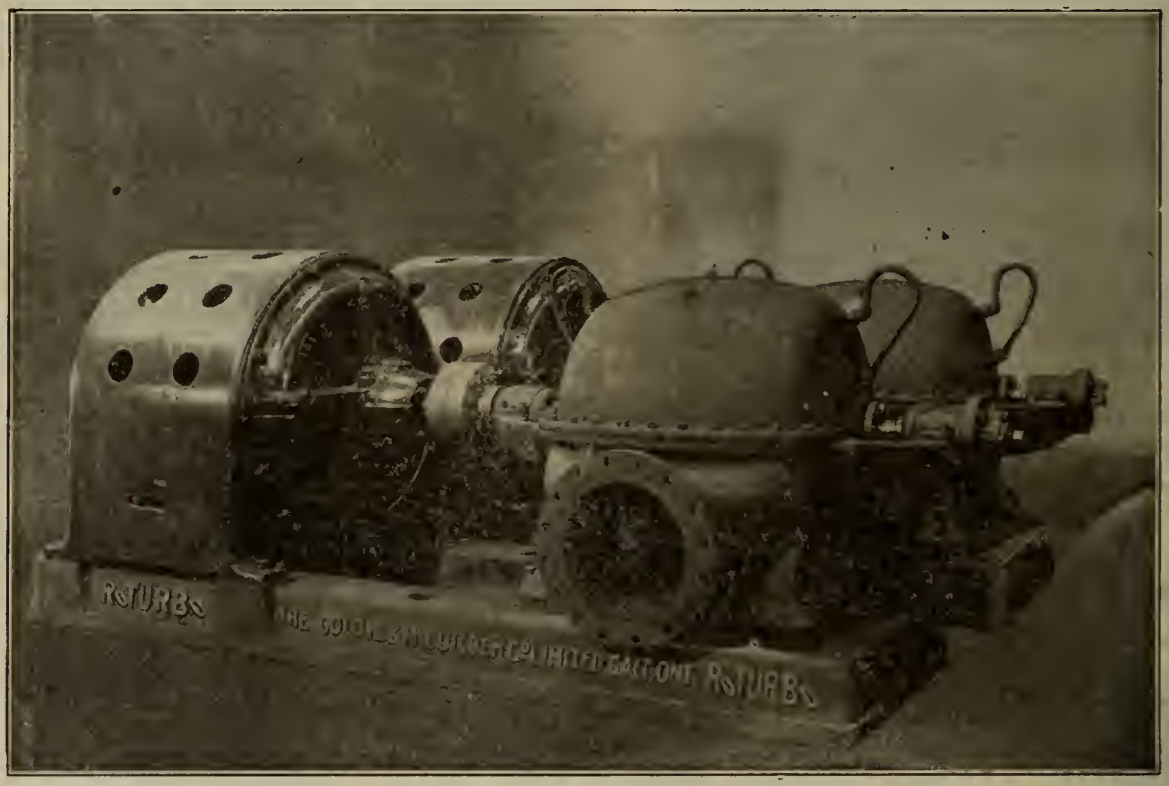
BATTLE CREEK, MICHIGAN

CANADIAN AGENTS—A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal. London Engine Supplies Co., London, Ont. Stuart Machinery Co., Winnipeg. Mechanics' Supply Co., Quebec, Que. Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.

REES RoTURBo

Patent Pressure Chamber Pumps Cannot Overload the Prime Mover

The self-regulating feature of the RoTURBo PUMP "when subjected to a variation in boiler pressure" causes it to adjust itself to meet the new conditions without danger to the prime mover.



Two Rees RoTURBo Pumps recently completed b y us for the Windsor Water Works at Windsor. Ont.

REES RoTURBo

Patent Pressure Chamber Pumps, Rotary Jet Condensers and Rotary Air Pumps are to-day giving splendid service the world over in MINES, POWER STATIONS, MARINE SERVICE, WATERWORKS and ALL KINDS of INDUSTRIAL PLANTS.

Ask for catalogues and further particulars.

Sole Canadian Manufacturers

The GOLDIE & McCULLOCH CO., Ltd.

Head Office and Works: GALT, ONTARIO, CANADA

TORONTO OFFICE:
Suite 1101-2,
Bank of Hamilton Bld'g.

WESTERN BRANCH:
248 McDermott Ave.,
Winnipeg, Man.

QUEBEC AGENTS:
Ross & Greig
400 St. James St.,
Montreal, Que.

BRITISH COLUMBIA AGENTS:
Robt. Hamilton & Co.,
Vancouver, B.C.

POWER HOUSE

Established 1907 — Published Semi-monthly

The Early History of the Steam Engine

The History of the Steam Engine May be Traced Very Far Down the Vast Avenues of Time. An Account is Given of the Development of This Prime Mover Up to the Time of Watt

By JOSEPH F. HEFFRON

IT is difficult at any time to determine the effect of any single invention on the welfare and progress of the human race; and the problem becomes doubly difficult where inventions of the first rank become crowded upon each other in rapid and bewildering succession, as they have in our own age. But notwithstanding these difficulties, when we look backward from our day, upon the progress of civilization, we are forced to the conclusion, that in the steam engine we have a central object without which, many of the notable achievements in the arts and sciences would have been quite impossible.

When in retrospection we sweep over the history of the world from the time when the Egyptians and Babylonian civilizations were at their height, and attempt a classification of the stages of progress in the mechanical arts during the intervening period, we remark a very significant fact. No great revolutionary invention disturbed the unbroken calm that prevailed throughout the world during the long centuries of pre-Christian antiquity, and in fact, this lack of development of practical mechanics upon which the outward evidences of our Occidental civilization in great measure depends, continued well into the middle ages of our newer era.

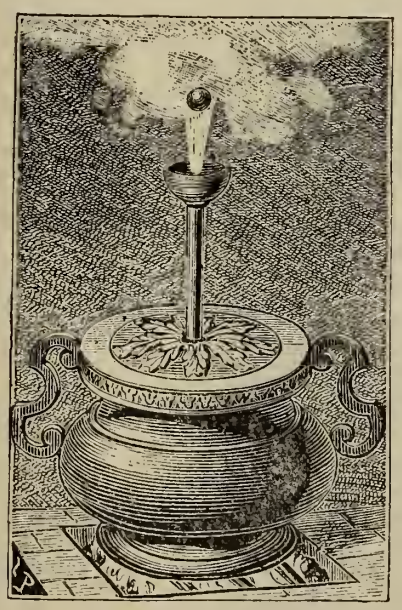


FIG. 1—HERO'S EOLIPILE.

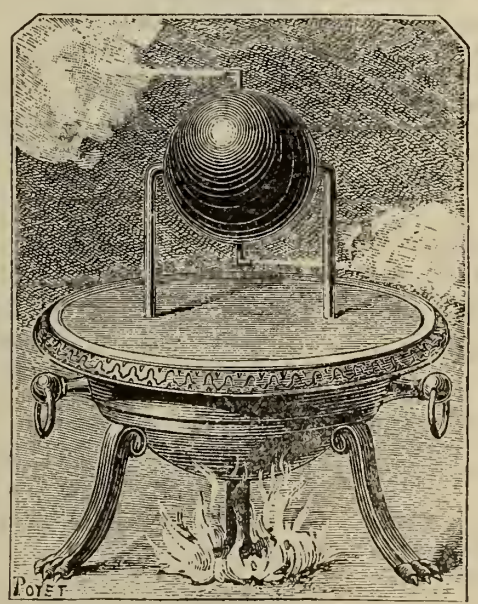


FIG. 2—HERO'S WHIRLING EOLIPILE.

The invention for which was reserved the honor of ushering in a new era was in effect a development of the eighteenth century, and did not come fully into its heritage until the early days of the nineteenth century. The invention was the application of steam to the purposes of mechanics. When this application was at last made in a practical way, a gap was crossed that was as wide as that which separated the Stone Age from the Age of Metal, and with the utilization of steam for mechanical purposes, the epoch in which the world was living when recorded history began, was brought to an abrupt close, and a new era, the Age of Steam, was ushered in.

The Earliest Known Experiments With Steam

The possibilities of the production or utilization of power from the forces of nature was but little understood by the ancients. Air as a motive power was doubtless first used through the application of sails to boats. The Phoenicians used a simple form of sail, and their example was probably followed by all the maritime peoples of subsequent periods. But even to the Phoenicians, the sail was a comparatively unimportant accessory to the galaxies of oars, which formed the chief motive power of their maritime vessels. The introduction of sails of various types adequate to propel large ships, and capable of adjustment for taking advantage of winds from almost every quarter of the compass, was a development of the Middle Ages.

It is doubtless a fact, that the existence and use of slave labor in the times referred to, made it scarcely worth while for man to tax his ingenuity in the invention of machines, since so efficient a machine provided by nature was procurable with but little expenditure of effort.

The properties of air and water were nevertheless studied at an early date by various mechanical philosophers, at the head of whom were Archimedes, the Greek mathematician and mechanician (287 B.C.), and the famous Alexandrian, Ctesibius, whose investigations are to some extent known to us through the publications of his pupil, Hero. We know little more of Ctesibius than that he lived in Alexandria, probably in the first half of the second century, B.C. His antecedents, and the place and exact time of his birth and death, are quite unknown to us. Neither are we quite certain as to the precise range of his studies or the exact number and character of his discoveries.

Of a number of the books published by Hero through which the record of the master's inventions were preserved to posterity, only one has been preserved. This work is known as "Hero's Pneumatics," and it is so interesting that it makes us doubly regret the loss of its companion volumes. For, had the remaining volumes been preserved, we should doubtless have a far clearer insight than is now possible, into some, at least, that exercised the minds of the ancient philosophers.

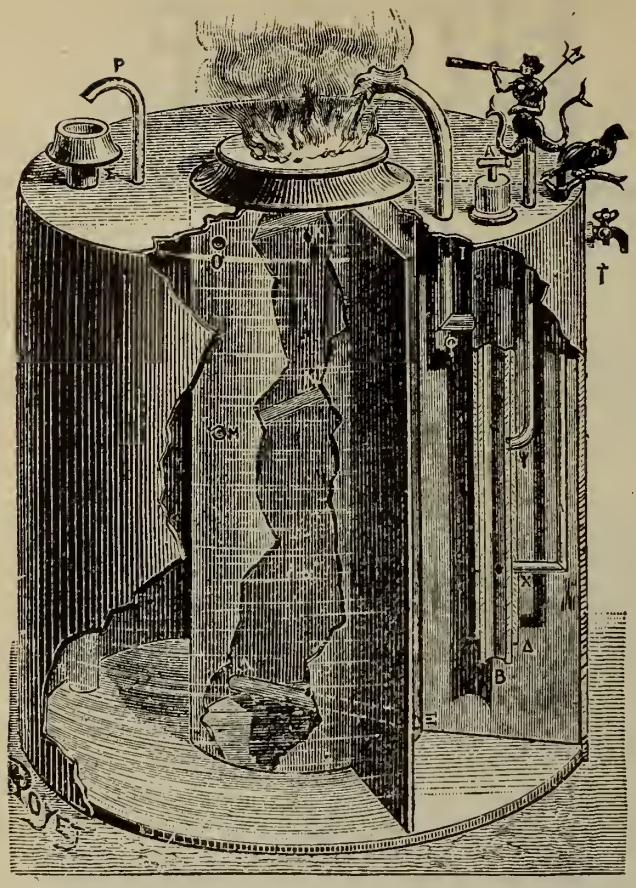


FIG. 3—HERO'S TUBULAR BOILER. SHOW OF ORNAMENTATION, ETC, THIS IS ONE OF THE EARLIEST TUBULAR BOILERS.

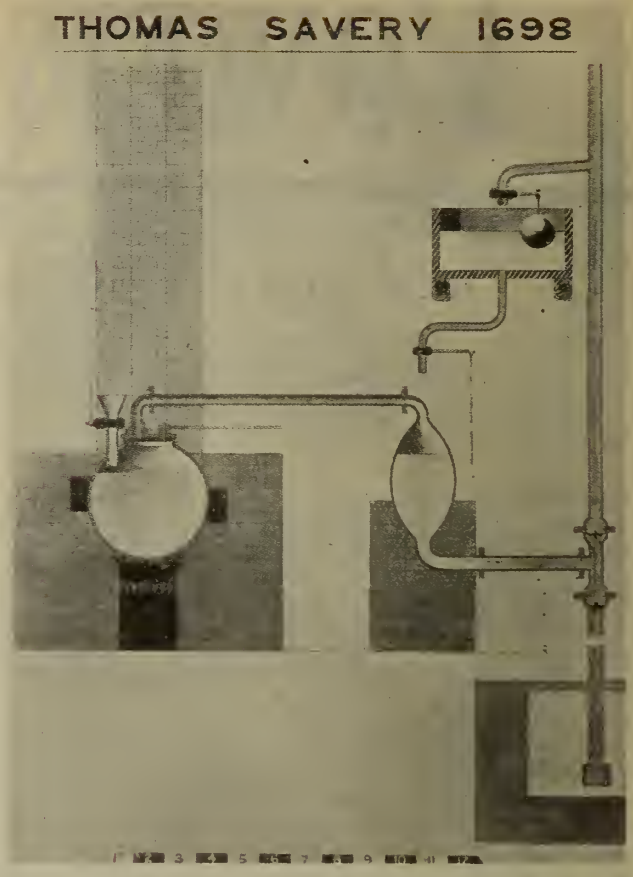


FIG. 4—THOMAS SAVERY'S STEAM ENGINE. THIS ENGINE UTILIZED THE EXPANSIVE FORCE OF STEAM AND THE SUCTION PRODUCED BY CONDENSATION TO RAISE WATER.

The contents of the "Pneumatics" as the name implies, are chiefly concerned with the study of gases, but it tells us also of certain studies in the dynamics of water, and of the invention of several pieces of apparatus that to the historian of science are of the greatest interest.

The First Record of a "Heat-Engine"

Among the devices in the "Pneumatics," we find the earliest mention of "heat-engines," and in this early work we find also the genesis of the tubular boiler and the Papin cock which was replaced in the more modern product by the long D-valve.

A literal translation of a passage from the "Pneumatics" having reference to the earliest known apparatus utilizing steam as motive power, the "eolipile" reads as follows:

"Balls may be held in the air by the following method: Fire is lighted under a boiler that contains water and is closed at its upper part. From the cover starts a tube which rises vertically, and at the extremity of which a hollow hemisphere is in communication with it. On placing a light ball in this hemisphere it will happen that the steam, on rising through the tube, will raise the ball in such a manner that it will remain suspended in the air."

Figure (1) shows a cut of the apparatus which is borrowed from a manuscript of the "Pneumatics" dating back to the Renaissance. The boiler, however, should have been placed over a fire-place which, obviously, was necessary to make the apparatus work.

Figure (2), taken from the same source, shows a view of Hero's "whirling eolipile." Here the same kind of a boiler is used. One of the two tubes bent at right angles, conducts steam into the hollow sphere which they support, and upon the escape of the steam from the interior of the hollow sphere through the smaller bent tubes facing tangentially in opposite directions at opposite ends of a diameter perpendicular to the axis, the sphere itself is caused to revolve by reaction from the escaping steam.

It does not appear that Hero had any thought of making practical use of this steam engine. It was regarded merely as a curious toy—nothing more. Yet, had not the age that succeeded that of Hero been one in which inventive genius was dormant, someone must soon have hit upon the idea that this steam engine might be improved and made to serve a useful purpose for man. As the case stands, however, there was no advance made upon the steam motor of Hero for almost two thousand years. And, indeed, when the practical application of steam was made, towards the close of the eighteenth century, it was made probably quite without any reference to the experiments of Hero, though knowledge of his toy may perhaps have given a clue to Watt or his predecessors. In recent time there has been a tendency to give this steam engine of Hero something more than full meed of appreciation. To be sure, it marked a most important principle in the conception that steam might be used as a motive power, but, except in the demonstration of this principle, the mechanism of Hero was much too primitive to be of any real importance.

Hero's Tubular Boiler

But there is another mechanism described by Hero which is of even greater interest to the scientific historian than is Hero's "whirling eolipile." This is known as Hero's "tubular boiler."

Figure (3) shows a sectional view of this boiler, and it also shows the early form of the Papin cock. In the centre we have the fireplace in the shape of a vertical cylinder, beneath which was placed an air vent—which is not shown in the illustration—around the cylindrical fireplace is the boiler, also cylindrical in form, and filled with water. Several tubes, such as O K and M N, place its various parts in communication with each other by passing through the fireplace, thus increasing the heating surface of the apparatus.

The cock T, permits the drawing off of hot water, while the funnel serves to introduce cold water into the boiler through the tube reaching to the bottom of the latter. The bent tube P, is used to permit the escape of air when water is placed in the boiler, and also served to permit the escape of steam, thus eliminating the possibility of an

ejection of water through the funnel when the apparatus was placed in operation.

In his text, Hero tells us that this tube debouches in the interior of the funnel and is therefore not easily perceived, as it is shown in the illustration for sake of greater clearness. It will be seen that there is in the boiler an angular shaped compartment formed by two vertical plates which do not permit the water to enter the compartment they form. This compartment is designed for the purpose of causing the different figures on top of the apparatus to operate, which result is obtained through the play of the steam and the several way cocks before mentioned. In the compartment will be seen two concentric tubes which are capable of revolving with slight friction one within the other. The external tube is fastened to the upper side of the boiler, and traverses it. In this tube are three apertures, each located at a different level and communicating, through smaller tubes, with the figures which are placed on top of the apparatus. The internal tube, A B, being open at its lower part, thus communicates with the interior of the angular compartment, but is closed at its upper part, which latter debouches above the upper surface of the apparatus and may be manipulated by the handle, A. This internal tube is also supplied with three apertures placed at the same level as the apertures in the external tube, but differently placed, so that when the tube, A B, is given a rotary motion by means of the handle A, one of the openings in the internal tube is brought into opposition with an aperture of the same level in the etxernal tube, and the smaller tubes referred to, communicating with the interior of the bodies of the different figures cause them to perform their various duties.

To operate the appliance, the tube A B is removed and a little water is placed in the angular compartment. This water passes into the tube A E (which passes under the fireplace and is closed at the side opposite to its aperture E,) and is converted into steam. When the tube A B has been returned to its place, it will be seen that the steam may be passed at will by turning the handle A, into the body of the bird, making it to warble, or into that of the triton, causing his trumpet to blow, or finally, into the body of the serpent, which will hiss as it blows into the fire, thus quickening the flames. The effect that the operation of this curious contrivance would have upon the credulous minds of an early and uninstructed audience can perhaps best be left to the reader's imagination.

Beginnings of Modern Discovery

Such sporadic experiments as these and of still later times, such as those conducted late in the fifteenth century by the great Italian, Leonardo da Vinci, have no sequential connection with the story of the evolution of the steam engine, but are simply of interest since they show that man had wrestled through long ages with a problem that was later on to be solved in a comparatively short space of time.

The experiments which led directly to practical achievements were not begun until the seventeenth century. In the very first year of that century, an Italian named Giovanni Battiste della Porta published a treatise on pneumatics, in which the idea of utilizing steam for the practical purpose of raising water was expressly stated. The idea enunciated by this inventor was put into effect in 1624 by a French engineer and mathematician, Solomon de Caus. He invented two different machines, the first of which required a spherical boiler having an internal tube reaching nearly to the bottom, a fire beneath the boiler produced steam which would force the water in the boiler to a height proportionate to the pressure obtained.

In the other machine, steam is led from the boiler into the upper part of a closed cistern containing the water to be elevated. To the lower portion of the cistern a delivery pipe was attached so that water was discharged under a considerable pressure. This arrangement was precisely similar to an apparatus employed by the Greek engineer Hero in various of his fountains, as regards the principle of expanding gas to propel a liquid. An important difference, however, consists in the fact that the scheme of della Porta and of de Caus embodied the idea of generating pressure simply by the aid of steam, whereas Hero had depended in most of his apparatus on the expansive property of air compressed by the water itself.

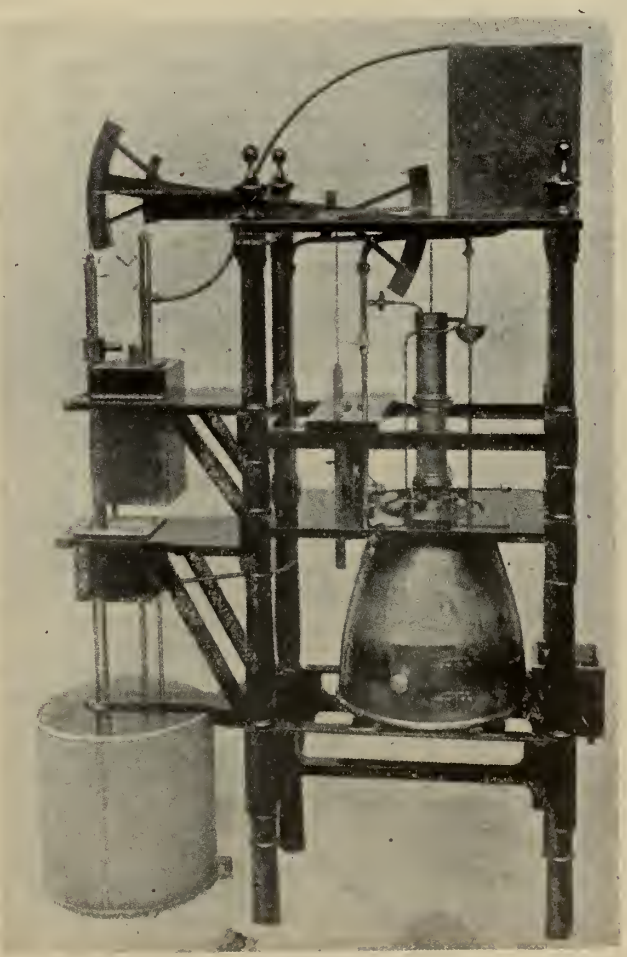


FIG. 5—A NEWCOMEN ENGINE MODEL—IT WAS ON A MODEL OF THIS TYPE THAT JAMES WATT FIRST EXPERIMENTED.

While these early mechanisms contained the germ of an idea of vast importance, the mechanisms themselves were of trivial utility. It is not even clear whether their projectors had an idea of the properties of the condensation of vapor, upon which the making of the practical steam engine so largely depends. This idea was probably first grasped about half a century later by an Englishman, Edward Somerset, the celebrated Marquis of Worcester, who, in 1663, described in his "Century of Inventions" an apparatus for raising water by the expansive force of steam. His own account of his invention is as follows:

"An admirable and most forcible way to drive up water by fire; not by drawing or sucking it upwards, for that must be as the philosopher calleth it, intra sphaeram activitatis, which is but at such a distance. But this way hath no bounder, if the vessel be strong enough; for I have taken a piece of whole cannon, whereof the end was burst, and filled it three-quarters full of water, stopping and screwing up the broken end, as also the touch-hole; and making a constant fire under it, within twenty-four hours it burst and made a great crack; so that having a way to make my vessels so that they are strengthened by the force within them, and the one to fill after the other, I have seen the water run like a constant stream, forty feet high; one vessel of water, rarefied by fire, driveth up forty of cold water; and the man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively; the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim, between the necessity of turning the said cocks."

It is unfortunate that the Marquis did not give a more elaborate description of this remarkable contrivance. The fact that he treats it so casually is sufficient evidence that he had no conception of the possibili-

ties of the mechanism, but, on the other hand, his description suffices to prove that he had gained a clear notion of, and had experimentally demonstrated the tremendous power of expansion that resides in steam. No example of his steam pump has been preserved, and historians of the subject have been left in doubt as to some details of its construction, and in particular as to whether it utilized the principle of a vacuum created through condensation of the steam.

Thomas Savery's Steam Pump

This principle was clearly grasped, however, by another Englishman, Thomas Savery, a Cornish mine captain, who, in 1698, secured a patent for a steam engine to be applied to the raising of water, etc. A working model of this machine was produced before the Royal Society in 1699. The transactions of the society contain the following: "June 14th, 1699, Mr. Savery entertained the Royal Society with showing a small model of his engine for raising water by help of fire, which he set to work before them; the experiment succeeded according to expectation, and to their satisfaction."

The following very clear description of Savery's engine is given in the introduction to Beckmann's History of Inventions:

"This engine, which was used for some time to a considerable extent for raising water from mines, consisted of a strong iron vessel shaped like an egg, with a tube or pipe at the bottom, which descended to the place from which the water was to be drawn, and another at the top, which ascended to the place to which it was to be elevated. This oval vessel was filled with steam supplied from a boiler, by which the atmospheric air was first blown out of it. When the air was thus expelled and nothing but pure steam left in the vessel, the communication with the boiler was cut off, and cold water poured on the external surface. The steam within was thus condensed and a vacuum produced, and the water drawn up from below in the usual way by suction. The oval vessel was thus filled with water; a cock placed at the bottom of the lower pipe was then closed, and steam was introduced from the boiler into the oval vessel above the surface of the water. This steam being of high pressure, forced the water up the ascending tube, from the top of which it was discharged, and the oval vessel being thus refilled with steam, the vacuum was again produced by condensation, and the same process was repeated. By using two oval steam vessels, which would act alternately—one drawing water from below, while the other was forcing it upwards, an uninterrupted discharge of water was produced. Owing to the danger of explosion, from the high pressure of the steam which was used, and from the enormous waste of heat by unnecessary condensation, these engines soon fell into disuse."

This description makes it obvious that Savery had the clearest conception of the production of a vacuum by the condensation of steam, and of the utilization of the suction thus established (which suction, as we know, is really due to the pressure of outside air) to accomplish useful work. Savery also arranged this apparatus in duplicate, so that one vessel was filling with water while the other was forcing water to the delivery pipe. This is credited with being the first useful apparatus for raising water by the combustion of fuel. There was great waste of steam needless to say, through imparting heat to the water, but the feasibility of the all-important principle of accomplishing mechanical labor with the aid of heat was at last demonstrated.

The Piston Engine of Denis Papin

The principle of causing expanding steam to press against a piston working tightly in a cylinder seems to have originated with a Frenchman, Denis Papin, a scientific worker, who, being banished from his own country, was established as professor of mathematics at the University of Marburg. He conceived the important idea of transmitting power by means of a piston as early as 1688, and about two years later added the idea of producing a vacuum in a cylinder, by cooling the cylinder—the latter idea being, as we have just seen, the one which Savery put into effect.

It will be noted that Papin's invention antedated that of Savery; to the Frenchman, therefore, must be given the credit of hitting upon two important principles which made feasible the modern steam engine. Papin constructed a model consisting of a small cylinder in which a solid piston worked. In the cylinder beneath the piston was placed a small quantity of water, which, when the cylinder was heated, was turned into steam, the elastic force of which raised the piston. The cylinder was then cooled by removing the fire, when the steam condensed, thus creating a vacuum in the cylinder, into which the piston was forced by the pressure of the atmosphere.

Such an apparatus seems crude enough, yet it incorporates the essential principles, and required but the use of ingenuity in elaborating details of the mechanism, to make a really efficient steam engine. It would appear, however, that Papin was chiefly interested in the theoretical, rather than in the really practical side of the question, and there is no evidence of his having produced a working machine of practical power, until after such machines worked by steam had been constructed elsewhere.

The Improved Engine of Thomas Newcomen

As has happened so frequently in other fields, Englishmen were the first to make practical use of the new ideas enunciated above. In 1705 Thomas Newcomen, a blacksmith or ironmonger, and John Cawley, a plumber and glazier, patented their atmospheric engine, and five years later, Newcomen had on the market an engine which is described in the Report of the Department of Science and Arts of the South Kensington Museum, as "the first real pumping engine ever made."

The same report describes the engine as "a vertical steam cylinder provided with a piston connected at one end of the beam, having a pivot or bearing in the middle of its length, and at the other end of the beam pump rods for working the pump. The cylinder was surrounded by a second cylinder or jacket, open at the top, and cold water could be supplied to this outer cylinder at pleasure. The single or working cylinder could be supplied with steam when desired from a boiler below it. There was a drain pipe from the bottom of the working cylinder, and one from the outer cylinder. For the working of the engine, steam was admitted to the working cylinder, so as to fill it and expel all the air, the piston then being at the top, owing to the weight of the pump rods being sufficient to lift it; then the steam was shut off and the drain cocks closed and cold water admitted to the outer cylinder, so that the steam in the working cylinder condensed, and, leaving a partial vacuum of pressure of the atmosphere, forced the piston down and drew up the pump rods, thus making a stroke of the pump. Then the water was drawn off from the outer cylinder and steam admitted to the working cylinder before allowing the piston to return to the top of its stroke, ready for the next down stroke."

From this point onward developments in the use of steam engines spread rapidly, and this engine of Newcomen's, illustrated in figure 5, was used rather widely in its time, especially after they had been supplied with automatic valve gear. We are told that in the neighborhood of Newcastle alone there were, in 1767, fifty-seven at work, ranging in size from twenty-eight inch to seventy-five inch cylinder diameter, and giving collectively about twelve hundred horsepower.

It is interesting to note that one of these engines of Newcomen's preserved at Wednesbury, near Birmingham, was put to a trial under steam but a few weeks ago in preparation for the centenary celebration at Birmingham. The engine was in continuous use for more than half a century. Designed for thirteen strokes to the minute, the ancient piece of machinery maintained sixteen strokes to the minute at the trial.

Elevator Hazards and the Public

The Elevator Has Dangerous Possibilities in Spite of the Excellent Service That the Majority of Them Give Day After Day. The Following Paper Read Before the Annual Congress of the National Safety Council Gives a Resume of Elevator Hazards

By DANA WEBSTER, Aetna Life Insurance Co., Indianapolis

BEFORE making any remarks on the safety of elevators, it might be interesting to cover, briefly, the gradual development in the manufacture of mechanical lifting devices.

Mechanical Lifting Devices

Lifting devices were undoubtedly used by Julius Caesar as far back as 256 B.C., as history mentions their lifting animals from the dens to the arena in the Coliseum of Rome. About the middle of the Nineteenth Century, platforms or cable-hoisted elevators were first installed in New York and Boston, but were not provided with any kind of safety devices, and, strange to say, you can find a few elevators without safety devices at the present time.

A few years later elevators were equipped with safety devices of such type that it was necessary for the hoist cable to break before the safety could actuate. There are a great many of this type of safety in use to-day, but with the introduction of high-speed elevators, which were required to meet the demands of the public, quite naturally it necessitated much better type of safety apparatus and a multiplicity of cables.

Accidents could, and did occur, from over-speeding elevators, caused by disarrangements of the controlling apparatus, and it became necessary to provide safety devices that would actuate should the elevator speed increase beyond a predetermined number of feet per minute.

The most essential elements of safety are the prevention of excessive speed from any cause, the over-running of the limits of travel at top and bottom, safe protection at the landing entrances to the elevator, and a regular examination of the cables and all parts of the elevator equipments.

Car Safety Device

The early type of the safety device was designed to stop the car instantaneously. They served the purpose satisfactorily for slow speed, but were not adequate for the higher speed of 400 to 700 feet per minute. It, therefore, became necessary to provide a safety device that would stop the car with an easy and gradual stop. This is accomplished by the friction clamp safety, which is actuated by a safety speed governor, usually set to trip at 40 per cent. above regular speed. This governor will act should the hoist cable break, allowing the car to drop, or should the car over-speed from some defect in the machinery after the governor trips and the car has dropped far enough to take up the clearance of the safety jaws. The jaws are forced hard against the guide rail (like a vice), and the car will continue to slide until the friction is enough to stop the car entirely. The distance the car will slide after the safety takes hold, depends upon the load; but the farther the car slides the tighter the safety grips the rail. Usually, a car will drop about six feet after the governor trips and clamps the governor cable.

Over-running of Limit Stop

The machine of all power-operated elevators should be equipped with automatic limit stops; that is, a device that will stop the elevator at the top and bottom limit of travel, regardless of the operator.

On Drum machines, the Automatic Limit Stop should be built with and made a part of the machine.

On Hydraulic elevators, the Automatic Limit Stop should consist of a Cut-off Valve, either in the to-and-from pipe, or in both the supply and discharge pipe.

On Traction type of elevators, the Automatic Limit Stops must be located in the hoistway, and the power cut off by the travel of the car. As there is more or less slippage of the hoist cables on the drive sheave, a machine automatic would not be dependable. In addition to automatic limit stops on electric elevators, there are hoistway limit switches located so that, should the car travel a certain distance by the automatic limit stop, the car would open a switch, thus cutting off the power and stopping the machine.

Safe Protection at Landings

The early types of passenger elevators —and, in fact, most elevators up to the present time—are provided with landing doors equipped with a catch located on the inside, so that the door can only be opened by the operator. The operator, however, in order to make speed—and the public is partly to blame for this—starts the elevator before the door is closed, and quite often the door would not fully close and latch, thus providing a very dangerous condition. Many persons have opened the door when finding it ajar, and, looking in the hoistway, have either fallen or have been knocked down the hoistway by the car and severely injured or killed. I might say, right here, that statistics show that 85 to 90 per cent. of all elevator accidents occur at the landing doors. Therefore, it became necessary to provide the landing doors with a locking device that would prevent the doors from being opened, unless the car was at the landing; also to prevent the car from being removed away from the landing until the landing doors were closed, This is termed the Interlocking Device, or Interlocks for Landing Doors. While I believe all landing doors of passenger elevators and gates for freight elevators should be equipped with interlocks, I am sorry to say that, at the present time, only a small percentage of elevators are equipped with this device, although they are becoming more and more in general use.

Cables

The Cables are the most essential parts of the elevator equipment, and their number and size should be equal to the load with a good factor of safety. The sheave should be of ample size, and placed in alignment, to prevent chaffing of the cables on the sides.

Great credit must be given to the manufacturers for the high state of perfection these devices have brought. This fact must be admitted when considering the few accidents on elevators, compared to the large number of passengers carried. Statistics show that 10,000,000 passengers are carried in the Borough of Manhattan daily, and it is said that this number exceeds the number of passengers that ride on all the surface, elevated, and subway cars; in other words—more people ride vertically than horizontally.

A great many elevator accidents are not due to faulty design in construction, machinery, or safety device, but to the carelessness of the injured party. It, therefore, becomes necessary for the City or State to enact Ordinances and Laws regulating the construction of elevators, and enforcing their equipment with effective safety devices, in the interest of accident prevention; that is to say—to prevent a person from being injured by his own carelessness, and also by the carelessness of the operator.

Elevator Inspection

Are the Safety Devices Kept in Proper Condition? is one important question. The only way this can be accomplished is by having the elevator regularly inspected by a competent elevator inspector, who should inspect all the different safety devices, machinery, cables, etc., in fact, everything pertaining to the elevator. The landing doors should be tried to determine whether they can be opened from the outside. The car safety device should be tested to be sure that it would actuate.

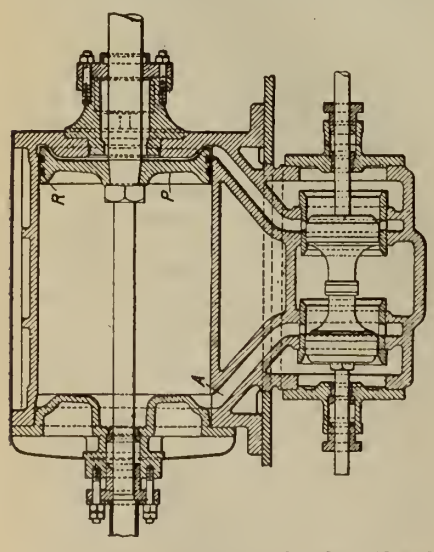
and hold the car from falling, should the cable break. The automatic limit stops should be tested so as to be sure the car will not over-run and strike the overhead beams or bumpers. The slack cable device should be tested to be positive the power would be cut off should the cables slacken. The brake should be examined to be sure there is no slippage. The cables should be examined very carefully for defects, as there is no part of an elevator that requires the exercise of more good judgment than the examination of the cables. It is just as essential that the safety devices, and all parts of the elevator, be kept in good working order, as it is that they should be installed in the first place. After an inspection has been made, the owner should proceed immediately to install safeguards and remedy any defects reported.

The elevator should be oiled and greased regularly by the engineer, and looked over carefully for any defects, and not wait for an inspector to make a thorough inspection, and oftentimes the engineer will discover some little defect which, if fixed immediately, may avoid a serious accident.

There is another feature that I wish to mention before closing; that is, the elimination of mirrors, in fact all glass, from the passenger cars (except the electric light bulbs), not only because of the fact that they are liable to cause injury to passengers by getting broken, but also because of their attraction, which results in passengers failing to notify the operator promptly as to their destination. This necessitates a stop between floors, and a trip back to let them off. They also have a tendency to retard the loading and unloading of the cars.

UNIFLOW LOCOMOTIVES

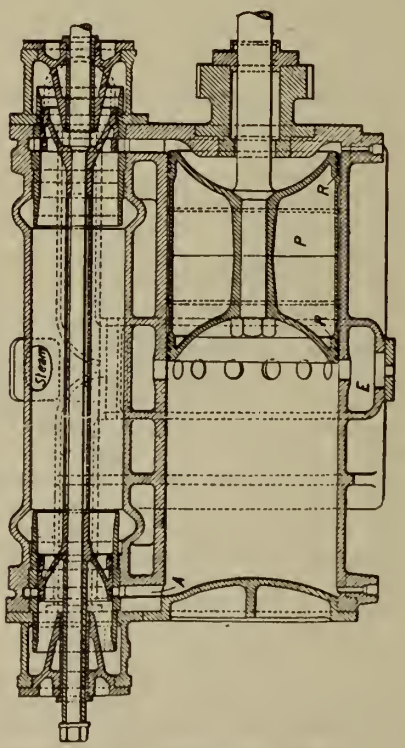
The Uniflow type of engine cylinder has been applied with considerable success in England to locomotive design.



SECTIONAL DRAWING OF ORDINARY CYLINDER.

ENGLISH UNIFLOW LOCOMOTIVE

The accompanying illustrations show the design developed by the North-Eastern Railway at the Darlington works. Three cylinders are installed, each of them 16½ in. dia. by 26 in. stroke. The design of these and their difference in appearance from the ordinary piston valve cylinder may be seen in the line drawing.



SECTIONAL DRAWING OF UNIFLOW CYLINDER.

The "Uniflow" principle differs from that of an ordinary cylinder in that the steam entering at one port does not have to return to the same point, but escapes through an exhaust port provided in the middle of the cylinder barrel. The steam, therefore, has only a forward and no backward movement; hence the term "Uniflow." Owing to the fact that the exhaust is in the middle, it is necessary to increase the length of the cylinder to about double what it would otherwise be, in order to allow the steam which enters through the port at one end of the cylinder to press forward the piston for the same length of time or distance before exhaust, as is done in the case of the ordinary engine. The piston in a "Uniflow" cylinder is called upon to govern the exhaust instead of, as in the usual type, leaving that function to the slide or piston valve. The piston is a hollow casting, with spring rings at each end, which prevent any steam passing through to its other side. It is claimed that this piston, being hollow and full of air, protects the live steam of the piston from the disadvantageous effects which the ordinary narrow piston possesses, due to its being a single solid surface, one side or the other of which is always wet from exhaust steam.

We are indebted to the North-Eastern Railway Magazine for the information contained in this article.

THE ALIGNMENT OF SHAFTS

The first indication of a shaft being imperfectly supported in its bearings is excessive end play, with the flywheel running out of truth. This is often caused by the springing of the crankshaft for want of support, the resultant effect being extension and contraction of the shaft endwise. This effect, it seems, can very well be noted without dismantling an engine; in fact, it can be done with the whole of the reciprocating parts in position. The author of the paper suggests that if delicate and careful measurements are taken between the crank webs when the crank pin is on top and bottom centres a difference of but one or two-thousandths of an inch will denote alignment inaccuracy. If an inner bearing of an engine is low the crank webs will close in slightly when the pin is on the bottom centre, and open out when the crank pin is placed on the top centre. If, however, it is an outboard bearing that is low, the reverse will be the case. Generally speaking, the amount of lack of support, or misalignment of a bearing is approximately the difference between the readings when the crank pin is at the top and bottom centre respectively. The instrument used for the measurement tests is an inside micrometer having telescopic rods. We think, however, that a dial test indicator would be more suitable.

Methods of Setting Piston Valves

The Piston Valve Has Many Advantages Over the Common "D" Slide Valve, Although Its Setting is Sometimes a More Difficult Operation. This Paper Gives Some Useful Information

By J. W: A. DRUMMOND, Drumheller, Alberta

NEARLY all vertical engines, and many types of horizontal engines, are fitted with piston valves, in the place of the common D slide-valve, to control the distribution of steam to the cylinder or cylinders.

This type of valve is particularly desirable in vertical engines, as it is possible by making the upper portion of the valve larger than the lower portion, to balance the weight of the valve and its valve-rod and thus reduce the power required to move the valve.

While the piston valve is similar in its action to a D slide-valve, its setting is not always a simple operation, as it is often placed in a cylindrical valve chest, which is covered with a valve chest cover. There being no cover plate at the side as in the case of a D slide-valve, it is necessary to use some other means of ascertaining when the valve is correctly set, and it is the purpose of this article to describe a very simple way to accomplish the desired result, accurately and quickly once the necessary equipment has been made.

I will first explain a few types of valves:—The valves are made both with and without piston rings, depending on the size and grade of the engine, the cheaper grades and smaller sizes being without piston rings. When the valve has no piston rings, the cylinder ports are plain, opening into the cylinder, as in the case of a D slide-valve, except that the openings are circular to conform with the shape of the valve chest. When the valve has piston rings, the ports have to be bridged, to prevent the possibility of the valve catching the ports. See Fig. 1 and Fig. 2.

The bridging consists of bars of metal cast integral with the cylinder casting, thus bridging the ports with narrow strips of metal, the passage between the bars being in effect a series of small ports, the sum of the area of which is that which would be required if the port were plain, when the valve chest is bored out, the portion that is bridged is also bored to the same size as the rest of the valve chest, thus leaving the port openings with a support which keeps the rings closed, and prevents them from catching in the openings (port).

There are two classes of valves, Direct and Indirect.

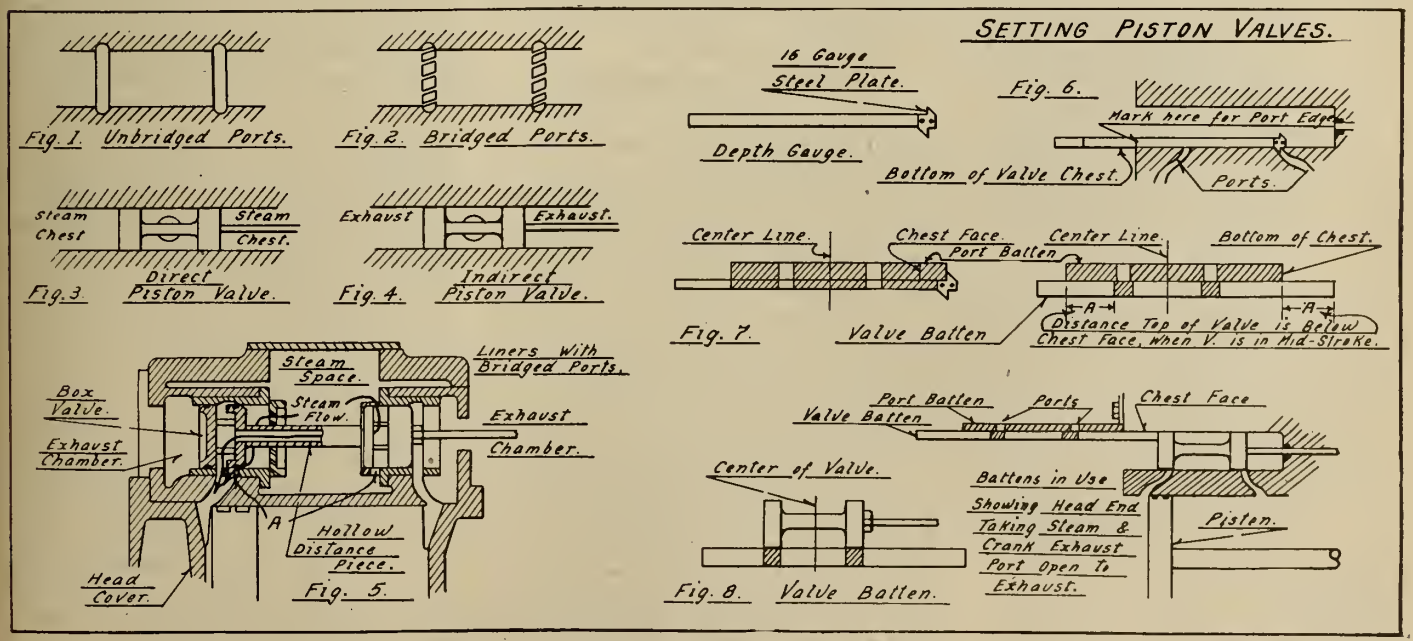
In the direct type the steam is admitted over the ends of the valves and is exhausted at the centre, in this type the lead can usually be measured at the head end, but not at the other end. See Fig. 3 and Fig. 4.

Then we have what is known as the indirect valve in which the steam is admitted to the central portion of the valve and the exhaust goes out over the ends, in this type it is not possible to measure the lead unless there is a cover plate at this side.

A third type of valve is known as the box type. It is also an indirect valve, in this valve, the ends are solid, the remaining portion of which is hollow. The two ends being held togther by a hollow distance piece, which bridges between the ends of it, and the solid ends.

When the box type of valve is used, the valve chest has a liner to each port, this liner has two ports in it, both of which are bridged, the reason there are two ports for each end of the cylinder is, the box type of valve is a double ported one, the action of which will now be explained. As will be seen in the sketch, the valve is just open the amount due to the lead, and steam is going to be admitted to the head end of the cylinder. It will be remembered that this valve is an indirect one, so the steam is admitted to the central portion of the valve chest, that being the case, the steam will be entering the cylinder through the opening at A, but on looking at the other end of the valve, it will be noticed that the hollow portion of the valve is also open to steam, so that some steam must also be passing through the valve to the other end and into the cylinder port, which is shown to be fully open to steam, so it will be plainly seen, that this valve is double ported, as the steam is admitted at two distinct ports, and in setting the valves, the lead has to be measured at the two points A, which would make this type of valve, a very difficult one to set correctly, unless the lead could be measured.

The crank end exhaust port is almost fully open, and the exhaust steam passes out over the end of the valve, to the spaces marked E, which in this case of a simple engine, is connected to a Y piece, or led through passages to the exhaust pipe, in the case of a compound engine, it may go to the receiver, or direct to the low pressure-cylinder, the same valve controlling the steam dis-



SETTING PISTON VALVES ON A STEAM ENGINE.

tribution in the L. P. by the addition of extra ports in the valve. See Fig. 5.

When an indirect type of valve is used, the eccentric has to be set behind the crank, and the angle of advance is 90 degrees, less the angle of advance, unless a reversing rocker is used, when the eccentric is set at 90 degrees, plus the angle of advance ahead of the crank, this rule is applicable no matter in which direction it is desired to run the engine.

In some types of engines, it is impossible to measure the lead directly, so that other means have to be resorted to, to set the valve, as both lead openings cannot be seen, when such is the case, one of the easiest and most accurate methods, is to proceed as follows:—

The piston valve should be removed from its valve chest, and a rod made as follows: for measuring the valve openings, a piece of flat steel say about 16 gauge, is marked out in this manner, first scribe a line across the centre lengthways, and then on the centre line on the other axis mark off the width of the stick to which it is to be attached, say ¾-in. wide, now on the horizontal centre line, mark off the width of the stick, a distance of ½-in., make the width of the plate about one and one-half inches, and join the marks on the centre lines, to the corners of the plates, with a diagonal line, and file the plate to shape, then drill two holes in it to secure it to the stick, which should be about ¾-in. wide, and about ½--in. thick, and long enough to reach the bottom of the valve chest, and have about 6 in. to spare, having made this, now secure two pieces of batten, say one and one-half inches wide, by ¾ inch thick, and about the same length as the depth gauge.

See Fig. 6.

Now with the depth gauge, measure the distance to the lower edge of the steam port in the valve chest, (see sketch) and make a mark, corresponding with the face of the valve chest face, then move the gauge up to measure the position of the upper edge of the same port, and again make a mark on the gauge corresponding with the valve chest-face, proceed in this manner, till you have the ports all complete on the gauge, then find the depth of the valve chest from the chest-face, and mark the depth gauge again.

Now lay the depth gauge along side one of the battens, which should have a square end, the line corresponding with the bottom of the valve chest, is taken to be the squared off end of the batten, then the lower port is marked off, then the upper, the solid spaces between the ports being cross-hatched, and then the lines corresponding to the steam chest face, is laid off, thus completing the valve port batten. The centre line between the ports must be marked on this batten.

See Fig. 7.

Then take the piston valve and lay it on the other batten, and mark off the position of the bridges, or valve faces, and also the centre line of the valve, and the position of the end of the valve, now lay two battens side by side, with the valve centre lines corresponding, and mark off valve chest face on valve batten, this distance is the distance the top of the valve is below the valve chest face, when the valve is in the centre of its travel, on the other end of the valve batten, the line corresponding to the bottom of the valve chest, must be marked on, and from this line a distance equal to the distance the top of the valve is below the valve chest cover, when in midposition, is added, and a line drawn with a square across the batten, the remainder, is then cut off at this line, we now have our sticks complete as below, (see sketch), Fig. 8.

Now make a piece of plate bent to a right angle, with one leg long enough to catch one of the valve chest bolts, and allow the angle piece to stand over the valve chest opening, drill it to fit the valve chest studs on the long leg, and three holes to fasten port opening stick to the angle piece, having done so, replace valve in chest, bolt on the port stick to the valve chest face, now get some one to rotate the engine to crank dead centre, lay valve stick against port stick and position of valve can be seen with reference to the ports, turn engine over to the other dead centre, and again observe position of valve with reference to the ports, it can now be seen, if the valve is correctly set, and if not, which way the valve has to be moved to place it in the correct position, and by having some one to turn the engine over, the action of the valve can be followed throughout.

Having once made a set of sticks, for an engine, of which you have charge, they should be preserved, as they form a very simple and quick method of replacing an eccentric in its proper place, should it chance to slip, or should it be necessary to check up the valve setting at any time.

PRIMING REMEDIES

A general indication leading one to think boiler priming is taking place is the violent agitation of the water in the gauge glass, together with its muddy and discolored appearance. Sometimes this level will record as much as two inches of difference within the space of a few seconds; sometimes disappearing below or above the glass altogether. If it is thought that fluctuation of steam demands is giving rise to the trouble close down the boiler stop valve a little.

The anti-priming pipe, usually found in Lancashire or Galloway type boilers, is a slotted pipe fixed inside the boiler towards the top, cast in sections and bolted together. This pipe should be at least three-quarters the length of the boiler, and the area of the slots at least equal to the bore of the steam valve. Whenever the boiler is opened up for cleaning or repairs, these slots should be examined for corrosion and reduction of orifice area, as priming trouble may be due to this cause. One peculiar feature of priming is that the trouble may be apparent in a more or less greater degree with the type of labor employed in firing, thus proving that the manner in which the boiler is fired is an important factor in this respect. The thinnest film of grease clinging to the water within the boiler will sometimes give rise to priming, hence care should be taken to eliminate this from the feed-water. Boiler compositions introduced for the purpose of reducing scale must be used sparingly and in small quantities at a time. A day's supply should not be injected within a few minutes by means of the boiler pump or injector; instead, it should be spread over a whole day's supply of feed-water. Priming due to a high-water value can be remedied by lowering the water line, but in this expert advice should be taken in order that the danger limit is not reached.

INTERNAL COMBUSTION ENGINE IMPROVEMENTS

Important improvements continue to be made by British engineers in the Diesel oil engines which are being so largely adopted for marine purposes and for the generation of electricity on land. One recent innovation is intended to enable tar oil to be successfully used as the fuel. A pilot jet of paraffin is provided to form a flame for the following jet of tar oil, thus overcoming the difficulties of ignition. Another novelty which is of special interest to central station engineers is a device for automatically controlling the pressure of the air supply to suit the varying loads met with in the supply of electricity. On one and the same gauge is a pointer registering the air blast pressure and another controlled by the current passing through the generator. The second pointer is arranged to indicate the correct air pressure according to the load on the generator, and everything is in order when the two pointers are together, in which position they close an electrical circuit controlling the compressor throttle. When the pointers are apart, the throttle opens and increases he air supply until the pointers come together. Greatly improved combustion is secured by this ingenious device. Another British firm has introduced an emergency governor which stops the engine completely in case of an excessive rise in speed—an emergency which is beyond the ordinary governor. This apparatus, works by by-passing the fuel into the atmosphere. Another emergency device stops the engine whenever the water circulation fails, the apparatus being operated by a diaphragm, which flattens when the water pressure upon it is withdrawn. All the British makers concerned in this field are standardizing their designs in order to provide the advantages of mass production.

Water Hammer Action

The Following Article, Reprinted from "The Locomotive," Gives Some Interesting Facts Relative to This Power Plant Trouble. The Theory of This Obscure Action is Well Explained

"WATER-HAMMER action" is the action which occurs in a steam boiler or in steam piping, when a mass of water is driven with considerable velocity against a solid body, or against another mass of water, in such a way as to have its motion suddenly checked or destroyed. Under these circumstances a severe momentary pressure is generated in the region where the collision occurs, just as happens when we bring a heavy sledge hammer down forcibly upon an anvil. If the moving water strikes directly against the boiler shell, the pressure is exerted directly against the shell; while if the moving mass is stopped by colliding with another mass of water, the pressure arises in the midst of the fluid, where the collision occurs. In the latter case, however, a pressure-wave is generated in the water, and this travels forward until it presently comes to bear against the shell of the boiler. In either case, therefore, the shell will be subjected to a shock, as the result of the sudden stoppage of the moving water; and under suitable conditions this shock may be very heavy indeed—quite sufficient, in fact, to rend the boiler.

Conditions for the Development of Water-Hammer Action

It is plain, from what has been said, that the immediate conditions for the development of water-hammer action are two in number. (1) Some portion of the water must be caused to move with a considerable speed, and (2) this moving mass must strike against the boiler, or against another mass of water, in such a way that its own speed is suddenly checked or destroyed. The pressure which is generated is only momentary, but it may be of great intensity during the instant it lasts.

The violent commotion which precedes and leads to the water-hammer effect cannot arise unless there are sensible differences of pressure or of temperature, within the boiler. There can be no water-hammer action, for example, in a boiler whose contents are everywhere at the same temperature and pressure.

In practice we find that the action develops in undrained steam pipes when steam is turned into them, and in boilers which are being cut in with a steam main which is already in communication with other boilers; but in order to realize it, the conditions referred to above must be fulfilled. That is, the water and steam must be at different pressures, or at different temperatures.

When a boiler is cut into a steam main, it will be the difference in pressure which determines the action, provided the pressure in the boiler exceeds that in the main; for when we open the stop-valve under these circumstances, the water in the boiler will tend to "lift," and considerable masses of it may be thrown against the shell, with a resultant shock which may be sufficient to produce rupture.

Conversely, if the pressure in the boiler is less than that in the main, the action will be primarily due to the difference in temperature between the steam in the pipe and the water in the boiler. (This will appear later.)

The case in which the pressure in the boiler is greater than that in the pipe, and the action consists in the lifting of the water, is undoubtedly the better understood of the two, and we shall therefore dwell, in this article, upon the second case, in which the pressure in the boiler is less than that in the main. This

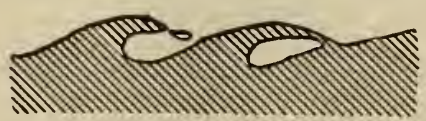


FIG. 1—FORMATION OF A BUBBLE.

second case appears to be widely misunderstood by engineers in general and yet it is the one which is most likely to arise in practice; for in firing up a boiler which has been out of service for a time, the attendant is far more likely to cut it in as soon as the pressure approaches that in the main, than he is to wait until it is higher. In fact, it is a more or less common (though highly dangerous) practice, to cut in the boiler as soon as the pressure comes up to within (say) ten or fifteen pounds of that prevailing in the pipe line at the time.

Our attention has been called quite recently to a plant in the South, where the practice was, for a time, to fill up a boiler with comparatively cold water, and then to open its stop-valve at once, so that the steam in the main would assist in bringing the water up to the operating temperature. It seems incredible that this can be true, and the boiler still remain upon earth; but from the representations which have been made to us we are forced to believe it. At all events the practice has been discontinued in that particular plant, on account of certain emphatic counsel given by our inspector. The superintendent of the plant admitted, by the way, that the boiler occasionally "jumped some" while it was being warmed up. Why it didn't jump a couple of miles is a mystery which we cannot solve.

The Two Points of View

We may look at the water-hammer problem from two different points of view. Thus we may ask ourselves (1) what pressure may be produced within a boiler by water-hammer action, or we may ask (2) what is the maximum mechanical work which can be performed, under given circumstances?

The first of these questions cannot be answered with any approach to precision, partly because we never know, in any given case, just how the water in the boiler is thrown about, and partly because the entire theory of impact is still in an imperfect state, as we have already explained at some length, in the issue of "The Locomotive" for July, 1909. The second question can be definitely answered, however, since, in solving it, we do not need to know the exact way in which the disturbance of the water takes place.

We shall take up these two questions in order.

Nature of the Disturbance in the Boiler

In dealing with the momentary pressure which water-hammer can produce in a boiler, we have, first, to get over a line of reasoning very similar to that given in "The Locomotive" for July, 1909; so that we can here treat the matter more briefly than might otherwise be permissible, referring the reader, for a further elucidation of the principles, involved, to the articles in the issue cited.

The steam which is discharged into the boiler from the main disturbs the surface of the water, and generates waves; and the moment one of these waves breaks, so as to form a sort of bubble enclosing some of the steam, the water-hammer action begins. (See Fig. 1.) For, by hypothesis, the water is somewhat cooler than the steam (on account of the original pressure in the boiler being lower than that in the main), and it follows that the steam enclosed within the bubble will condense, leaving a partially vacuous space there. The pressure acting upon the surface of the water will then close the bubble up almost instantly, the water which forms its upper wall being brought down against that which forms the bottom of it, with great speed and corresponding violence. The hammering action thus initiated will increase the disturbance in the water, and larger bubbles will be formed in the same way, with the production of increasingly violent shocks when they collapse.

A more concrete idea may be had of the action by considering the familiar operation of blowing steam into cold water from a small pipe. A bubble of

steam forms momentarily, and is immediately condensed by the cooler water, the sides of the bubble coming together with a resounding crack. In the boiler the case is similar, but the experiment is there performed on a terrible scale, with steam furnished by a battery of boilers, through a six-inch pipe (perhaps) instead of a quarter-inch one, and with the bubbles, quite likely as big as water pails, collapsing under a pressure of 100 pounds or so, per square inch, instead of under simple atmospheric pressure.

Ideal Case of a Cylindrical Plug of Water

In order to estimate the magnitude of the momentary pressure which is produced in the water by these sudden shocks, we proceed as follows:

Consider first (as in our previous article of July, 1909, already cited), the case of a cylindrical plug of water, moving along the interior of a smooth cylindrical tube which it just fills. (See Fig. 2.) Underneath the plug there is a space which is filled, at the outset, with steam fresh from the main steam pipe, and having therefore a temperature higher than that of the water in the boiler. Now let us suppose that the imaginary tube in which the plug travels is surrounded by water at the temperature which prevails in the boiler, and that the walls of the tube are not real walls, of metal, but that they are imaginary, permitting the free passage of heat, while not allowing the water composing the plug to flow out sidewise.

Under these circumstances the steam under the plug, being surrounded by water cooler than itself, will partially condense. Its pressure will promptly fall, in fact, to the pressure corresponding to the temperature of the water.

If we represent the pressure in the steam main by p_1, and the reduced pressure below the plug by p_2, and if we also assume that the sectional area of the plug is one square inch, we see that (as indicated in Fig. 2) the plug is subject to a downwardly-directed force equal to p_1, and an upwardly-directed force equal to p_2. Since p_1 is greater than p_2, the resultant force acting on the plug is downward, and equal to $p_1 - p_2$. In forcing the plug downward through a distance of V inches, so as to cause the space under it to disappear, the work done by the steam is therefore $(p_1 - p_2)$ V inch-pounds.

As soon as the plug strikes the water below it, a pressure is produced at the surface where the two come together, accompanied by a local compression of the water along that surface, in the vertical direction. This pressure at the surface of contact acts downward on the free substratum of water, and upward on the water-plug. The motion of the plug is arrested at this point, but the rear (or upper) part of the plug will continue to press forward, for a moment, after the front part has become stationary. So far as the pressure within the water is concerned, the effect will be as though there were a wave of compression transmitted through the water, traveling with the same velocity as sound (since sound is only a succession of compression waves). As soon as the wave of compression has passed back through the plug and reached its rear (or upper) surface, this rear surface will also become stationary, and for an instant the entire plug will be motionless and in a state of uniform compression. The compressive stress to which it is subjected at this instant, by reason of its own sudden loss of momentum is, in fact, the "water-hammer pressure" which we are seeking to determine.

The water below the plug will be compressed, in just the same way as is the water of the plug itself; and since the compression wave will have the same velocity, downward through the free water, as it has backward through the

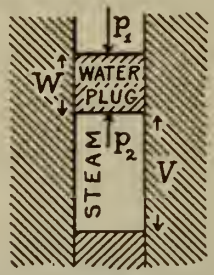


FIG. 2—THE CYLINDRICAL PLUG OF WATER

plug itself, it follows that at the moment when the pressure-wave reaches the back end of the plug (the length of which we will call W inches), it will also have penetrated the water below the plug to the same distance. Hence, at the instant the plug comes to rest, there will be a total volume of water under compression, equal to 2W cubic inches (the sectional area of the plug being one square inch); half of this being the volume of the plug itself, and the other half being the volume of that part of the free water which is also at the same time under an equal compression.

If we think of this volume 2W, as being under a momentary uniform compression equal to P lbs. per square inch, we may deduce the pressure, P, by the following process: Let C, be what is termed the "modulus of compressibility" of water. That is, C is the pressure, per square inch, which would suffice to compress the water to nothing, if its diminution of volume, at indefinitely high pressures, should follow the same law which holds for pressures which are moderate. (Of course there is no pressure which actually would compress the water to a zero volume; but the "modulus of compressibility," as defined above, is an exceedingly convenient thing to use, in practical computations.) Also, let x be the amount by which the volume 2W of the compressed water is reduced by the actual (though as yet unknown) pressure P. We then have the proportion

$$P : C :: x : 2W$$

And solving this for x we find

$$x = \frac{2PW}{C}$$

The work done in compressing a liquid is very nearly independent of the way in which the compression is performed. (We mention this, because the fact is quite otherwise with a gas or vapor.) Hence the potential energy stored up in the compressed water will be the same (or sensibly the same) as it would be if we effected the compression slowly and uniformly, beginning with the pressure at zero, and gradually increasing it up to P. Now in this case the average pressure applied would be ½P; and multiplying this by x (the height by which the volume 2W has been reduced), we find that the total work done would be ½Px. And if we replace x by its value as just found, above, we see, finally, that the potential energy stored in the 2W cubic inches of water under compression is

$$\frac{P^2 W}{C}$$

Now since energy cannot be created nor destroyed, this must be equal to the work done by the steam in pushing the plug to the end of its cylindrical passage; and hence we have the equation

$$(p_1 - p_2)\ V = \frac{P^2 W}{C}$$

which, upon being solved for P, gives

$$P = \sqrt{\frac{(p_1 - p_2)\ C\ V}{W}}$$

This, it is to be remembered, is the expression for the pressure which may be produced in the ideal case, in which a plug of water is driven along a cylindrical channel so as to come suddenly and violently against another mass of water of equal cross section, and extending indefinitely in the direction of the length of the channel.

Application to the Actual Case

In order to see how the foregoing formula for P applies in the actual case which arises in practice, let us consider a bubble of rectangular shape, such as is indicated in Fig. 3. This consists, as will be seen, of a sort of slab of water, of thickness W, raised to a distance V. Let us imagine the upper slab, the space below it, and the water which lies below the space, to be divided into imaginary cylindrical tubes, as suggested by the dotted lines. If now, the top wall, or slab, comes down uniformly in all its parts when the bubble collapses, the water in each of these imaginary cylindrical tubes will act just as we have supposed the plug to act, in the ideal tube described above. There will be no sidewise flow of the water, or none of any account, provided the rectangular bubble is big enough in its horizontal

dimensions. Hence the formula will be as applicable to this case, as it is to the case of the single plug in its cylindrical tube.

Finally, if the bubble, instead of being rectangular, is more or less oval or ellipsoidal, as in Fig. 4, the pressure actually developed will agree with the calculated pressure to an order of approximation corresponding to the (unknown) degree in which the conditions in the actual case conform with those which were assumed to exist, in deriving the formula.

After the pressure which is due to the impact has been generated, it is transmitted through the water to the boiler shell. In this transmission it will be somewhat lessened in intensity, and it will be propagated mainly in the direction in which the top slab of the bubble collapses.

We have supposed, for the sake of simplicity, that the bubble collapses vertically; but since the water in the boiler is thrown about in an utterly indescribable manner, the actual collapse may take place horizontally or obliquely, and hence the maximum pressure may be exerted upon the boiler shell sidewise, or in any other direction.

The formula may be expressed in words as follows: First find the difference $(p_1 - p_2)$ between the pressure in the steam main and that in the boiler before opening the valve, and multiply this by the modulus of compressibility of water (C), which may be taken as equal to 300,000 lbs. per square inch. Then multiply again by the depth (V), in inches, of the steam inside of the bubble, measuring this depth in the direction in which collapse takes place. Finally, divide the product so obtained by the thickness of the upper layer (W) of the bubble, in inches, and take the square root of the quotient. The result will be the momentary pressure produced in the water by the collapse of the bubble.

This rule, be it understood, cannot be used to determine anything but the general order of magnitude of the pressures produced by water-hammer. No rule could do more than this, however, when applied to a problem as indefinite as the one with which we are dealing. Yet with all its limitations the rule has a considerable value, since it shows that water-hammer effects may be exceedingly serious, and that we need to guard against their production, with the greatest care.

Numerical Example

Let us now apply the formula to the calculation of the maximum possible pressure which water-hammer might produce, in a particular case. We shall suppose, for this purpose, that a boiler is being cut in with others, and that the pressure it carries is less than that prevailing in the steam main at the time. We shall assume that the pressure in the main is 95 lbs. per square inch, and that in the boiler is 88 lbs. per square inch.

In this example, as in all others of like nature, we shall have to arbitrarily assume the thickness of the bubble and of the top layer thereof. We cannot tell what these thicknesses were, but we must endeavor to choose values for them which might reasonably be expected to occur. Let us suppose that the thickness of the steam-filled portion of the bubble was 6 in., and that of the slab, or top portion, was 3 in. Then our rule works out as follows: The difference between the pressure in the steam main and that prevailing in the boiler just before opening the stop-valve was 95 — 88 = 7 lbs. per square inch. This, multiplied by 300,000, gives 300,000 × 7 = 2,100,000. Multiplying again by the thickness of the steam space of the bubble, we have 2,100,000 × 6 = 12,600,000. Then, dividing this by the thickness of the top layer of the bubble, we have 12,600,000 ÷ 3 = 4,200,000. And, finally, taking the square root of this last number, we have $\sqrt{4,200,000} = 2,049$ lbs. per square inch, which is the maximum pressure which could be developed by water-hammer action in the given boiler, under the assumed conditions. It is evident, here, that we may make very large allowances indeed for the fact that the conditions may not have been just like those presupposed, and yet we shall have a pressure quite sufficient to cause rivets, or any other part of the boiler, to snap at once—especially when we remember that the instantaneous pressure developed by the water-hammer action was in addition to the normal load of 95 lbs. per square inch, which the steam exerted upon the shell directly, as soon as the stop-valve was opened.

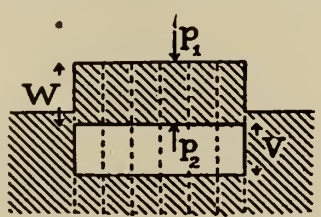


FIG. 3—RECTANGULAR BUBBLE.

Once again we may state that when a boiler is burst by water-hammer action, the pressure which is generated acts only for an instant, and its effect upon the boiler is similar to that of a sudden hydrostatic pressure. That is, it disrupts the boiler, but it does not throw the pieces about. The momentary water-hammer pressure having separated the parts of the boiler, it is the normal steam pressure within the boiler which does the rest of the work.

The Maximum Amount of Mechanical Work Which Can Be Performed

We come now to the second aspect of the water-hammer question. Namely, we have to look at the case from the following point of view, which is more general than the one from which we have approached it above. A boiler containing a mass of water at a given temperature is placed in free communication with a steam main capable of supplying a practically unlimited amount of steam at a pressure higher than that due to the temperature prevailing within the boiler. As we have here two bodies, or substances, at two different temperatures (namely, the steam in the main and the water in the boiler), the theory of heat teaches us that a certain amount of mechanical energy can be developed, as an accompaniment to the process of temperature-equalization which at once begins. The quantity of mechanical energy which can be so developed, however, is strictly limited by the laws of thermodynamics; and it is not at all difficult to find an expression from which its maximum amount can be calculated.

Let t_1 be the temperature of the steam which is admitted from the steam main —this being constant throughout the entire operation, since the steam is furnished by outside boilers, at a constant pressure and temperature. Also let t_2 be the temperature which the water in the boiler has at the outset, just as the stop-valve is opened. As soon as the steam, at the higher temperature t_1, enters the boiler, it comes in contact with the cooler water there, and begins to condense; and although the heat which it gives out in condensing may be partially converted into mechanical energy, available for throwing water in the boiler about, the major portion of it must go to the direct heating of the water, without the production of any such mechanical work. In fact, the principles of thermodynamics, upon which we have dwelt in many of the previous issues of "The Locomotive," show that when, in the equalizing process, the incoming steam gives up a small quantity of heat—a quantity so small, namely, that it does not materially alter the temperature of the water in the boiler as a whole—we may find the maximum quantity of mechanical energy which can be developed, by multiplying this small quantity of heat (expressed in foot-pounds) by the fraction

$$\frac{t_1 - t_2}{t_1 + 459.7^\circ}$$

the constant number 459.7° being the Fahrenheit temperature of the Fahrenheit zero, on the absolute scale of temperature.

If, as in the example worked out above under the other rule, we take the pressure in the main at 95 lbs. per square inch, and that in the boiler before the stop valve was opened at 88 lbs., we find, by consulting a table of the properties of steam, that the temperature (t_1) of the steam in the main was 334.4°, and the temperature (t_2) of the water in the boiler was 329.5° Fahr. Hence $t_1 - t_2 = 334.4^\circ - 329.5^\circ = 4.9^\circ$, and $t_1 + 459.7^\circ = 334.4^\circ + 459.7^\circ = 794.1^\circ$. With these values of the temperatures, the foregoing fraction becomes equal to 4.9 ÷ 794.1 = 0.00617; so that when the entering steam begins

to condense, the first foot-pound of heat which it gives up can generate 0.00617 of a foot-pound of mechanical energy, which can manifest itself by throwing the water about; but the remaining 0.099383 of the foot-pound must pass directly and quietly into the water, without appearing in the mechanical form at all.

As the water in the boiler rises in temperature, owing to the heat which it is receiving from the steam, the same sort of calculation can be made at every stage of the process. The only difference will be that the value of t_2 will increase as the water warms up, while the value of t_1 remains constant. The fraction hich expresses the proportion of the heat which can be converted into mechanical energy will grow less, therefore, as the temperatures become equalized. The average value of the expression given above for the efficiency of the conversion is

$$\frac{1}{2}\,\frac{t_1 - t_2}{t_1 + 459.7^\circ};$$

and if we multiply this last expression by the amount of heat given up by the steam, we shall have the total amount of mechanical energy which can be developed, within the boiler as a result of cutting it into the steam line, at a temperature (or pressure) below that of the steam in the main.

Now the total amount of heat which is given up by the steam is equal to that absorbed directly by the water, plus that which is converted into mechanical energy. But since considerably more than 99 per cent. of that which the steam gives up is directly absorbed by the water, we shall not commit any error of the slightest practical importance if we assume, in this particular calculation, that the two are equal. If the average specific heat of the water between t_1 and t_2 is S, then each pound of water, in becoming warmed from t_2 to t_1, will absorb S $(t - t_2)$ units of heat. To express this quantity of heat in foot-pounds, which is a more convenient way for our present purposes, we have merely to multiply it by Joule's equivalent, which we will take at 780 foot-pounds per Fahrenheit heat unit. Moreover, we may take the specific heat, S, of the water as equal to unity. Hence, the total quantity of heat absorbed by the water is 780 $(t_1 - t_2)$ foot-pounds. Assuming that this is equal to the amount given up by the steam (as explained above), we have merely to multiply it by the fraction given in the preceding paragraph, and again by the number of pounds (say w) of water in the boiler, and we have the total number of foot-pounds of mechanical energy which can be developed when the boiler is cut in with its fellows. Thus the expression in question becomes

$$\frac{390w\ (t_1 - t_2)^2}{t_1 + 459.7^\circ}$$

In words, this may be expressed as follows: Find the square of the difference in temperature between the steam in the main and the water in the boiler, multiply this by the number of pounds of water in the boiler, and multiply again by the constant number 390. Then divide the product so obtained by the temperature of the steam plus 459.7°. (Fahrenheit temperatures are to be used.) The result is the greatest possible number of foot-pounds of mechanical work which the water can do, in being thrown about as a consequence of the boiler being cut in before the pressure within it has become equal to that prevailing at the time in the steam main.

Application to a Numerical Example

By way of illustration, we shall apply this formula to the same example as before. We have already found the difference of temperature between the

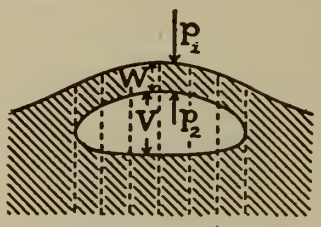


FIG. 4—OVAL BUBBLE.

water and the steam to be 4.9°. The square of this is $4.9 \times 4.9 = 24.01$. We shall throw away the small decimal, and call it 24. We next need to know the total weight of water in the boiler, and for the purposes of illustration we shall take this to be 12,000 lbs. Then proceeding with the application of the rule, we have $12{,}000 \times 24 = 288{,}000$; and $288{,}000 \times 390 = 112{,}320{,}000$. We have already found that $t_1 + 459.7^\circ = 794.1$. Hence we have $112{,}320{,}000 \div 794.1 = 141{,}440$ foot-pounds, which is the maximum quantity of mechanical energy which could be developed inside of the boiler, as a consequence of cutting it in with the others before the pressure had become equalized to within less than seven pounds per square inch.

As before, this result is merely a maximum one, but in obtaining it we do not have to make any supposition respecting the proportions of the steam bubbles which are formed. The result is exact, save that we have made certain assumptions of a merely arithmetical nature, in the interest of simplicity—assumptions which certainly do not affect our conclusion by more than a few per cent.

A mere fraction of this maximum available amount of work would suffice, without doubt, to start the rivets shearing; and, as we have several times remarked, it is the steam pressure normally within the boiler which throws the parts asunder, when once the work of disruption has been well begun. The energy developed directly by the water-hammer does not have to account for any portion of the mechanical work of the explosion, save that which is required to stress some parts up to their breaking points.

We would direct attention particularly to the fact that the quantity of mechanical energy which can be developed within the boiler, and be manifested by throwing the water about with more or less violence, varies as the square of the difference in temperature between the water and the steam. Hence if this difference were twice as great as we have assumed, the quantity of mechanical energy which could be developed, under otherwise similar conditions, would be four times that calculated above.

Can the Water-Hammer Action Be Delayed?

Water-hammer action, if the conditions for its occurrence exist, usually begins the moment the stop-valve is opened. If, however, the pressure in the main exceeds that in the boiler, and the stop-valve is opened cautiously, there appears to be no reason why the steam might not enter quietly. Part of it must condense, of course, on account of the chilling action of the water upon it; but this might conceivably occur without mechanical disturbance, the superficial layers of the water in the boiler becoming heated, so that a sort of equilibrium would be established. If nothing should occur to agitate the water, this state might persist until the entire bulk of the water became heated up to the temperature of the steam in the main; and after that no water-hammer would be possible.

The pseudo-equilibrium thus established would be highly unstable, however, and the least disturbance of the water, by bringing its deeper and cooler layers to the surface, would precipitate water-hammer action at once. It would be only under the most exceptional circumstances that delayed development such as we have suggested could occur, and yet such delay is manifestly possible.

Precautions for the Avoidance of Water-Hammer Action

In conclusion, let us emphasize the fact that it is of exceeding importance, in cutting in a boiler, to be sure that the pressure upon it is as nearly identical as possible with the pressure which is prevailing, at the time, in the steam main. Mathematically, equality can hardly ever be attained, however, partly because commercial steam gauges will seldom agree to within a pound or so. Hence when the equality of pressure is judged to be exact, the stop-valve should be opened very carefully, indeed opened just a bare crack at first, and then, as the slight outstanding difference of pressure equalizes itself, opened wider, very slowly, until it is open full. The complete operation should occupy a couple of minutes or more, and the attendant should hold himself in readiness, at every instant, to close the valve at once, if there is the slightest evidence of any unusual jar or disturbance of any kind, about the boiler.

Correspondence Re Graded Certificates

A SUGGESTION

The Editor:

Sir: The controversy re graded certificates is now on and I think it would be a good plan for the publishers of this Engineers' Journal to request all writers to give their names and address for publication. Readers would give more respectful atention to letters if they knew the standing of the writers. "Justice" and "Chief" may be my next-door neighbors and from the composition and phraseology of their letters I gather that they are, "from an engineer's standpoint," educated and experienced men. Sign your name, boys, it will do you and others good. You and I are willing to meet the board or any one else in a fair field and no favors asked. The graded certificate has been made law for better or for worse, according to individual opinion. I was seretary of the C.A.S.E. in this city when the full examining board went from end to end of the province to meet all the unions, lodges and associations of engineers and get first-hand opinions. We were asked to put our views in writing and did so, as far as we could from the mass of conflicting opinions. The Examiners had all this material before them when they sat down to frame a law. And from all this material, like a bench of judges, they framed the present law, and who were better qualified to do so? Now, no law ever yet made by man could suit all parties, and even laws made by God do not suit some people. Personally, I propose to support the board in their efforts to better the engineer and will assist with what knowledge and experience I possess to help my brother engineers to get a 1st class certificate.

I have much more to say, but will leave it till the next issue.

London. Ont.

D. F. Campbell.

A GOOD SOLUTION

The Editor:

With reference to the letter, "A Reply to Justice," which appears in your issue of Nov. 20th. I would like to express an opinion about a point brought forward in that letter. The writer says he was given to understand that it is not essential for a man to have all the different formulae in his mind, and I think we will find that will be the case. The rule regarding books and papers in the Board of Trade Examinations for marine engineers in the United Kingdom reads: "candidates are prohibited from bringing into the examination room books or papers of any kind whatever. The slightest infringement of this regulation will subject the offender to all the penalties of failure." Many of the questions have the formula given with them. I submit three as an example, and I think we will find in our examinations for a stationary engineer's first-class papers that the examination will have something the same form.

Question 1:

The piston is 60 in. diameter, steam 32 lbs. per sq. inch, length of crank 18 in., diameter of shaft 12 in. What is the stress on the shaft per sq. inch?

$S = \frac{5.1\ Wa}{d^3}$. S = stress. W = total pressure on piston. a = length of crank. d = diameter of shaft.

Question 2:

A safety valve 6 in. diameter has a spiral spring 5 in. diameter outside, ⅞ in. thickness of steel. What is the pressure per sq. inch?

$\frac{8000\ S^3}{d^3}$ = total weight. S = the thickness of the steel d = the diameter of the spring from centre to centre.

Question 3:

With double butt straps and double riveted, what would be the safe working pressure of a boiler, whose diameter is 11 feet and the thickness of the shell plates ⅞ in. ?

The safe working pressure may be found approximately by taking the thickness in inches, shifting the decimal point three places to the right and dividing by the diameter in feet.

Dryden, Ont.

Arthur Smith.

A REPLY FROM JUSTICE

The Editor:

Adverting to Chief's reply to my letter re. graded certificates, I do not see that I can add much to what I have written. My point was that the new act does not give any encouragement to young engineers, and this point was corroborated by T. H. Fenner in Nov. 5th issue.

I also called your attention to the clause which states that an engineer in charge of a plant of 150 B.H.P. or over is entitled, if he holds a 1919 certificate, to continue until he changes his position, and made the suggestion that engineers who receive a grade lower than what the act calls for should sit for an examination. etc

Chief states, many of the engineers who have been influential in the securing of this act are placed in an embarrassing position by its wording, and he refers to engineers in charge of plants of unlimited capacities who know the ins and outs of engineering from A to Z. etc. In this he is quite correct, and I agree with him. But are there not some so-called engineers in charge of plants who are not so well informed and qualified? Hence, if a special examination was held as I suggested, the engineers referred to by Chief would be granted a 1st class, and those who I had reference to would not.

I feel certain that the examiners will not turn down a man who knows engineering from A to Z, even if he is not well informed in trigonometry and calculus. And as a first-class is only to be granted by an examination, and to conform with Section 15a, I still think this is the best solution.

Trusting this will give Chief a clearer idea of what I meant in my last letter and that he, being a gentleman, will withdraw the remark that I am a Bolshevik.

Justice.

A WORD FROM JUSTICE THE SECOND

The Editor:

In your issue of November 20th I have been more than amused reading the letter of one who calls himself "Chief."

This man seems to think that a man who knows engineering from A to Z should have a first-class certificate granted him: yes, so do we all, but, how is he going to prove this to others? Have others to accept his word for it? Most certainly not! Let him sit down with the other chief engineers and prove his knowledge in a straight-forward manner. The majority of chiefs think they know their own plant, but, allow me to inform my honorable friend that very few of the chiefs in one of our large cities will enter into a debate or argument, and if possible, will shun the engineering topic entirely. What is the reason? Because in their own estimation they know engineering from A to Z, while at the same time they are merely holding their positions by bluff. Now the Government of Ontario has called their bluff and they are shaking in their shoes and, will call out in vain as they have yet to prove to the Government of Ontario through their qualified examiners, what they really know. not to their employers as "Chief" would like to emphasize in his letter as it is an easy matter to convince or lay down facts to one who is entirely ignorant of engineering in any of its branches.

Let justice be done to everyone; with no red tape, no string pulling, and no influence connecting the present-day engineers with the gaining of first-class certificates on and after January 2nd. Let all chiefs and engineers prove their ability and show that they are worthy of holding such papers by gaining the qualifying percentage to the questions set forth to them on or after the aforementioned date. By so doing they will have demonstrated to those in authority that they are really masters of their profession.

Justice II.

Laying Out Boiler and Engine Foundations

This Article Takes Up the Actual Construction of the Foundation From the Excavation to the Mixing and Placing of the Concrete

By T. H. FENNER

HAVING run the lines and located all the points of the foundation, the next operation will be the excavating.

Don't forget that when you are putting in and squaring up the forms for the concrete, you will need room to work so make the excavations about six inches wider than the form will be. In the case of a deep foundation, the width of the excavation would be governed by the room necessary for a man to work in. The nature of the ground has to be considered carefully. If of a wet, clay-ey nature, liable to slip, it will be necessary, in ordinary foundation work, to dig the trenches for the forms two or three feet wider than the width of the form. Either that, or the sides will have to be sheathed with planking to prevent slipping. If the foundation is a deep one in this sort of ground, sheathing is an absolute necessity. However, if the ground is dry clay, soft rock, or any solid material, there will be no need to consider methods of retaining it. It will just be a straight digging proposition.

You will now, or before this time, if your source of supply is a distant one, have considered the amount of material required for concrete, and made arrangements to get it on the job. Let us see how much concrete we shall need, and how much of each of the different constituents that are used in making it.

Estimating Quantity

It will be necessary to figure up the number of cubic yards of concrete in the whole foundation. Then having determined the proportion of the mixture of cement, sand, and stone, determine the quantity of each. Get them delivered as close to the job as possible, always taking care that the cement is put in a perfectly dry place.

First of all, to estimate the total quantity of concrete. We have 2 side walls, the centre wall, back wall, bridge wall, and front wall foundations. The side wall foundations are 20 inches wide by 36 inches deep by 22 feet long. That is $1.66\times3\times22\times2=220$ c.f. nearly.

The centre wall, say, 24 inches wide, but the same depth, gives $2\times3\times22=132$ c.f.

The back wall, 20 inches wide by 17 feet long by 3 feet, $1.66\times17\times3=84.66$ c.f.

The bridge wall, $1\times17\times3=51$ c.f.

The total amount of concrete will be $220+132+85+51+51=539$ c.f.

This is roughly 20 cubic yards of concrete.

Now comes the question of the proportions to be used. For foundation work, using stone of 1½ to 2 in. sieve, the mixture should be 1 cement, 2 stone, 4 sand, and for larger stone, 1 cement, 2½ stone and four sand. Suppose we conclude to use the latter proportion: We have a total of $1+2\frac{1}{2}+4=7\frac{1}{2}$ or 15. Now the cement will be $\frac{1}{2}\div7\frac{1}{2}\times20$

$$=\frac{20}{1}\times\frac{2}{15}=\frac{40}{15}=2\ 2\text{-}3\text{ c.y.}$$

The stone will be $\frac{2\frac{1}{2}}{7\frac{1}{2}}\times20=\frac{5\times2}{2\times15}$

$20=6\ 2\text{-}3$ c.y.

The sand will be $\frac{4}{7\frac{1}{2}}\times20=\frac{4}{1}\times\frac{2}{15}$

$\times\ 20=10\ 2\text{-}3$ c.y.

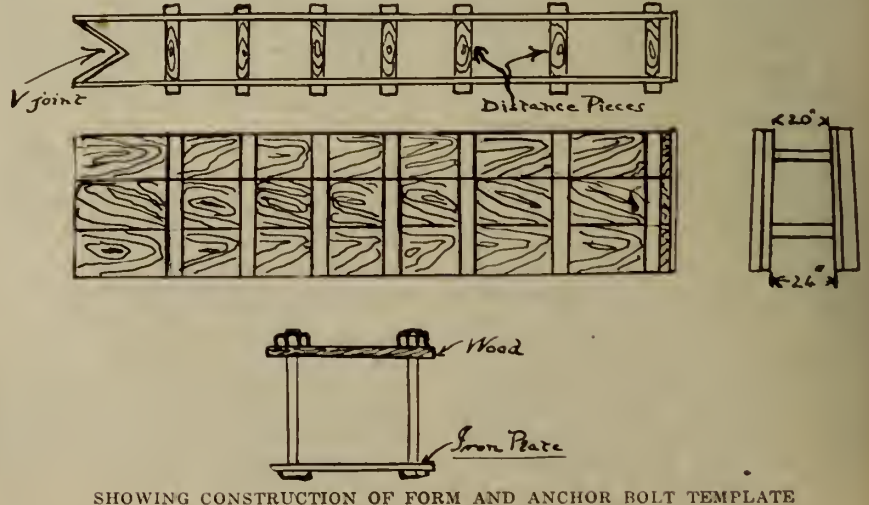
$2\ 2\text{-}3+6\ 2\text{-}3+10\ 2\text{-}3=20$ c.y.

That is taking the proportion by volume. A cubic yard of concrete weighs, roughly, 3,350 lbs., the specific grayity being 2. Sand weighs about 2,430 lbs. to the cubic yard, and common stone 4,239 lbs. Cement weighs about 2,187 lbs. to the cubic yard. Cement is always ordered by the ton, but sand and stone or gravel by the cubic yard.

When the men are fairly started on the excavation work get the carpenters busy on making the forms. At the same time get the board that the concrete is to be mixed on into the boiler room. This should be a good flat board about 8 feet square, round which about eight men can work comfortably. I am assuming that you have no mixer. Arrange the runways for the bringing of cement, sand and stone to the board, and then determine how much you will mix in each batch. This will, of course, be governed by the size of the board and the number of men available. Wherever possible you should get two boards, and have a gang mixing and a gang pouring.

However, we are not yet ready for mixing and pouring. The excavating has been started, and you have got to keep the ground clear, which means you must wheel the stuff away as fast as it is thrown out. The distance you have to wheel the stuff out will determine the number of barrows you need. If there is room for a horse and cart, use one, because that is the quickest and cheapest way to handle the stuff. The horse and dump cart take as much earth away in one load as six men with wheelbarrows, and is quicker covering the distance. Generally speaking, in ordinary ground, four men digging can keep three men busy wheeling. They will be too fast for three men at the beginning, but as they get down deeper the wheelers can handle them all right. Of course, if the stuff has to be wheeled very far, you need more men, working in relays. That is, where the team is a benefit.

Having started on the excavation work and found a place to store your material, the next thing is to get the carpenters down to make the necessary forms. For foundation work, only the cheapest forms are necessary. It should also be arranged so that the same forms can be used more than once. For instance, the side walls and centre wall are all the same length, and so are the back, bridge, and front walls. The side walls are 22 feet. The carpenters should get one inch boards, twelve feet long. For the side walls, which are 22 feet long over all, but only about 18 feet between the back and front walls, two forms twelve feet long and two six feet long should be made. These four forms should be enough for the whole job, unless you have a big enough gang working to run the whole foundation at once. This is unlikely. In cases where the stationary engineer is handling the job himself, unless he is rushed for time, too big a gang is a hindrance. It is different with a contractor, who has



SHOWING CONSTRUCTION OF FORM AND ANCHOR BOLT TEMPLATE

his foremen and sub bosses to handle his men, and is used to quick work. It pays him to get the job done and get his plant away. The proposition is different with the man who is going to erect the machinery as well as the foundation. You may rush all you like, but concrete has got to set, and you might as well let it do its hardening in such a way as not to delay the job. The best way is to get one foundation excavation made, say, one side wall, and get the men digging on another while the forms are set and the concrete poured in the first. The forms are merely 12 inch planks, laid edge to edge, and nailed to studding every two or three feet. Where points have to be made, as in this case, the end of the form should be closed with a V shaped piece, so as to provide a dovetail joint. Another way is to fill the form only partially at the end to make a scarph joint. By the time the forms are set, and the concrete mixed and poured, there will be enough of the second foundation excavated to enable a form to be put in, either a long or short one, and keep going on the pouring. The remaining part of the excavation will be carried on at the same time, and the third wall excavation started before the concreting of the second wall is finished. The first concrete will now be well enough set to enable the forms to be removed, and these forms can be used on the third wall, while the second one is hardening. In this way work can go on steadily, the concrete hardening as the work goes on. There need be no fear of the concrete not knitting where the joints are made, and the whole foundation will be one piece when finished.

Placing the Forms

Before placing the form in the excavation, go over the lines again, and check up the measurements. The lines may have been moved or broken during the digging out, and must be corrected before the form is set.

The forms are three feet deep, and the foundation is to be 20 inches wide. Make the forms 20 inches wide inside at the top, but spread them out at the bottom to, say, 22 inches or 24 inches. This will use up a little more concrete, but it makes the foundation stable. That is, it will stand on its own base. The completed form consists of two sides and two ends. Between the two sides, and coinciding with the studding, pieces of 4 in. square timber are nailed to keep the necessary width of opening. If the form is to be put end to end with a second form, that end will, of course, be left open. The ends of the forms are butted close together, and a board nailed to the outside, covering the joint, when in place.

The forms are put in the trench and nailed up in place. The usual practice is to place packing in the form of bricks under the corners to bring them to the desired height. They are then carefully levelled with a spirit level and long straightedge, and after that, must be secured. Here is a point that should be given attention. Don't forget that when men are dumping barrow loads of concrete into a form, they are far from gentle. Don't spare any pains in making the form secure. Brace it well from the walls of the trench so that it cannot move in any direction. Get the forms in proper alignment and all secure before a bucketful of concrete is poured. A little time spent in that way will repay itself in the long run. To ensure against the forms sinking, lay a couple of boards across the top of the form, resting on the ground each side of the trench, and nail them to the form.

The next thing to do is to place the anchor bolts which hold the columns. These must be placed in position and secured firmly. Measure off the distance along the line from the back or front of the boiler to the first column centre, and from there to the second column centre. Mark this on the side of the form for a guide. Then get your anchor bolts and template and place it in position. The template will be a simple piece of two inch board, with holes for the bolts drilled at the proper distance apart. A centre line will be marked on the template, which is placed in line with the mark on the form. The bolts are passed through a piece of flat iron about ½ inch thick, and wide enough to allow of the bolt holes being drilled. This is dropped down on the bolts to the bolt heads, and the template is nailed on top of the forms, after being accurately located. The screwed ends of the bolts are passed up through the board and the nuts put on to hold them. The lower part of the bolts and the anchor plate must be chocked off, so as to prevent moving. This is the simplest form of template.

The next step is the mixing of the concrete and pouring, which will be taken up in a later article.

NEW METALS FROM NEW FURNACES

Some details are now available of the manufacture in Great Britain of cupronickel originally undertaken for the production of small arms ammunition, and now continued on a large scale for industrial purposes. Research was instituted by Sheffield University into the production of satisfactory qualities and even the difficulties of using a large percentage of scrap metal were rapidly overcome. A special school was established for training casters in this and other non-ferrous metals. Electric furnaces are used for the melting of such metals, and in one Sheffield works there are over five such furnaces at work, ranging in capacity from 40 to 1,000 kilowatts. The resistance type of furnace has been adopted as best suited to metals which readily burn and vaporise. In this type the heating element consists of a trough lined with a granular material which becomes hot when current is passed throgh it. So efficient are these British furnaces that the actual metal losses in melting yellow brass scrap were less than one per cent. The current consumption varies from 300 to 350 kilowatt-hours per ton of yellow brass scrap melted. One of the 1,000-kilowatt furnaces melts brass at the rate of two tons per hour when supplied with 600 kilowatts, and is also used for remelting aluminum pig, taking three tons at a time and using 500 kilowatts. When melting zinc, the same type of furnace has a capacity of 200 tons per day, and shows only 0.024 per cent. of waste metal. These developments suggest that Great Britain intends to play a very important part in the wide field opening up for non-ferrous metals.

BOILER PRIMING TROUBLES

Priming is the technical name given to the passage of water along with the steam, from the boiler into the steam pipes, engines, etc. When occurring in a pronounced form it may be attended with very serious results, since the withdrawal of a large quantity of water from the boiler may lay bare the furnace, combustion chamber, or firebox crowns, thereby causing overheating and possible damage to the boiler, engine cylinders, pistons, and so on; and perhaps loss of life through an explosion. The cause of such phenomenon may be due to (1) undue and sudden fluctuations of steam pressure or demand; (2) an absence of an anti-priming pipe; (3) a partially choked anti-priming pipe; (4) undue forcing of a boiler in the matter of steam raising; (5) impure feed water; (6) the presence of sediment or grease in the water or an excess of lime or soda, or other materials injected into the boiler with a view to the reduction of mud or scale, and (7) to the water level being maintained too high.

Warren Webster & Company announce, with regret, the resignation of Mr. Frank G. Phegley, who severs his relations with the Webster organization after nine years of valuable service as manager of their Cleveland office, in order to enter the professional field as consulting engineer in heating and ventilating work. Their Cleveland office will be maintained at the same location, No. 706 Rose Building, but will hereafter be under the direct management of the home office. Mr. Clyde W. Colby, who has an extensive acquaintance with the heating trade in Northern Ohio, has been appointed as Cleveland district manager, and will have associated with him as assistant district manager, Mr. William Roebuck, Jr., who has been a part of the home office sales-engineering organization for the past nine years.

A Fourth-Class Certificate Requires——

A Candidate for Fourth Class Certificate Should Have a Knowledge of the Following Subjects. The List is Based on the Requirements for Examination and is Authoritative

By W. F. SUTHERLAND

He should have a fair knowledge of addition, subtraction, multiplication and division. This does not mean speed in calculation, but sufficient familiarity with arithmetic to work out problems met with in everyday life. This does not include fractions, either vulgar or decimal.

He should be familiar with the various types of boilers, should be able to describe them and to tell wherein they differ. This does not mean that he should have a knowledge of the strength of boilers or of their parts. The boilers with which he will have to deal may be given as follows:—

Horizontal return tubular.

Vertical fire tube, both dry tube and submerged tube types.

Water tube boilers of various types.

He should be able to describe the functions of the various parts of these boilers, manholes, shells (for fire tube boilers), drums (for water tube boilers), etc.

He should be able to describe the method of using man and hand-holes, their making steam-tight, and precautions to be observed in opening up a boiler.

He should be able to describe the general construction of and the functions of tubes. In addition, he should know how to clean tubes and why, how to expand them and to plug them when necessary.

He should be familiar with the function performed by the blow-off, how, when and why to use it. This is in the regular operation of the plant, and he should also be acquainted with the necessity of securely shutting the blow-off connection when working inside the boiler and when other boilers form a portion of the plant.

He should be familiar with the various types of safety valves, such as spring-loaded, lever-loaded and dead-weight. He should also be familiar with the functions performed by fusible plugs.

He should be familiar with the function performed by the safety valve and should know how to maintain it in a safe operating condition. Above all he should know that the escaping steam should have a free and unobstructed passage without hindrance by other valves or obstructing material. In this connection also he should realize that additional weights, monkey wrenches, etc., should never be hung on a lever safety valve, and that blocking the valve is a sure way of stepping heavenwards.

He should also realize that if safety valves are not operated once in each shift someone is neglecting his duty, and that valves so neglected are apt to make for trouble some day.

He should be familiar with the functions performed by the main steam valve and non-return stop valve in the securing of safe operation, and should know how to operate them in the cutting in and out of boilers. He should also be acquainted with the fact that such valves should be locked when anyone is working in a boiler down for repairs or cleaning, and that the person in the boiler, as the one most concerned, should carry the key.

He should be familiar with the construction of and the functions performed by the water-gauge and try cocks. He should know that the best way to keep try cocks in condition is to try them at least once in each shift. He should know how to take care of spare gauge glasses and how to insert them and make other necessary adjustments.

He should be able to read a steam gauge correctly.

A knowledge is desirable of the functions performed by and method of operation of feed-water heating apparatus such as open and closed heaters.

He should be familiar with the function and operation of feed-water pumping equipment, whether pumps or injectors.

He should be able to give intelligent answers as to the control of the feed water entering a boiler.

He should be able to tell what safety precautions are to be observed when cleaning a boiler and should be able to describe how to go about the cleaning itself.

He should know that it is unwise to attempt repairs to any vessel or packing when under pressure.

He should know what to do in the event of low water, or other emergency conditions likely to be encountered in the boiler room.

He should be familiar with the construction and operation of the different parts of a boiler setting, and should know the functions performed by each. These parts would include ash pit and doors, grates, stationary and dumping, bridge-wall, combustion chamber, dampers, flues, breechings and stacks.

He should know how to maintain proper combustion conditions in so far as an air supply and regulation are concerned.

Indicating and recording instruments are of much use in the boiler room and the fireman ought to be familiar with their use. Aside from the steam gauge and water gauge, of which a very full knowledge is required, the fireman ought to be acquainted with the draft gauge and other instruments of similar type. Their use in controlling firing conditions should be known.

He should be familiar with the functions performed by the proper method of lubrication and the general operating features of bearings.

He should be familiar with the construction of pipe runs and their joints and packing, the functions each of the above perform should also be familiar to him, as well as the maintenance features incidental to their care. He should know, for instance, how to properly pack a joint and how to draw up the bolts holding flanges or fittings together. He should also be familiar with the construction and function of fittings in general and should know how to care for valves and how to operate them.

Traps and separators come under the care of the fourth class engineer, and he should know how to take care of them, and should know what they are for and how they function.

The above is only an outline of some of the most essential information which the fourth class applicant should know. Many other features of the boiler room are familiar to firemen working in the particular plants where these are installed, and it is to the advantage of the fireman to know something about them. The applicant's experience will necessarily affect the type of question asked him, and, where, in view of this experience, he is able to answer questions with respect to the particular equipment in his care this will certainly count greatly in his favor. For instance, if he is firing in a plant where fuel oil is used, a knowledge of the functions and operation of the apparatus employed would be of help to him.

WELDING REPAIRS TO WATER WHEEL

An electric welding repair job that is of considerable interest to the power plant operator and the mechanical engineering field in general, is shown in the accompanying illustration. In the initial construction of these water-wheels, difficulty has frequently been experienced in obtaining a firm and rigid connection where the vanes join the supporting rings. Generally speaking, the vanes are steel castings that are placed in position in the sand mold so that the molten iron will flow about the edges and form an integral casting. However, the result has often been unsatisfactory, as the subsequent expansion and contraction of the vanes and the rings causes a looseness in one or more of the connections. The peculiar construction of the vanes makes it difficult to use the oxy-acetylene process in uniting the vanes to the retaining rings, and relatively poor success has, so far, been obtained by the use of the electric process, when working together steel and cast iron. However, the St. Lawrence Welding Co., of Montreal, who accomplished the repair on the wheel here shown has effectively formulated a special flux that overcomes former difficulties, and the vanes can be rigidly secured to the cast-iron rings, by means of the electric arc method, so that the force of a sledge upon any of the vanes will not produce the slightest defect in the welded joints. The cut shows the work immediately after welding; the rough appearance of the added metal was subsequently removed by grinding, leaving a smooth fillet weld in from the outer edges. Water-wheels treated in this way have shown greater efficiency after welding by this method.

BUILDING UP A WATERWHEEL RUNNER BY WELDING.

THE "NO-REPAIR" AEROPLANE

One of the accidents of war led to a very convincing proof of the remarkably high standard of British engineering work. A British fighting aeroplane was delivered by the makers in September, 1917, and immediately put into commission. After a busy period of war service it was forced to land in Holland. The pilot was interned and the aeroplane was bought by the Dutch Goxernnment. Since then Dutch officers have flown it continuously, but it has never been repaired or renovated even in the slightest detail. Not even the "dope" on the wings has been renewed. This machine is still in service, and is very popular with the Dutch pilots.

THE DAM AT BASSANO, ALBERTA, SUPPLYING WATER TO EASTERN SECTION CANADIAN PACIFIC IRRIGATION BLOCK

By FRANK C. PERKINS

The accompanying illustrations show the great Canadian concrete dam at Bassano, Alberta, supplying water to Eastern Section Canadian Pacific Irrigation Block. The purpose of the dam is to raise the water of the Bow River to such a level that it will run out along the main canal. It is of interest to note that the main canal is 5 miles in length and there are some 475 miles of secondary canals and over 2,000 miles of distributing ditches supplied from it. The dam, which was begun in 1910, brings under intensive cultivation 440,000 acres and directly affects the settlement of over 1,000,000 acres of land of great fertility, which will, undoubtedly, become one of the greatest diversified farming and stock-raising regions on the North American continent.

The magnitude of this engineering feat is made clear from the fact that the dam has a total length of 7,014 feet and the spillway portion of dam, crossing the Bow River, has a length between abutments of 720 ft. The height from floor to the over-flow crest is about 40 ft., above which 11 ft. of water is retained by 24 sluice gates, operated by electricity.

It is stated that the spillway contains some 42,000 cu. yds. of concrete and 2,500,000 pounds of reinforcing steel. The dam will hold in check 4,000,000 tons of water, and the discharge into the main canal will be 3,800 cu. ft., equal to 100 tons of water per second. The Bassano dam illustrates the latest construction in concrete structures of this type as built by modern methods.

IRRIGATION DAM AT BASSANO, ALTA.

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Recommends Coal as a Fuel

THE possibilities of developing power in Alberta are carefully analyzed by James White, of the Commission of Conservation in a paper now published, but read before the Industrial Congress at Calgary.

While a little apart from the subject, it is interesting to note that the factories of the world, including electric lighting and street railways, use 75,000,000 horse power; the railways of the world, 21,000,000, and the shipping of the world, 24,000,000, or a total of 120,000,000 horse power. Of the 75,000,000 horse power used in factories and general industrial and municipal activities of the world, about 13,000,000 is used in the United Kingdom, about 29,000,000 in United States, and 6,000,000 in the British Dominions.

There has been more or less of a popular belief, or illusion, that the gas wells of Alberta were the greatest producers of power, and would continue to be. This conception may have come to pass from several reasons, and no doubt the rather extravagant claims of some of the publicity exploiters of the various centres have much to do with it.

Alberta has a great power proposition. This can be proved in several ways. She has, in the first place, 87 per cent. of the coal deposits of the Dominion, a splendid gas supply with a very high B.T.U. grading, while the waterpower of Alberta is by no means lacking.

The report of Mr. White makes it very plain that he considers that the greatest prime mover that Alberta can develop successfully is found in the steam-electric plant. Water power, owing to high labor costs, is laboring under a heavy, permanent handicap. Gas is an uncertain quantity regarding permanency, and depending on it might lead to serious losses. Regarding coal as a source of power, the report says, "Now, the great source to which Alberta must look for power is her coal. During recent years, the great advance made in the art of the production of steam power is phenomenal. This advancement has given coal, as a prime agency for power development in competition with other prime agencies, almost a premier position. Those interested in the furnishing of power on a wholesale scale in Alberta must make their research into, and selection from, the achievements made in recent years in the field of power produced from coal."

The Coal Strike

WHILE the Eastern and Western provinces of Canada are independent of foreign countries for their supply of fuel, the central ones, particularly Ontario, are not so fortunate and depend on our neighbor to the south for coal. It is fortunate, indeed, at the present juncture that Ontario has developed her water power resources to their present extent, but fuel for heating and, to a less extent, for power, is required in large quantities.

The industrial troubles prevalent in the United States thus have a direct bearing on Canadian industry, and while escaping more lightly than the United States, heatless days and lightless nights, at least to the previous war-time extent, are an unpleasant possibility. It is, perhaps, idle to talk of economy and conservation when no fuel is available, but while our present stocks are still of an appreciable, although rapidly diminishing size, any slight economies possible in the heating plant or power house are of an immense value. The engineer best knows how to operate his individual plant at its best efficiency, and it is idle to enumerate the many ways in which coal may be husbanded.

And when plentiful supplies are again available it is still of importance that rigorous care be exercised in maintaining the power plant at its highest efficiency. Together with making the best of equipment on hand, the chief executive officer and the engineer might well have a session or two together, discussing ways and means of improvement.

In no single way can money be better spent than in purchasing indicating and recording instruments, together with other plant equipment not, perhaps, essential, but greatly conducive to economy.

The question of fuel economy has a national bearing as well as a direct monetary advantage. At the present rate of exchange imports of any kind have an adverse influence, and when fuel is unnecessarily wasted it simply means that the restoration of normal conditions is made that much more difficult.

WIRELESS AT THE RATE OF 200 WORDS A MINUTE

Remarkable Developments Have Taken Place — Messages Sent Over 12,000 Miles

A PAPER on "Recent Progress in Wireless Telegraphy" was read before a recent meeting of the E. I. C., and the speakers was J. O. G. Cann, chief engineer of the Marconi Wireless Company of Canada, in Montreal. During the address Mr. Cann spoke on the widespread use of wireless by the Germans and the enterprise of the British and other allies in the destruction of many stations in various parts of the world that had been utilized for enemy war purposes. Mr. Cann outlined the different systems now in use, describing briefly the operation of each, stating that the spark method of the Marconi Company was the one generally used throughout the world. Some conception of the efficiency of wireless may be gathered from the fact that signals from Carnarvon, in Wales, have been regularly copied at Sydney, Australia, a distance of 12,000 miles. Mr. Cann read two of these messages that had been transmitted during the period of the war.

Wonderful advancement has also been made in wireless telephony, and sets are now available which will permit of telephonic speech from one airship to another, or from the plane to the ground. Sets are also made for conversation between ship and ship. Mr. Cann also spoke on the progress of direction finding and the advantages that had been derived by its use in minimizing or eliminating many of the Zeppelin raids over France and England. This feature was also extensively used in locating enemy submarines and subsequently destroying them. Some idea of the progress of wireless may be had in the speed that is now possible in transmitting messages. The hand-sending method, with a speed of about 20 words per minute, is being replaced by apparatus with a capacity of over 100 words per minute, and special machines are now under construction, at Montreal, that will be capable of transmitting 200 words per minute. Signals from this new device will be transferred direct to the land circuit and from there taken off on a tape passing through a printing telegraph. Samples of these messages were on exhibit, and it is interesting to state that one of these was recorded when the operator was absent from the office. In addition to the address, Mr. Cann had with him some modern wireless equipment, and illustrated, with a number of slides, some of the essential mechanism of a wireless station.

Cyrus W. Field

WE are all too apt to pass over the achievement of the man who, while not an inventor himself, yet by his persistency and vision of greater things to come, makes possible, in a commercial sense, the fruit of some other person's inventive genius, to the everlasting benefit of mankind. Of such a type was Cyrus W. Field, the man to whom more than to anyone else the successful conquering of the Atlantic ocean was due, and who, after many unsuccessful efforts, succeeded in laying the first Atlantic cable.

It seems most fitting that the close of the one hundred years that have elapsed since his birth, November 30, 1819, should mark the beginning of a new era in which the status of wireless telephony and telegraphy has reached a high state of perfection through the travail of the last few years.

His early years were marked by nothing of startling import and were devoted to the accumulation of a fortune modest in these days, but of considerable size at that time. At the age of 34 he had amassed the tidy little sum of $250,000 and purposed retiring from active business life.

Ten years before Morse had succeeded in establishing telegraphic communication between Washington and Baltimore and Field's interest was aroused in the possibilities of the submarine telegraph through a meeting with N. Gisborne, an engineer who proposed laying a cable between St. Johns, Newfoundland and the United States.

Visions of retirement were abandoned in favor of an active attempt to lay an Atlantic cable which would put Europe into communication with the United States. And while no claim can be made that Field was the first to conceive of the idea of laying a cable under the Atlantic, he was the man who enlisted the capital on both sides; of more importance still, he furnished the abiding enthusiasm necessary to achieve success after three costly failures.

The first attempt was made in 1857 and when 260 miles from Valentia Bay, Ireland, where the start was made, the cable parted and sank. The second attempt made the following year met with a partial success for the cable was successfully laid between Newfoundland and Ireland amid much rejoicing. Twenty-six days after its first operation this cable in turn failed, ruined by the ignorance of the engineer in charge, a current of high potential being used.

It was not until 1865 that another attempt was made. Field by this time had some difficulty in securing the necessary funds and so 'tis said made somewhat of a nuisance of himself amongst his friends. The Great Eastern was employed as a cable ship and the third attempt met with failure when 1,062 miles had been laid and when the cable ship was only 600 miles off the shore of Newfoundland.

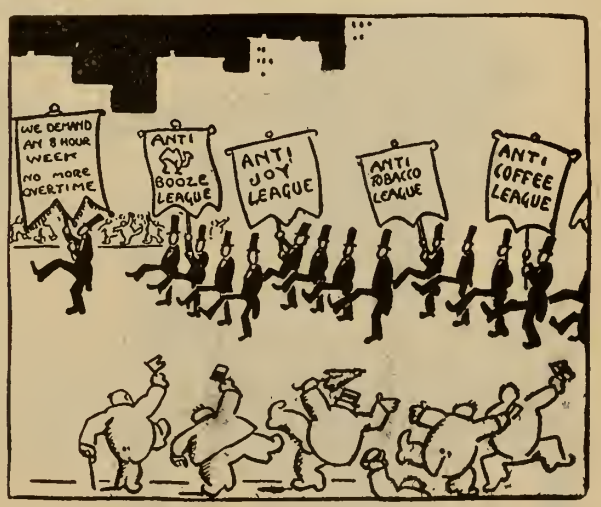
The final attempt was made the following year and not only met with success but the broken cable of the year before was successfully lifted, spliced and terminated on shore.

The interest aroused in these attempts may be estimated by the names of the men who lent encouragement and assistance to the enterprise. Michael Faraday and Lord Kelvin, then Professor W. Thomson, were among the English scientists interested with Maury and Morse in the United States. Thackeray and Lady Byron were stockholders.

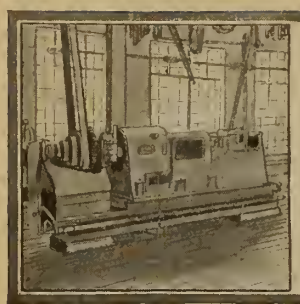
McCarthy's "History of Our Times," says:—

"He was not a scientific man; he was not the inventor of the principle of inter-oceanic telegraphy; he was not even the first man to propose that a company should be formed for the purpose of laying a cable beneath the Atlantic.

"But the achievement of the Atlantic cable was none the less distinctly the work of Mr. Cyrus W. Field than was the discovery of America by Columbus. It was not he who first though of doing the thing, but it was he who first made up his mind that it could be done, and showed the world how to do it, and did it in the end. The history of human invention has not a more inspiring example of patience living down discouragement and perseverance triumphing over defeat."



IF THE REFORM LEAGUES WOULD ONLY GO ON STRIKE!
—New York "World."



NEW POWER PLANT EQUIPMENT

THE NEW COPES REGULATOR

IN 1912, the Northern Equipment Co., Erie, Pa., brought out and patented the now well-known continuous feed principle of boiler feed control. They showed that water should be fed proportionately to and variably with the load. This gives a variable water level temporarily inversely proportional to the load; it gives a temporarily decreased feed on sudden increase in load; and a temporarily increased feed on sudden decrease in load.

Up to the year 1912 all feeding was intermittent in character and an absolutely constant water level was considered ideal. Now, however, opinion is unanimous with regard to correct feeding and authorities agree that the so-called "Copes Method" is correct in principle.

Since the introduction of this mechanical regulator changes have been made from time to time in the details of construction, the principle of feeding in the meantime remaining the same as that cannot be improved.

Fig. 1 shows the design of the new Copes control valve. It will be noted that the reciprocating stuffing boxes have been abandoned, and in their place we have a horizontal shaft which rotates very slightly, performing the same function as the old reciprocating rod. Naturally, this new design is very sensitive. The frictional resistance has been reduced as much as 6 to 16 pounds. It is now practically zero because the shaft rotates very slightly and the same part of the shaft is always in the stuffing box.

The valve, as will be noted, is of the balanced piston type. The weight on the valve lever exerts a constant closing force of 50 pounds on the valve piston at all times. A weight is used here rather than a spring, because gravity does not vary, whereas springs grow weak with age, corrode, stick, break, etc.

A vertical section through this valve is shown in Fig. 2, which displays the horizontal shaft, the stuffing box, the link work connecting the shaft with the piston valve, etc.

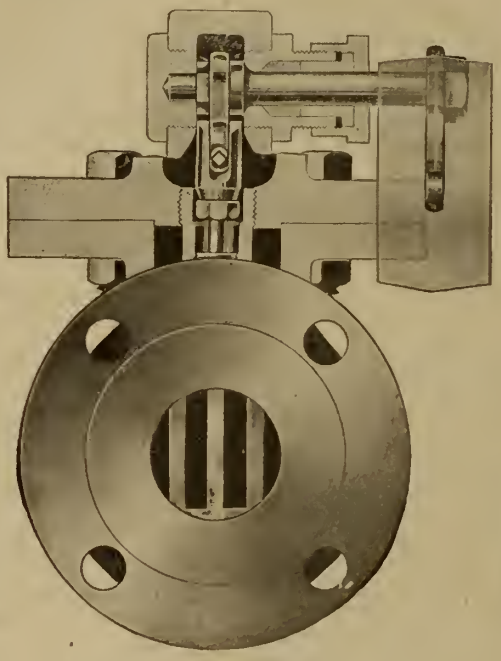


FIG. 2.

FIG. 3.

Another novel feature is shown in Fig. 3. The valve cap or bonnet can be unbolted and removed with fittings attached as photographed without removing the valve body from the pipe line. Any engineer will appreciate the great advantage inherent in this feature.

Fig. 4 shows how easily valve fittings are removed and renewed. A monkey wrench or any other kind of a wrench and a piece of flat stock are the only tools required. One of the seats is here shown after removal.

The assembled regulator complete is shown in Fig. 5. It consists principally of a heavy expansion tube—the long diagonal tube plainly visible in the illustration. This is known as the "thermostat." It is a straight piece of heavy metallic tubing 1⅛ in. in outside diameter. There is nothing about it to wear out, and as stated by the manufacturer it will "outlast any boiler." The top of the thermostat is connected with the steam space of the boiler and the bottom with the water space. Hence there is a water level in the thermostat corresponding with the water level in the boiler. It is this water level in the thermostat that determines the rate of feed. The tube lengthens and shortens with drop and rise of water level. The lengthening and shortening are caused by change in temperature of the tube as the water rises and falls. This expansion or contraction is amplified by means

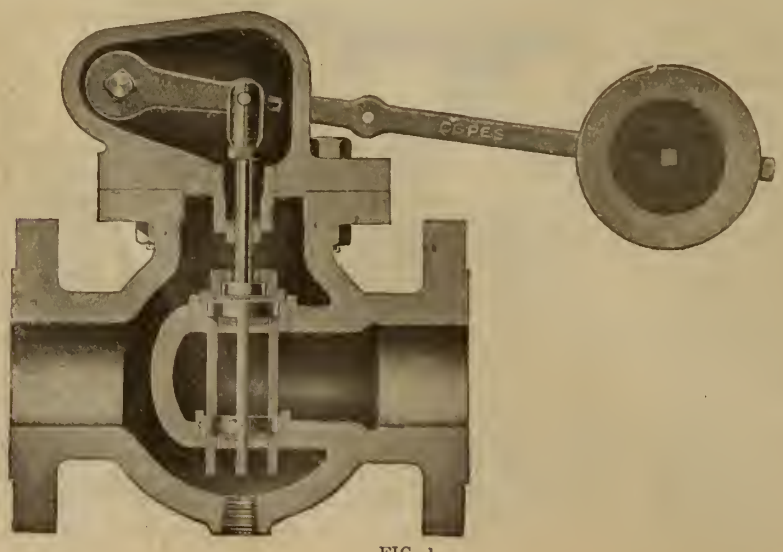


FIG. 1.

of the link work plainly visible in Fig. 5, and through the link work operates the control valve. All parts are simple, strong, heavy and rugged.

A Copes name plate has also been added as shown in Fig. 5. This has been done because regulators are usually placed on the level with the water in the drum, which is high above the heads of the operators or observers, hence the regulator is not noticed, and is often entirely forgotten even by the plant operatives. The Northern Equipment Co. want their regulator to be noticed and remembered occasionally—hence the name plate.

THE GAS TURBINE

In reviewing the development of the internal combustion engine in a paper read before the Institute of Marine Engineers, Mr. Charles Baxter touched on the problem of the gas turbine.

He remarked that the design of the internal combustion engine as it exists to-day does not seem likely to be radically changed since the principles are now well understood. Supercharging—i.e., forcing in an extra quantity of mixture or air at the end of the induction stroke—has been accomplished with a little success, but nothing very revolutionary has happened, the engine becoming complicated by the addition of such items as pump cylinders. From time to time suggestions have been made that a great advance in thermal efficiency might be obtained by combining the steam and the internal combustion engine. This idea occurred to the author several years ago, and he got out a simple design, which, however, eventually assumed such a complicated form that the idea was given up for the time being. Judging by test results, the engine of this form evolved by Mr. Still is likely to justify much of the confidence reposed in it.

The construction of a successful gas turbine is regarded as the next and final step in the development of devices for internal combustion. The great heat generated is the principal obstacle. One suggested arrangement consists of a chamber of refractory material in which combustion of the fuel takes place, the gases impinging upon buckets on a wheel, Pelton or de Laval style. In another, of a pulsating type, the action is that the chamber, being charged and fired, the gas rushes out of the jet, overrunning itself by inertia and drawing another charge of mixture after it through the flap valve. This action is rapidly repeated and is analogous to that which takes place in a gas burner turned very low.

The heat generated in these devices is, of course, very great, and the combustion is so continuous that no chance is given for cooling. In the ordinary type of high-speed engine the explosions, though very rapid, are intermittent so that the combustion chamber walls can be kept at a reasonable temperature, the

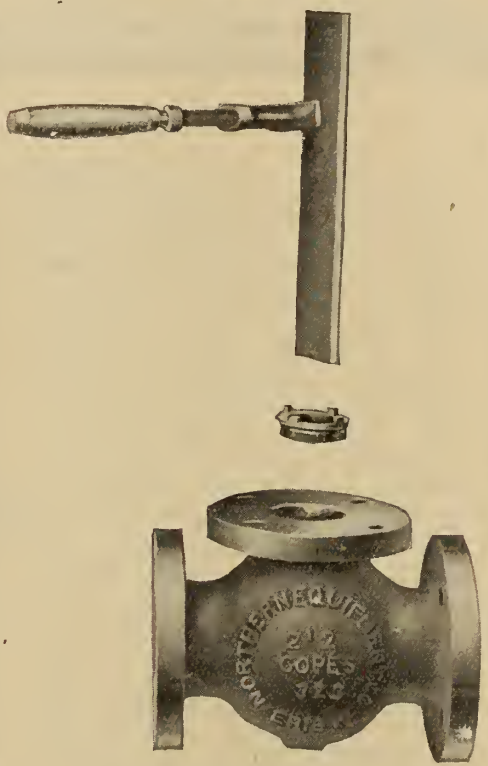


FIG. 4.

incoming cool gas being of great use in this direction. In a turbine design evolved by the author some years ago the gas was exploded in a chamber forming part of the casing. The resulting explosion did work by impinging on a chamber in the rotor, from which it escaped, being returned to the rotor vanes by means of a jet. The following charge under pressure scavenged and refilled the chamber. Such difficulties as holding the ported rings up to the rotor with just the correct pressure were surmounted by balancing the explosion pressure by means of a piston and fulcrum, the proportions being such that the pressure tending to force the ring from the rotor face was exactly balanced by the pressure upon the piston. These arrangements involved the use of turbo-compressors, the efficiencies of which are at present low, and even if a compressor of reasonable efficiency were forthcoming, there is no direct prospect of high combined efficiencies being obtainable. A combined gas and steam turbine, however, may do much to solve the problem, and the resulting machine, even if its efficiency was not such as to render existing prime movers obsolete, would undoubtedly be of some utility.

WIDENING THE RADIUS FOR ELECTRIC POWER

Recent achievements are increasing the distances of economical transmission of electric energy. In long distance transmission of electricity, high pressures or voltages are required—the higher the voltage, the lower the losses. For several years after long-distance transmission had been introduced, it was the practice to allow a pressure of approximately 1,000 volts per mile. It was found, however, particularly with distances of over 100 miles, that the distance allowed could be increased to as much as two miles per 1,000 volts. In other words, lines operating at about 100,000 volts pressure have been transmitting energy over distances exceeding 200 miles. More recently, lines operating at 150,000 volts have demonstrated their practicability; one of these has been in successful operation for over five years.

Electrical experts are of opinion that pressures of 220,000 volts are quite feasible and it is stated that "the handling of electrical potentials of 220,000 volts does not appear to involve any disturbing complications or uncertainties. In fact, the manufacturers do not recognize that any serious problem exists. Current design principles and materials now in ordinary use will be employed, the principal difference from present high voltage equipment being the greater amounts of insulation and the larger clearances required. The step to 220,000 is relatively no greater than that previously taken from 66,000 volts to 110,000 volts or from 110,000 volts to 150,000 volts. Certain of the manufacturers have already developed designs and assert readiness to undertake the commercial production of 220,000 volts. equipment on short notice."

The advantages of long distance transmission are of particular interest to Canada, where much of our water-power is found in large units and, to reach many consumers, it may be necessary to transmit the energy for a considerable distance. It is perhaps of greatest interest in connection with our abundant water-powers in the river St. Lawrence and in the area lying to the north of the settled regions of the Praire Provinces. It brings us closer to the possibility of making these vast stores of energy available within the settled portions.

FIG. 5.

The Operators' Point of View

SOLDERING FOR SHOP MEN

By Donald A. Hampson

Repair and maintenance work calls for ability to turn one's hand to many a trick that is foreign to every-day machine shop practice. Soldering is one of these tricks, yet a great many machinists are totally unfamiliar with such work, or have only seen it done, while still others despise such a method of making repairs. Soldering is not to be despised—it fills a very definite place—a good soldered joint is better than a poorly welded one. Many jobs that could easily be fixed up with solder are repaired by more expensive methods and by renewals. It is not a hard matter to make a good job of soldering if a few essentials are understood, nor is there required any expensive equipment.

Cleanliness is the first and last requisite for a successful job. The surface of the work must be mechanically and chemically clean. Mechanical cleanness is obtained by machining, filing, and scraping, together with the use of emery cloth that has not been contaminated with dirt and grease. Brass castings may be soldered on the surface if clean, but with cast iron it is necessary to cut or file off the outer surface or skin to expose the fresh metal. Cleaning should be carried a quarter of an inch beyond any part which the solder will touch so that by no chance will be work be retarded by the iron's slipping on to an unclean spot and thus carry dirt back to the joint being made.

The chemical cleanliness is obtained by the application of muriatic acid to the surfaces being joined. This provides for all necessary cleaning and prevents oxidation of the surface during the work. If it happens that the work pieces are galvanized or of zinc, then the commercial acid is used just as it is, but if any other metals are being handled (and the majority of jobs are such) then the acid must have dissolved in it all the zinc which can be absorbed by the acid; this "cut" acid is ready for use and is preferably prepared in small quantities so as to have always fresh acid on hand, and that as clean as such things can be kept which are being dipped into and exposed to air and swabs.

Sal-ammoniac is the most commonly used flux for soldering. Rubbing the hot iron over the surface of this is sufficient. Some men imbed a small amount of solder in a cake of sal-ammoniac and tin the iron by rolling the iron around in this hole, but it cannot be said to be good practice, for the hole gets constantly bigger and less efficient, finally getting bored clear through the cake, spoiling a chunk that at present prices may be worth two or three dollars. Tinsmiths invariably keep the surface of such a cake flat on top and use a holder or container that allows the greatest wear from the rather expensive chemical in use, a couple of movements per side of the iron is all sufficient.

Both the iron and the work must be "tinned" before any kind of a job can be done. This is the second great law of soldering. Oil, grease, dirt, all these prevent the tinning of iron and work, and they have to be removed. Tinning is the process of coating the surface with a thin layer of solder. So far as the work is concerned tinning may be done as a separate operation previous to joining the two pieces, or it may be done as a part of the work with the pieces clamped together. The iron, however, is always tinned before it is applied to the work. Soldering jobs are usually either joining two separate pieces together or filling up cracks, and in both cases it is preferable to tin the surfaces separately because when that is once done it is an easy matter to place more solder in the form of a bond between the two in whatever form or amount is desired.

Some materials resist tinning more than others. With those that offer greater resistance, patience is required to secure the coating, and the iron must be rubbed for some time on the surface before the result is secured, in the meantime keeping dirt and oxidation from accumulating. It is a help in tinning cast iron to coat the surface with a thin layer of copper by rubbing on blue vitriol, the surface having first been machined or filed.

Lack of heat is a detriment to soldering, in fact, most beginners fall down on this one point, and they try to solder with a cold iron and to make solder stick to a cold surface. The iron itself, however, should not be overheated; this is a common mistake around machine shops where the forge fire is used to heat, and where it is very easy to raise the iron to red heat. Soldering "irons" are made with a copper bit, and the red heat is injurious to copper; moreover the red heat burns off the tinned surface of the iron, necessitating doing this part of the work over again. A temperature of 400° Fahr. will melt solder, and there is no need to go a great deal above this.

The function of the iron is three-fold: to carry the solder to the work, to heat the work, and to distribute, or place the solder where wanted. If the iron consisted of the point only, it would fail in the first two functions, but it does not, and we have a large mass of copper back of the point which feeds the heat down to where it is used. Where sheet metal is being soldered the heat from the iron is sufficient, but where the parts are bulky it is preferable and quicker to heat the work in some sort of a clean flame, bringing the work up to about a straw color on steel.

Cast iron requires more heat than steel or brass. Aluminum requires a hotter iron than the other metals and also a special aluminum solder. Ordinary solder will not stick to aluminum; usually aluminum is soldered without any flux, or if any is used it is a specially prepared composition.

Separate parts being jointed by soldering require some sort of fastening to keep them together and in true relation until the bond has cooled. The work may be clamped on a surface plate or held in a vise, or it may be screwed and riveted together, or it may be wired.

The Editor:

In my opinion, the trouble with the setting of the valves, judging from the Indicator Diagrams, which appear in your issue of the 20th of Nov., is, that she opens too soon, closes too soon, and has too much lead. The remedy is put the eccentric back a little.

Dryden.

Arthur Smith.

R. M. Rook, who, for the past five years has been associated with the Metal Thermit Corporation, of New York, has been appointed general foreman of the St. Lawrence Welding Company. Mr. Rook has had a wide experience in welding work of every description, and was directly responsible for the successful repairs on what is considered the largest job yet accomplished by the thermit process. This was on the frame of a large stone machine, the weight of which was approximately 75 tons, requiring about 5 tons of thermit. Nearly seven weeks were required in preparing the mould.

The Marconi Wireless Company of Canada have removed their main offices from 173 William Street (the plant location), to 11 St. Sacrament St., Montreal, in the heart of the business district.

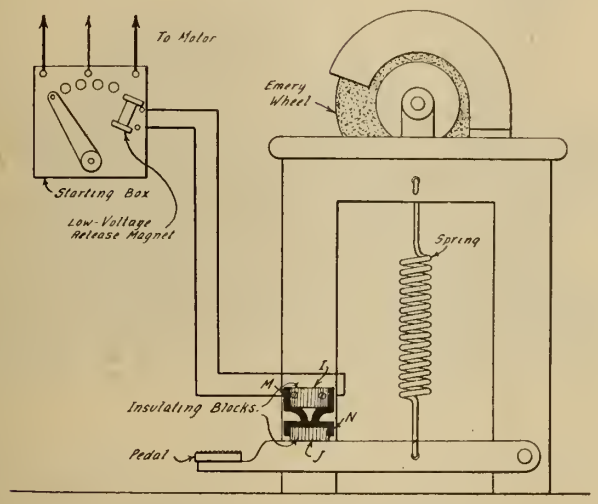
AUTOMATIC STOP FOR GRINDER

By Wilbur B. Burton

(Copyright. All rights reserved.)

GRINDERS are high-speed machines. The workmen often leave them running, after they have finished grinding their tools. The result is that the wear on the bearings is excessive, and considerable power is wasted.

An automatic grinder stop, Fig. 1, will eliminate these disadvantageous features. The scheme is, of course, applicable only on an individually-motor-driven grinder. A block of insulating material, I, was fastened to one of the legs of the grinder frame. To this block was secured two strips of sheet metal, M and M. Conductors were then wired, as indicated, from each of these contacting strips, M and M, to the low-voltage release magnet on the motor starter. The wires were fastened under the release-magnet binding posts, providing an electrical connection. If a short circuit or shunt is arranged across M and M, the low-voltage magnet is de-energized and the starting handle is released. It will then return to the "off" position, and stop the motor. To effect this short circuiting automatically, the pedal illustrated was provided. On it was mounted an insulating block, J, carrying a strip of copper, N.



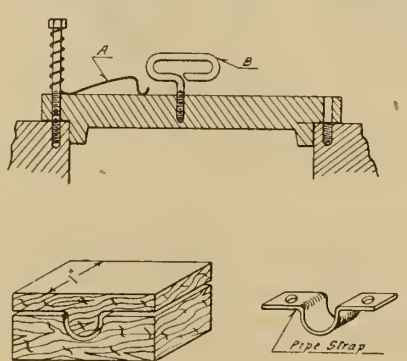
AUTOMATIC STOP FOR GRINDER

When a man wishes to start the grinder, he first steps on the foot pedal. This removes the short circuit from around the release magnet. He then starts the motor in the usual way. When he has finished grinding his tool, he must, of course, remove his foot from the pedal when he leaves the grinder. When he does so, N contacts with M and M, short circuits the low-voltage coil and automatically stops the motor.

TWO KINKS FOR THE POWER PLANT

The cover on a large gear box was held in place by two stud bolts; every time lubricant was put into the box the bolts had to be taken out. Ultimately, the cover was arranged as shown. A bolt extending above the cover for several inches was placed at one side of it, a piece of flat spring, A, and a spiral spring was placed as shown, also a hook at the centre of the cover. The other bolt hole was not used. When filling the gear box with lubricant, the cover was lifted by the hook and swung back, the grease or oil put in and the lid brought back. This was an improvement over the bolt arrangement.

Another simple kink is shown in Fig. 2. Cut two pieces of hardwood into the form shown and about one inch wide. To make a good pipe clip, all that is necessary is to cut a strip of fairly-heavy galvanized sheet iron about ¾ in. wide, place it between the wooden mold and force together between the jaws of a vise; trim the ends to the desired length and punch a couple of nail holes. The mould will only make one size strap of course. However, each mould will be good for thousands of straps.

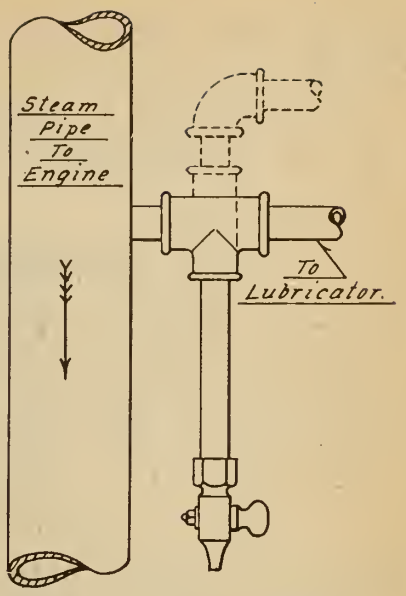


TWO POWER PLANT KINKS

SCALE TRAP FOR LUBRICATOR

A certain amount of sediment or scale from a pipe will often find its way into a lubricator with the result of closed up oil outlet holes. A simple way to overcome this trouble is to attach a drip, as shown in the sketch by the full lines, or as shown in the dotted lines. Some men seem to think that there is a better chance for the drip to catch the sediment when installed in the latter way.

J. ELLETHORN.



SCALE TRAP FOR LUBRICATOR

VANCOUVER CO. INSTALS A "GREAVES-ETCHELLS" ELECTRIC FURNACE

After an extensive investigation of the various types of electric furnaces and a visit to the U. S. Navy Yard at Puget Sound, where a 6-ton "Greaves-Etchells" furnace is in operation, the Vancouver Engineering Works, Ltd., Vancouver, B.C., has given an order to the Electric Furnace Construction Company for a "Greaves-Etchells" furnace.

The Dominion Bridge Company will utilize the plant of the St. Lawrence Bridge Company at Rockfield, for the building of the pulp and paper machines, a post-war development that promises to grow into extensive proportions. They also anticipate the building of a grey iron foundry for the making of the large number of castings that will be required in these machines and the turbo-equipment that they are now building.

Railway Board Reserves Decision.—On the application of the Canadian Manufacturers' Association, demanding that the express companies be compelled to carry electric light bulbs at first-class rates instead of double rates as at present, the Board reserved its decision. The express companies claimed that owing to the bulbs being very light, and occupying excessive space, they were not profitable to carry. The chairman said that he could not accept the idea that express companies should carry only what they wished. They were a public utility, and as such must perform the services the public demanded of them.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Black Galvanized

Size.	Per 100 feet	
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 95
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	25 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 67	99 74
Standard Lapweld		
2 in.	$33 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.

4½" and larger, 50%.

4" and under, running thread, 30%.

Standard couplings, 4" and under, 40%.

4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill	list plus 5%
At warehouse	list plus 25%

Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 25
Steel bars, base, Toronto	4 25
Steel bars, 2" to 4" base	5 50
Steel bars, base, Montreal	3 75
Best grades	15%
Iron bars, base, Montreal	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28..	$6 55	$6 00
Sheets, Black, No. 10..	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10% galvanized	....	....
Queen's Head B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S..	....	7 50
Premier, 10¾ oz.	....	7 80

PROOF COIL CHAIN

B

¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	60
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	60
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	22½
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard	30, 10%
Cut leather lacing, No. 1	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers	list plus 20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank	add $0 75
Nuts, square, tapped	add 1 00
Nuts, hex., blank	add 1 00
Nuts, hex., tapped	add 1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs	40c 05
Boiler rivets, base ¾" and larger	$8 60
Structural rivets, as above	8 40
Wood screws, flat, bright	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass	55
Wood screws, O.&R., brass	56½
Wood screws, flat, bronze	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, per cwt.	15 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A.	list plus 43
Emery Cloth	list plus 37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 6c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd.	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING.

Standard	10%

extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets	list plus 10
Planer head bolts, with fillet	list plus 10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws	list plus 20
Collar screws	list plus 20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts	add 20
Cold pressed nuts to 1½ in.	add 1 00
Cold pressed nuts over 1½ in.	add 2 00

METALS

METALS

Lake copper	$24 25	$25 00
Electro copper	24 00	25 00
Castings, copper	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

ROPES AND PACKING

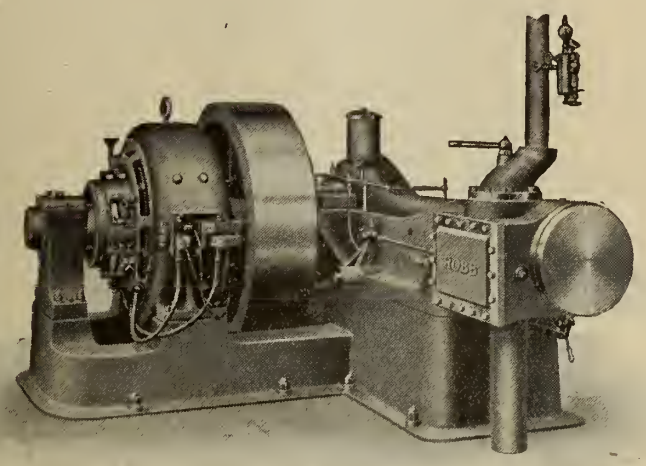
Packing, square braided	$0 39
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb.	$12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.

ROBB POWER PLANTS



Engines

Corliss, slide valve, vertical, horizontal simple and compound.

Boilers

Water tube, return tubular, improved Scotch marine and portable.

Robb Engineering Works, Limited, Amherst, N.S.

Montreal Office:
Phone Westmount 6800

Toronto Office:
20 Victoria Street

Nobel Plant is Sold.—The British Cordite Munitions plant at Nobel, near Parry Sound, has been sold to Mr. I. Cohen, a well-known merchant of Kingston. Nothing is known of what Mr. Cohen's intentions are with regard to the property, which includes buildings, machinery, trackage, etc.

First Oil Locomotive.—The first French locomotive to generate steam by the use of oil fuel has been tried out successfully, a heavy train being hauled without difficulty. It is understood that following this trial two hundred locomotives will be equipped to burn oil instead of coal.

Railway Board Decides Dunnage.—The amount of dunnage that will be allowed on agricultural machinery, implements, stoves, street cars, vehicles, etc., shipped in box or stock cars, has been fixed at 650 pounds by a judgment of the Board of Railway Commissioners. The allowance was formerly 1,000 pounds, and this has now been cancelled.

Van Horne Property Sold.—The Realty Service Company have sold the property on the north side of Van Horne Street, west of Dovercourt Road, to Soren Bros., tinware manufacturers, who will erect a new factory there. The property contained 332 feet, and the price obtained was in the neighborhood of $50,000.

Thos. Firth & Sons, Limited, Sheffield, Eng., announce that Mr. James A. Sherwood, who has for a number of years represented them in Canada, is retiring, and that Mr. John J. Coleman, who has had charge of the Toronto branch, has been appointed as successor to Mr. Sherwood. Mr. Coleman has just returned from Sheffield, England, where he spent the month of September.

No Coal From Ontario.—The Fuel Commissioner has issued an order prohibiting the shipping of any bituminous coal from Ontario without a permit from him. This order is to insure the supply of bituminous coal for Ontario needs as the commissioner feared that attempts might be made to ship some of the coal stored here to points outside the province.

Bridgeburg Gets New Plant.—The Reliance Manufacturing Company, with a capital of $500,000, will locate in Bridgeburg. The factory will be on Lewis Street, and the product will be electrical goods, such as fuses, switches, etc. The Brazil Motors Company, of Brazil, Ind., which is considering Welland, Port Colborne or Bridgeburg as sites for a factory, has arrived at no decision yet.

Black & Decker, Baltimore, have issued a new catalogue on portable electric tools, electric air compressors and special machinery. The catalogue is an excellent specimen of good typography and presswork. Besides the above-mentioned lines are drills, tapers, sleeves, etc. Black and Decker products are covered by the usual guarantee. The firm warns against having repairs made by unauthorized parties. The catalogue is being issued twice a year by this firm.

City of North Battleford, Sask.

TENDERS FOR POWER PLANT EQUIPMENT.

Sealed Tenders, addressed to the undersigned, and marked "Tender for Power Plant Equipment," will be received up to 5 p.m. on Saturday, December 6th, 1919, for two 250 H.P. Water Tube Steam Boilers, one sheet metal stack, 50" x 60', and a quantity of metal smoke flue.

Plans, specifications and all further information may be obtained on application to M. D. Cadwell, Supt. of Utilities, City Hall, North Battleford, Sask.

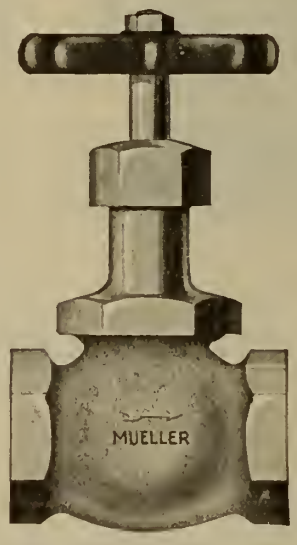
ROBERT FARQUHARSON,
City Clerk.

The City Hall,
North Battleford, Sask.,
November 18th, 1919.

MADE IN CANADA

Over in the Power House is where that extra percentage of service counts

Featuring
The
Bonnet
With
Inside
Thread



The
MUELLER
Brass
Disc
Globe
Valve

Voluntarily registered by Chief Inspector of Boilers for the Provinces of Ontario and Alberta for 175 lbs. and 150 lbs. respectively.

Contains a high grade of virgin metal only, with high copper and tin content, giving a tough, close-grained casting with pressure resisting quality.

Special packing composed of asbestos fibre and graphite with lead core. (Can be repacked under full pressure).

A valve featuring the bonnet with inside thread, a feature found only in valves of the highest grade.

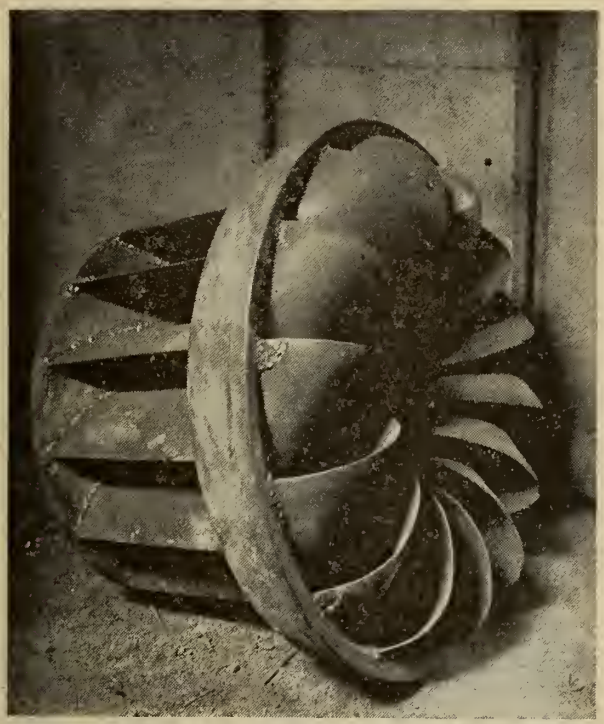
MUELLER

Bibbs, Basin Cocks, Bath Cocks, Ferrules, Bath Supplies, Basin Supplies, Sill Cocks, Curb or Service Cocks, Corporation Cocks, Tapping Machines for Water and Gas, Service Clamps, Regulators for Water, Steam, Gas and Oil, Reducing Valves, Bubbling Fountains Gas Cocks, *Globe, *Angle and *Check Valves, etc.
Forgings in Brass.
Bronze and Aluminum Castings.

H. MUELLER MFG. CO.
LIMITED

SARNIA -:- CANADA

MANUFACTURERS OF HIGH GRADE MUELLER WATER PLUMBING AND GAS BRASS GOODS



We Can Weld
Anything—Anywhere

Cast iron runner with steel buckets cracked and loose in casting welded and made good as new by us. This work in different sizes and conditions is quite common to us.

Heavy shafting built up where worn in bearings and machined out to full size.

Grinder shaft threads built up. Tanks, boilers and digesters that have cracks, leaky seams or corroded parts electric welded and made bottle tight.

Machinists, Boilermakers, Welders, Blacksmiths and Tank Manufacturers Lead Burning.

THE ST. LAWRENCE WELDING CO., LTD.

138 Inspector St. **MONTREAL** Phone Main 5779, West 3483

NON-CORROSIVE

CYLINDER OIL

MANUFACTURED ONLY BY

E. H. KELLOGG & CO.

NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.

FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner yon lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done—give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOGG & CO.,
New York, U.S.A.

WANTED

Representatives to handle special line of British made "Elastic Steam Jointing Cement" (for all joints) and Iron Cement for casting, etc. Exclusive territory offered parties conversant with trade. Replies treated confidential. Apply Box 151, Power House.

WANTED — BY LARGE ONTARIO BOILER manufacturer, an experienced draughtsman, familiar with the designing of tubular, locomotive and stationary boilers. Write Box 153, Power House.

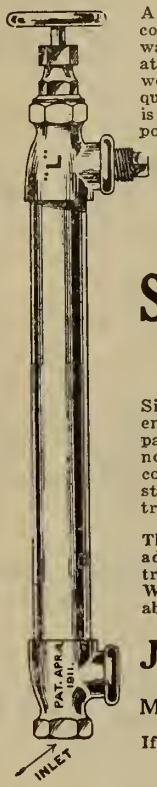
WANTED — FIRST-CLASS ENGINEER TO take charge of steam plant; prefer a man with knowledge of Detroit Stokers, also one who has had some experience with electrical machinery. Box 154, Power House, 143 University Ave., Toronto.

You Try This

When you desire any information on matters pertaining to the trade it will be gladly furnished free upon application through the columns of this paper. If you enclose stamped, addressed envelope we will also reply direct to you. Don't hesitate to ask us. We will do our best.

Kindly mention this Paper
when writing to
advertisers.

Power House Economy



A Steam Trap that saves coal by abolishing heat-wasting steam leakage, and at the same time does its work efficiently without requiring constant attention, is the trap you want in your power plant.

The Long Patent Steam Trap Fills the Bill

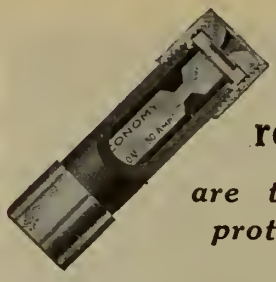
Simple, reliable and efficient. Has but one moveable part. Automatic — requires no valves except those which control the admission of steam to apparatus to which trap is attached.

The Long Trap has several advantages over all other traps. Protected by patents. Write and let us tell you all about it.

J. T. LONG
84 ADAM ST.
MONTREAL, CANADA

If your dealer does not sell it, write direct.

6



ECONOMY renewable FUSES

are the RIGHT fuses to protect YOUR electrical circuits

—because they afford the right sort of protection; their reputation lends assurance that you can safely depend on them for accuracy of rating and all-around efficiency in operation.

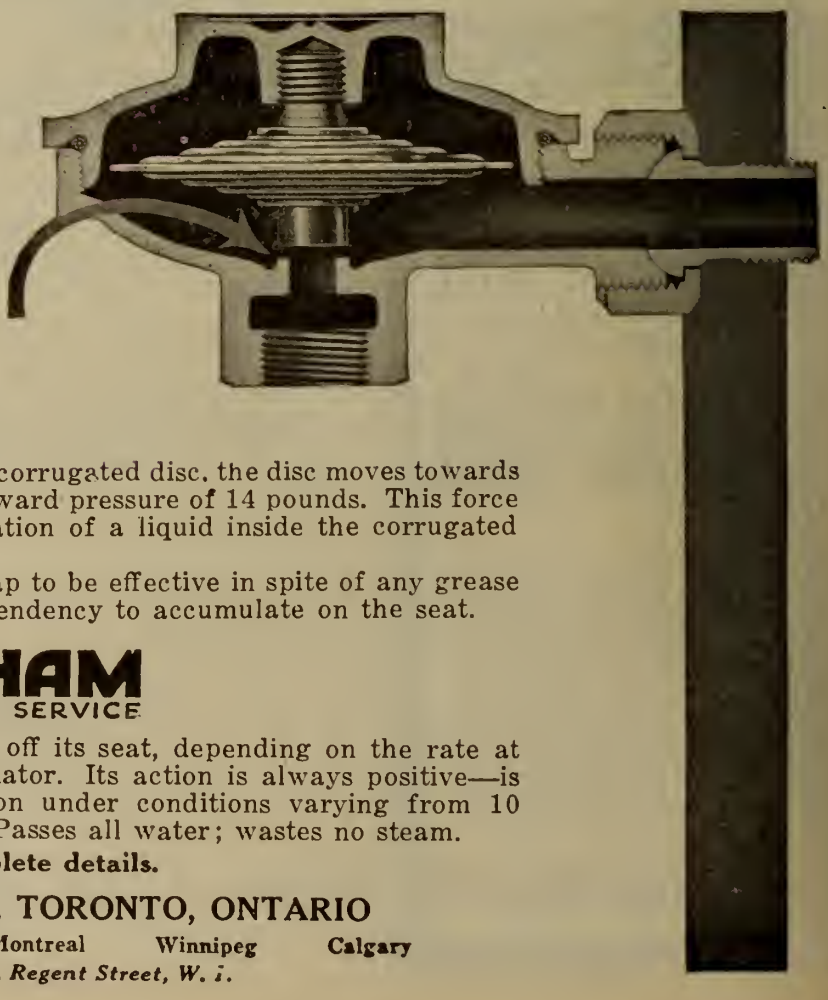
—because they cut annual fuse maintenance costs 80% as compared with the use of one-time fuses, owing to the fact that an inexpensive "Drop Out" Renewal Link restores a blown Economy Fuse to its original efficiency.

—because it's the work of a moment to replace the link and renew the fuse.

—because a good sized stock of "Drop Out" Renewal Links always on hand represents but a small outlay. ***Write for Catalog 24***

ECONOMY FUSE & MFG. CO.
OF CANADA, LIMITED
UNITY BLDG. MONTREAL
Manufacturers in Canada of
S. & C. HIGH POTENTIAL FUSES—TO 150,000 VOLTS

14 Lbs. Pressure downward



AS soon as steam strikes the sensitive corrugated disc, the disc moves towards its seat and exerts a maximum downward pressure of 14 pounds. This force is exerted uniformly by the vaporization of a liquid inside the corrugated disc.

This downward pressure causes the trap to be effective in spite of any grease and foreign matter which might have a tendency to accumulate on the seat.

The DUNHAM HEATING SERVICE

In action, the disc is alternately on and off its seat, depending on the rate at which the steam is condensed in the radiator. Its action is always positive—is never sluggish—and can be depended on under conditions varying from 10 pound pressure to 15 inches of vacuum. Passes all water; wastes no steam.

Write for complete details.

C. A. DUNHAM CO., LTD., TORONTO, ONTARIO

Halifax Ottawa Vancouver Montreal Winnipeg Calgary

London: 64 Regent House, Regent Street, W. 1.

Jenkins Bros. Valves

They Stay Tight

When the power house superintendent makes an inspection of the pipe lines he tests the valve bearing the Jenkins Bros. Diamond trade mark with a smile of confidence. He knows from experience, that above all things it can be depended upon to STAY TIGHT. Only valves of highly scientific design and quality construction can be depended upon to stay tight under severe conditions — Jenkins Bros.' Valves are made of first-class material by workmen who know Valve requirements.

Furnished in brass or iron body, in globe, angle, cross, check, Y or blow-off, hose whistle and other patterns.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

Head Office and Works: 103 St. Remi Street, Montreal, Canada

Agencies in all the Principal Countries of the World

European Branch: 6 Great Queen St., Kingsway London, W.C. 2, England

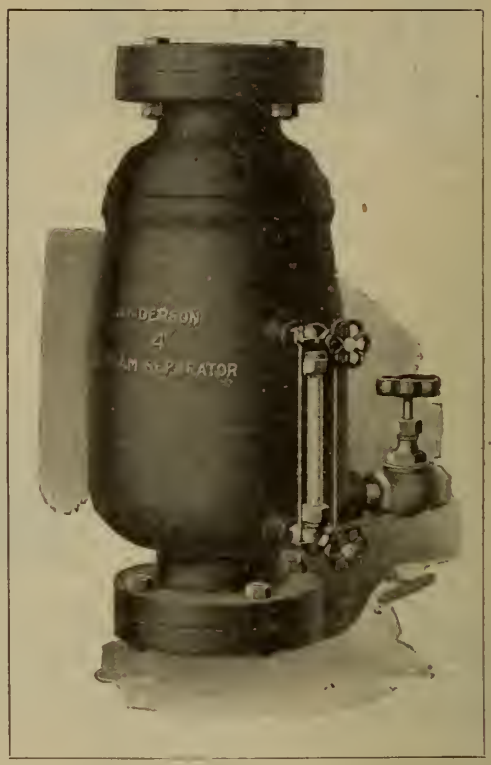
TRADE JENKINS MARK Jenkins Bros

Catalogue No. 8 free on request

Breakdowns a Thing of the Past!

You can't afford to have any engine breakdowns due to accumulated moisture in engine cylinders and turbine casings these days of high production costs—time and labor are too expensive to stand idle. You can count breakdowns of this nature as a thing of the past in your plant by installing the

Anderson Steam Separator



The "Anderson" delivers DRY STEAM under all operating conditions.

The moisture is completely separated by the combined action of centrifugal force, and the sudden reversal of high velocity steam current. All danger of the moisture passing the throttle is obviated.

The moisture cannot be picked up again when once separated. You'll observe from the illustration, that the whirling motion is obtained by means of the internal helical baffle coil.

Write for the catalogue which describes all the Anderson Power Plant Specialties.

THE V. D. ANDERSON COMPANY

1935 West 96th Street, Cleveland, Ohio

ECONOMIC Carling BLOWERS SUPERIOR

Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

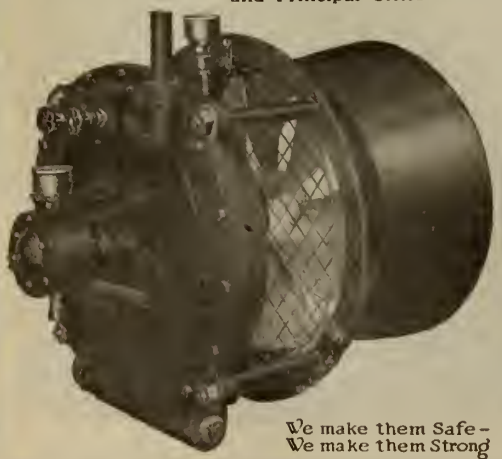
Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY

Engineers and Manufacturers **WORCESTER, MASS**

Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



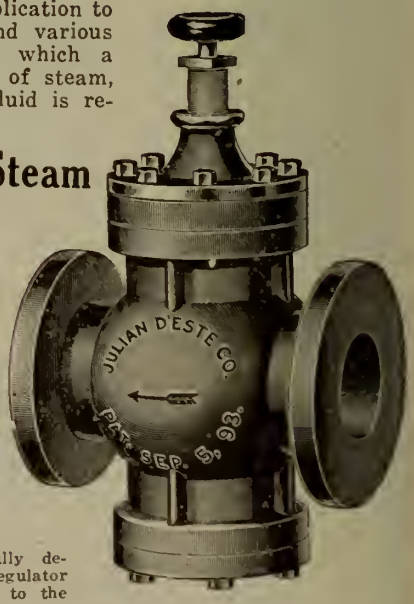
Turbine Undergrate Blowers, Centrifugal Blowers and Exhausters, Small Power Turbines, Damper Regulators and Grates

We make them Safe—
We make them Strong

CURTIS Engineering Specialties

Universality!

For universal application to all the varied and various conditions under which a reduced pressure of steam, water or other fluid is required the



Improved Steam Pressure Regulator

has no equal.
It is compact and self-contained, without levers, weights or projections.
No glands or packing; no drip or leak of steam or water. Suitable for any boiler pressure; made entirely of metal: is a lock valve, very simple and sensitive.
Send for leaflet fully descriptive of this Regulator (contains price list) to the manufacturers.

MANUFACTURED BY THE

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 83 BARCLAY ST., NEW YORK CITY; 174 N. MARKET ST. CHICAGO, ILL.

In Bulk

SAFETY PLASTIC

METALLIC PACKING

For steam, water, air, gas, etc. Self-lubricating. Practically frictionless.

Pat. December 22, 1903.

Highest Award World's Fair, St. Louis, 1904.

GUARANTEED TO LAST THREE YEARS

Without Renewal.

Drop us a line and let us tell you all about this remarkable packing.

STEEL MILL PACKING CO., WINDSOR, ONT.

In Cotton Tubes

Mason Steam Specialties

Mason Reducing Valve

ASSURE YOU RELIABILITY OF SERVICE

The practical knowledge of experts who are continuously coming into contact with difficult engineering problems should be of considerable assistance to you. Let us demonstrate the "Mason Service" on your next problem.

THE MASON LINE

Mason Reducing Valves (Genuine)
Mason Pump Governors
Mason Pressure Controllers
Bundy Steam Traps for every service
Coppus Turbine-driven Blowers
Sims Hot Water Generators
Sims Storage Heaters
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Bundy Oil Separators
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Everlasting Blow-off Valves
Babbitt Sprocket Rims
Stratton Steam Separators
Reilly Multi-coil Feed Water Heaters
Reilly Evaporators and Distillers
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Our Salesmen are practical engineers. They sell from knowledge — not from catalogue.

The Mason Regulator & Engineering Co., Limited

Successors to H. L. Peiler & Co.
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135-153 Dagenais St.

Toronto Representative:
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CYCLONE GRATES

Burn Screenings and Low-Grade Soft Coal and Give Maximum Results

Note of Warning
Coal miners demand a shorter number of working hours. Strikes are probable! A coal shortage is almost certain to result! You may be compelled to burn screenings and other low-grade fuels. These conditions will cause no worry if you are a user of CYCLONE GRATES. Investigate without delay!

Cyclone Shaking and Dumping Grates are designed on a scientific principle which ensures perfect combustion even when using low-priced fuels. They are constructed to give 60% air space and 90% underdraught—**no clinkers, no waste!**

The new jarring, shaking movement sifts the worthless ashes through—but not a particle of good fuel.

Write for our 30 Days' Free Trial Offer now.

The Canadian Steam Boiler Equipment Co., Ltd.

Sole Makers for Canada

20 McGee Street Phone G. 3660 Toronto, Ontario

AGENTS:
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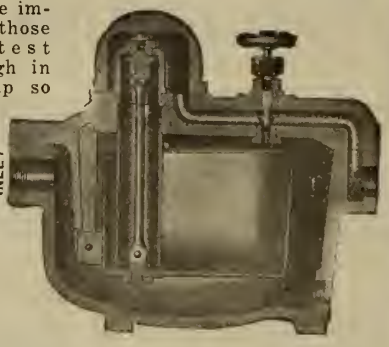
KIELEY

IMPROVED HIGH AND LOW PRESSURE

STEAM TRAP

For General Service

No power plant should be without a dependable steam trap. It is the great economizer of fuel and promoter of power plant efficiency. The KIELEY Improved Trap is the latest development in the art of steam trap construction, and is suitable for all service, either high or low pressure. The important parts and those subjected to greatest wear are placed high in the top of the trap so that by removing two nuts and the small cap all parts are easily accessible and removed for repairs — no breaking of connections necessary, neither do you have to remove the cover. Seats and discs are of best metal, absolutely non-corrosive; for exceptionally severe service seats and discs are constructed of nickel or monel metal, and the bodies of cast iron. Kieley traps never leak when in service—our water seal assures you this.



Leaky, unreliable steam traps are expensive. Adopt the KIELEY and be certain of efficient, economical service.

THE ARTHUR S. LEITCH CO.

Kent Building, TORONTO

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.
Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company

BOSTON, MASS.

TORONTO REPRESENTATIVES:
The Arthur S. Leitch Co.,
506 Kent Bldg., Toronto.

Top and Bottom Branch Pipes

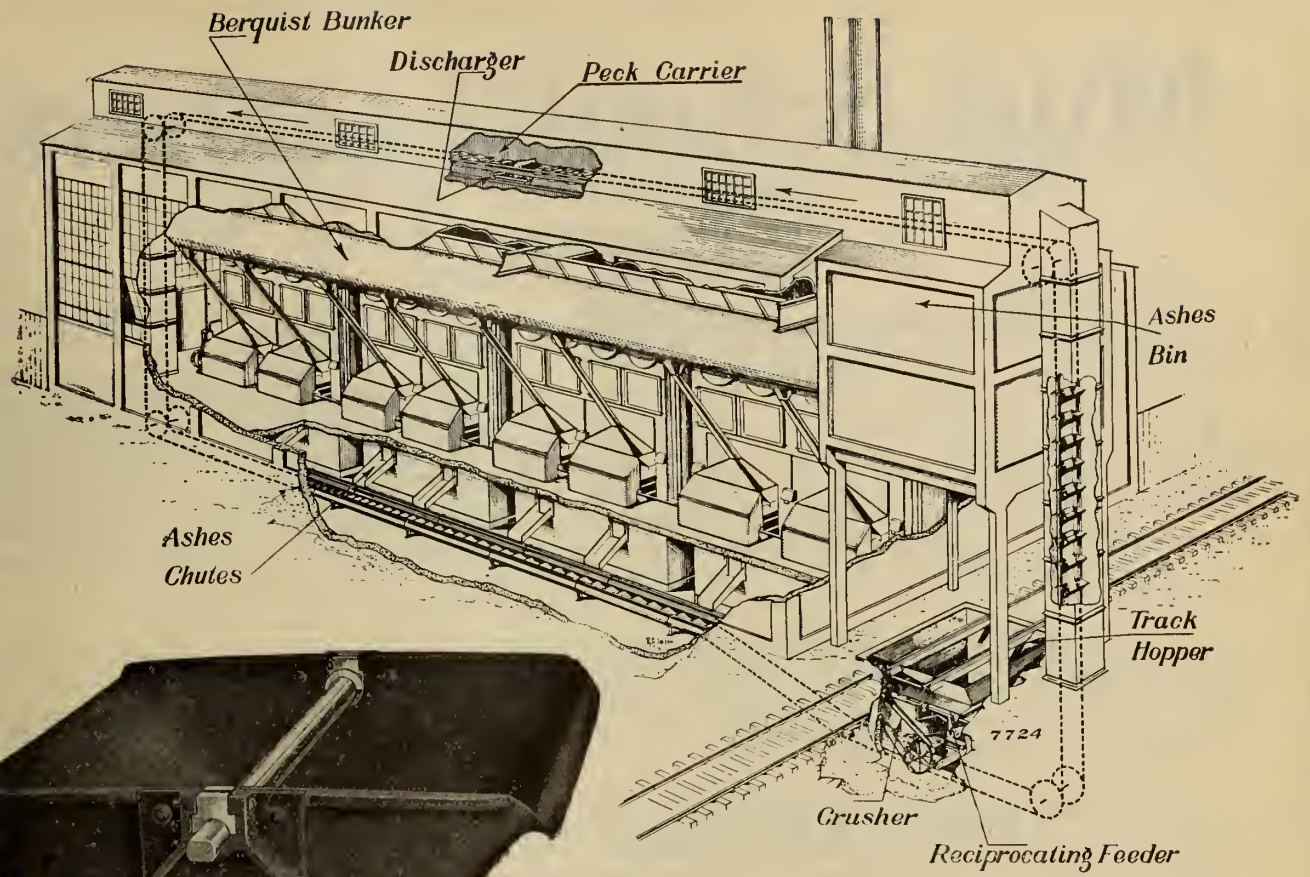
Article No. 5

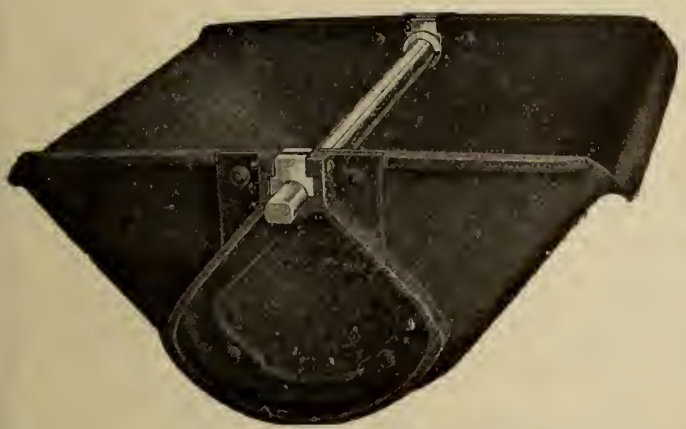
The bottom access branch pipe as shown above connects the bottom headers. The water entering the economiser through this pipe at the end farthest from the boiler, or cold end. Directly opposite each section is a flanged nozzle with lid for inspecting or cleaning the bottom headers.

A blow-off valve is mounted on the bottom branch pipe, through which sludge and sediment may be discharged.

The top branch pipe is similar to the bottom access branch pipe, but cast in one piece with no nozzles for inspection. The hot water leaves the economizer through this pipe at the end nearest the boiler or hot end. The relief valve is mounted at this end of the top branch pipe.

GREEN'S ECONOMISER, LIMITED.
TORONTO





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Coal Handling Machinery

GRAVITY Bucket Carriers, consisting of a continuous series of buckets pivotally suspended between two endless chains, represent the highest development of the conveying art. As the buckets at all times maintain their carrying position by gravity, a single Carrier can transport material horizontally, vertically and again horizontally, or in any desired path.

The Peck Carrier, Patented, is the highest development of this type of conveyor—in its inherent design, details of construction, and accuracy of workmanship. It is the recognized standard machine for handling coal and ashes in modern power houses, as well as cement clinker, stone, ore and other abrasive materials.

Send for our Peck Carrier Catalog No. 320 and learn why the Peck Carrier is the superior of all conveyors for coal and ashes.

We also design and build elevators and conveyors for handling all kinds of material; coal and ashes handling machinery; coal crushers; chutes; screens; belt conveyors; locomotive cranes; grab buckets; portable loaders; electric hoists; Link-Belt and sprocket wheels; silent chain drives; transmission machinery, etc., etc.

Catalogs sent upon request.

CANADIAN LINK-BELT COMPANY
LIMITED

WELLINGTON AND PETER STREETS, TORONTO

Must School Teachers Starve?

By Sir Robert Falconer, President of the University of Toronto

CANADA is threatened with another epidemic—cheap teachers! A grave warning, showing the seriousness of the situation, has been made public, through the medium of MACLEAN'S MAGAZINE.

The financial attractions in commerce and trade are proving such a lure to the clever Normal School and University graduates that public schools, high schools and universities throughout the Dominion are being driven to engage inferior teachers—if they can get any at all! One teacher in Ontario is paid the princely sum of $300 per annum.

The article gives the opinions on this vital topic of such men as: Sir Robert Falconer; Principal R. Bruce Taylor, of Queen's; Dean of Arts W. Sherwood Fox, of Western University; A. P. S. Glassco, Secretary of McGill; President MacLean, of the University of Manitoba; President Klinck, of Canada's youngest university—British Columbia; President A. Stanley Mackenzie, of Dalhousie; and many others.

"The Thread of Flame"

By Basil King

This famous Canadian novelist has written a remarkable story that deals with a man who loses his identity while fighting in France. This strong novel, "The Thread of Flame," starts in the December issue of MACLEAN'S. This is the first occasion that a novel by Mr. King has appeared in any Canadian periodical prior to book publication.

Other Features of the December Number

"Merrie Gentlemen"—By Arthur Beverley Baxter.
You will think this the best Christmas story since Dickens' "A Christmas Carol."

"Capital and Labor"—By Ralph Connor.
One of a series of articles on "The New Canada and Its Needs."

"Ottawa is Ready for the Worst"—By J. K. Munro.
A humorous and pithy review of events at the Federal seat.

"Better Late Than Never"—By C. W. Stephens.
A bright Christmas story.

"Some Canadian Snobs"—By Montgomery Dix.
A humorous article on some phases of Canadian society.

"A Blighty Christmas"—By Gertrude Arnold.
An article on the way Yuletide was celebrated in a Red Cross Hospital.
And a dozen other articles and stories all of equal interest.

MACLEAN'S will be Twice-A-Month

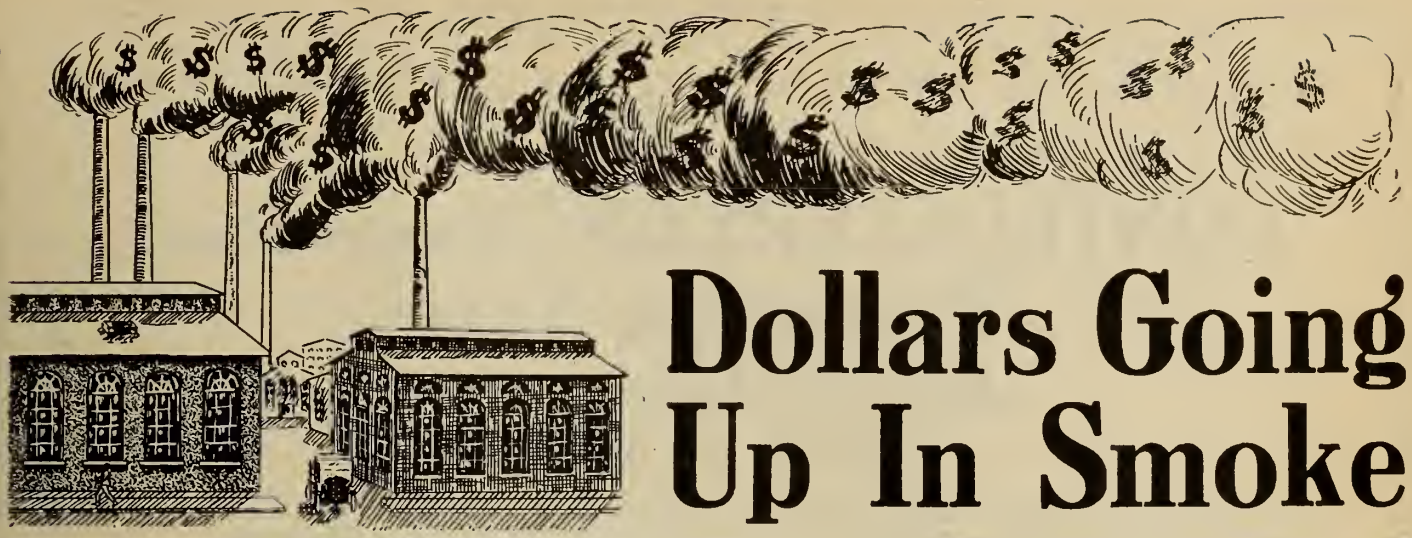
starting February 1st, next year. An important point to remember. If you want to keep up with things **nationally Canadian,** you'll have to get the MACLEAN'S Twice-A-Month habit.

Over 350,000 Canadians Read

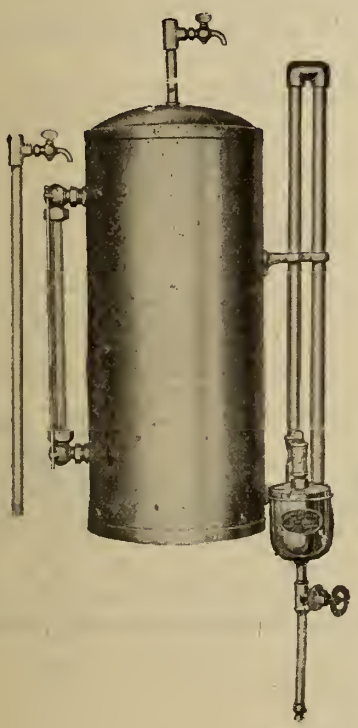
MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

DECEMBER ISSUE *Now On Sale At All News Dealers* *20c*



Dollars Going Up In Smoke



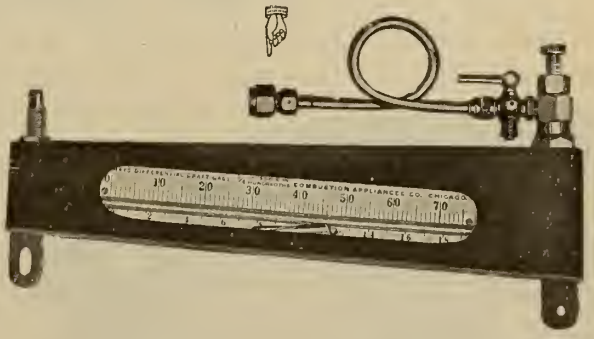
Give the Heat Units to the Boiler

HAYS combustion testing apparatus effects a huge fuel economy. It is a friend of the fireman and a very profitable investment for the plant owner.

It shows at once if draft is proper—if there are holes in the fire—if settings are leaking—if firing periods are improperly timed and other causes of fuel waste.

Gas Collector with water-flow regulator.

The Hays Differential Draft Gage indicates the draft over the fire or the drop in draft through the boiler.



HAYS Automatic CO_2 and Draft Recorders, Automatic Gas Collectors, Draft Gages and other Hays Equipments installed on your boilers keep you posted as to just what conditions your boilers are operating under.

Hays Combustion Efficiency Appliances are leading the way to increased efficiency in boiler firing, a most effective way in offsetting high coal prices.

Ask for our book, **"How to Build up Furnace Efficiency."** It tells how fuel is wasted, how to stop that waste and keep it stopped.

The Jos-W-Hays Corporation

Michigan City
Indiana
U.S.A.

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Allen Ritchie, Standard Bank Bldg., Vancouver, B.C.
Western Supply & Equipment Co., Calgary, Alta.

If you don't know where to get it—Write us
See if it is listed below:

CONTROLLERS for Temperature, Pressure or Time

Meters for Measuring Steam, Water, Air or Gas.

CO^2 Gas Analyzers—Hand Type.
Roberts WATER FILTERS.
THERMOMETERS for every use.
GAUGES—Indicating or Recording.
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LEONARD RETURN TUBULAR BOILERS.
TANKS—STACKS—PLATE WORK.

Your enquiry will bring full information from

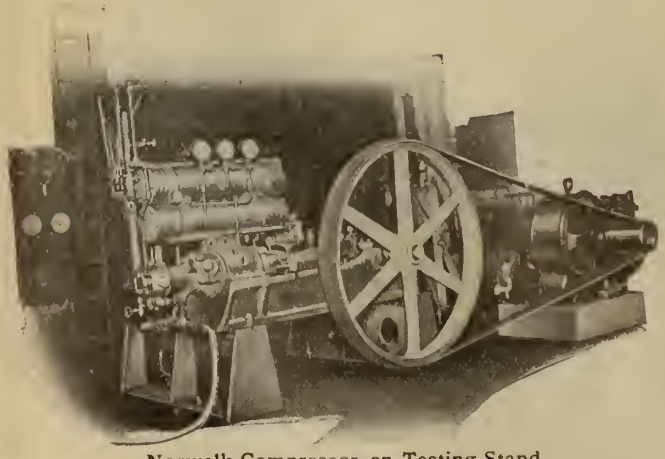
E. J. PHILIP & SONS

57 Queen W. Toronto, Ont.

NORWALK

AIR & GAS · COMPRESSORS

For Dependability

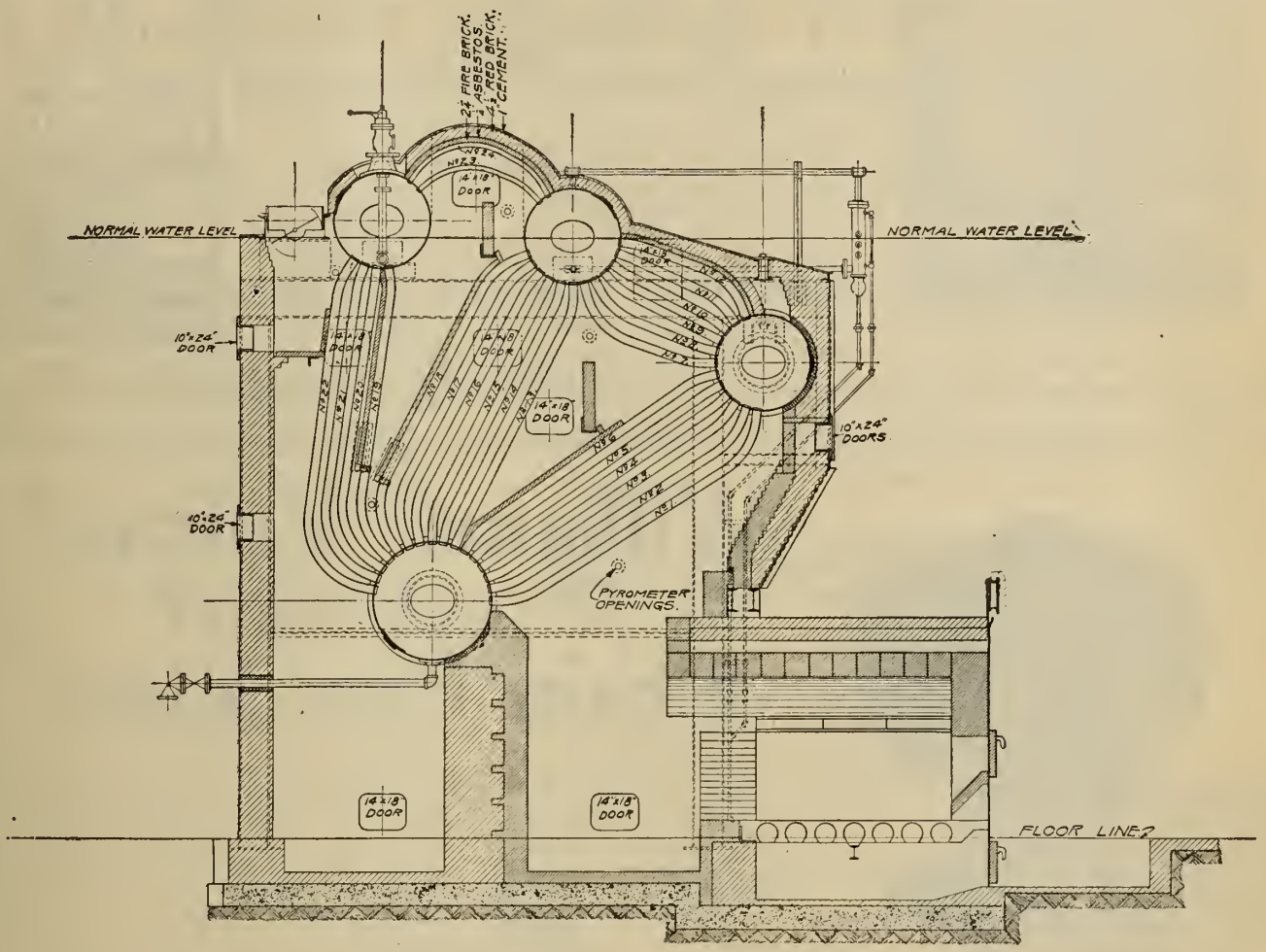


Norwalk Compressor on Testing Stand

Every Norwalk compressor before it leaves our plant is given a test which subjects it to a strain far greater than any it will be put to in actual service. As a result Norwalk compressors have a dependability which is as close to the absolute as high grade materials and skilled workmanship can give.

THE NORWALK IRON WORKS COMPANY
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE



Connelly (Patented) Water Tube Boilers

Made in Canada by

E. LEONARD & SONS, LIMITED

Are of the four drum type and have 100% tube area in the path of circulation which enables them to deliver not only dry, but slightly superheated steam under normal conditions and also when overloaded.

A few of their good points—

Simple in design. Have no flat surfaces. Free from hundreds of joints. No hand holes at end of tubes.

Contain a tremendous volume of water, in proportion to their size. All stress due to expansion and contraction is well taken care of. Boiler tubes are so spaced that any one may be removed without moving the rest.

Designed to get the maximum horsepower in the smallest cubical space.

Can be built in units up to 4,000 horsepower.

E. LEONARD & SONS
LIMITED

London **Ontario**

Showing ease with which Plibrico is laid in place.

A Jointless Fire Brick Lining

under your boiler is a sure and determinable saving of one of the largest preventable losses of economy in any boiler plant.

Send for a free copy of our 36-page book of useful information on furnace building and maintenance

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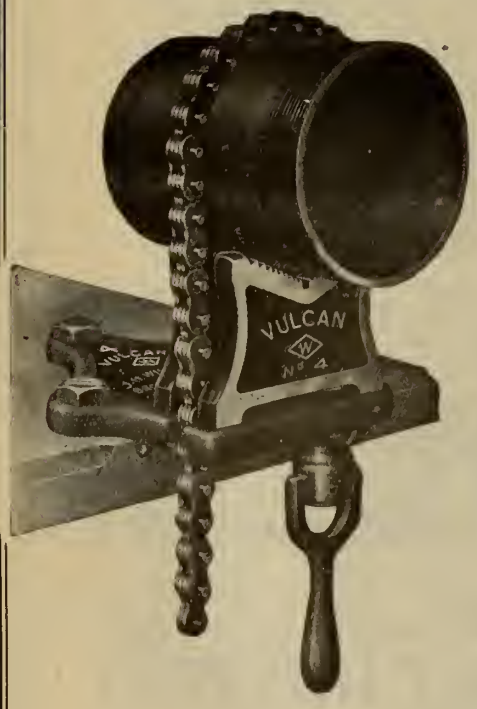

Williams' "Vulcan" Drop-Forged Chain Pipe Vises

ARE attachable anywhere—to bench, post, or other convenient support. They are compact in design—being smaller and lighter than clumsy, heavy cast tools. They are unbreakable—being made entirely of wrought steel. They are positive in their grip, readily adjusted, rapid and powerful in action.

When looking for a superior Pipe Vise, remember that Williams' Chain Pipe Tools have been *Standard* for nearly half a century and have behind them Williams' unconditional guarantee of service. Vises in 3 sizes—for ⅛ to 8-inch pipe.

May we send you a copy of our new catalog?

J. H. Williams & Co.

"The Drop-Forging People"

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The A. G. LOW CO., LTD., 78 Pacific Ave., Saskatoon, Sask. Agents for Manitoba, Saskatchewan, Alberta and British Columbia.

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In Power Plant Equipment and Service—that's our Policy.

Study POWER HOUSE advertising and editorial pages—brimful of latest technical and new equipment information. Keep thoroughly up-to-date and you'll profit.

SPECIAL Send in **your** subscription to-day for any number of years at the remarkable rate of **$1.00 Per Year.**

VULCABESTON

The General Utility Packing that works right in every class of service

"VULCABESTON" RED FIBRE STEAM SHEET PACKING

The Universal Packing

Most plants paint each kind of piping a different color. Each color means some particular kind of line—and each color usually means some particular variety of packing taking up space in the supply room and keeping somebody on the look-out to see that the stock doesn't run low.

VULCABESTON
Red Fibre Sheet Packing

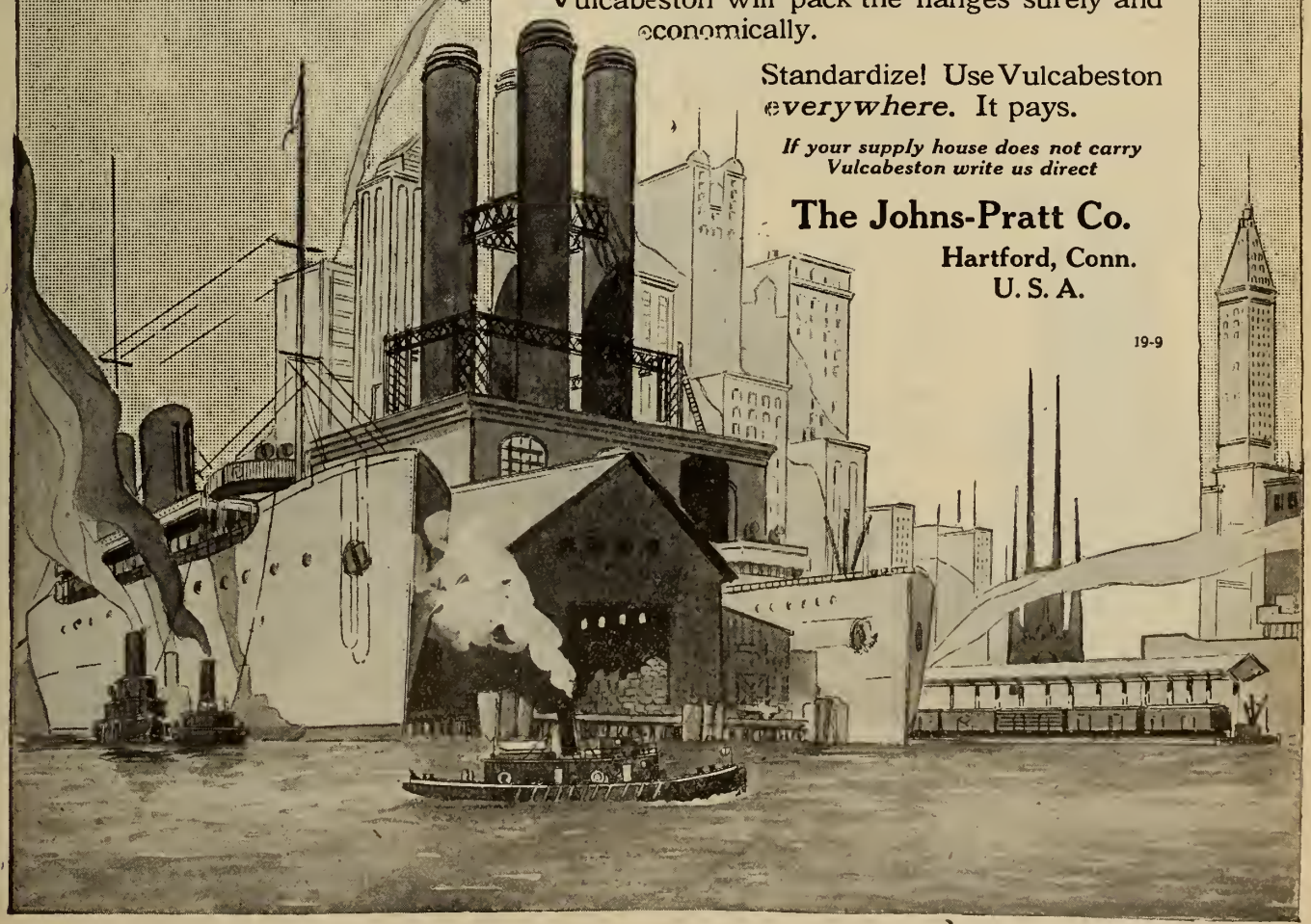
ends this trouble. It takes the place of all "specialty" packings because it serves equally well on *all* the lines. No matter whether the color indicates saturated or superheated steam, high pressure or low, hot water, oil, gas, ammonia, acids, alkalies, or compressed air, Vulcabeston will pack the flanges surely and economically.

Standardize! Use Vulcabeston *everywhere.* It pays.

If your supply house does not carry Vulcabeston write us direct

The Johns-Pratt Co.
Hartford, Conn.
U. S. A.

19-9



Port Hope, Ont.,
Nov. 13th, 1919.

The MacLean Pub. Co.,
Toronto.

Dear Sirs,—

I enclose . . . . and just here I may speak a word for the "Power House." I do not know that I can cite any particular part of it for special mention, as it presents to view so many phases of the engineering business that it is almost a general education in engineering.

And all that a person has to do to keep posted on the latest accessories and appliances is read the ads.

From cover to cover the "Power House" is replete with valuable information.

Wishing you every success,
I remain,
Yours very truly,
JOHN W. S. McELORY.

"From cover to cover "Power House" is replete with valuable information."

Remember

December is the Last Month during which subscriptions for "Power House" will be accepted at

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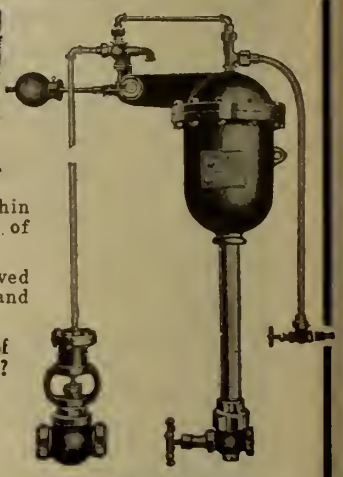

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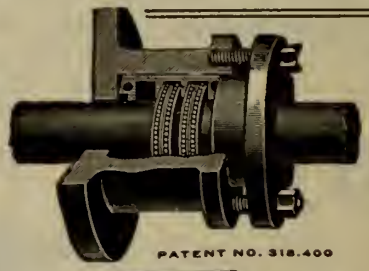

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" "	534,104	" "	830,830
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" "	654,541	" "	878,238
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" "	725,368	" "	895,791
" "	774,490	" "	898,066
" "	775 193	" "	905,103
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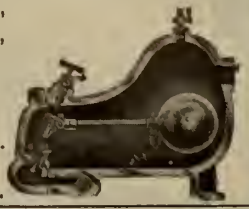

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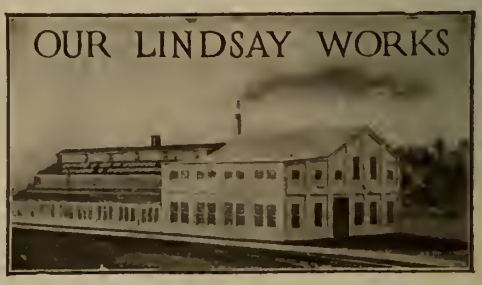

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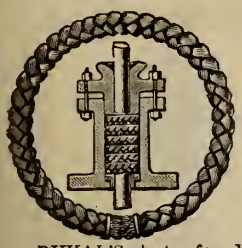

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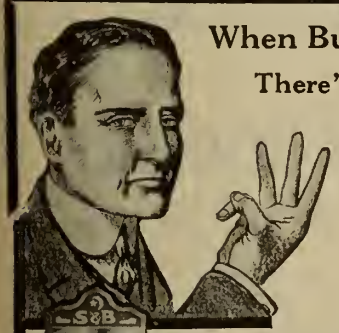

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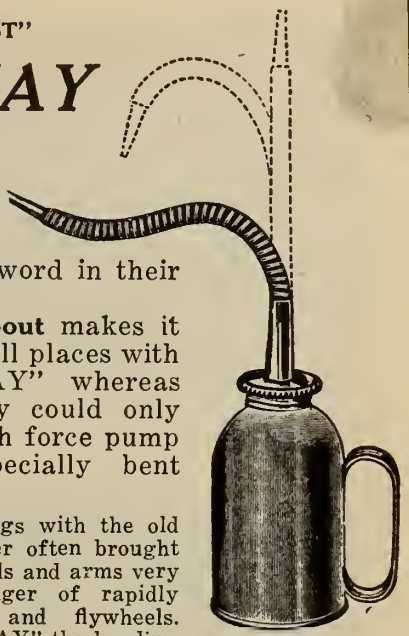

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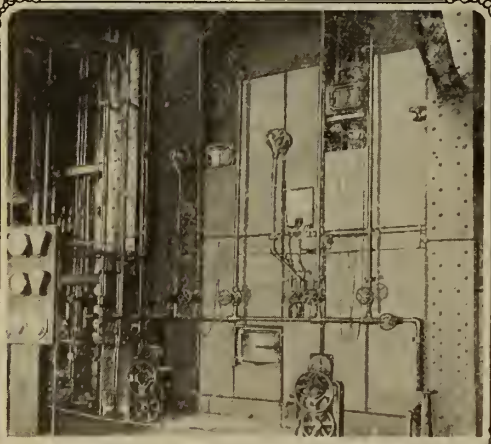

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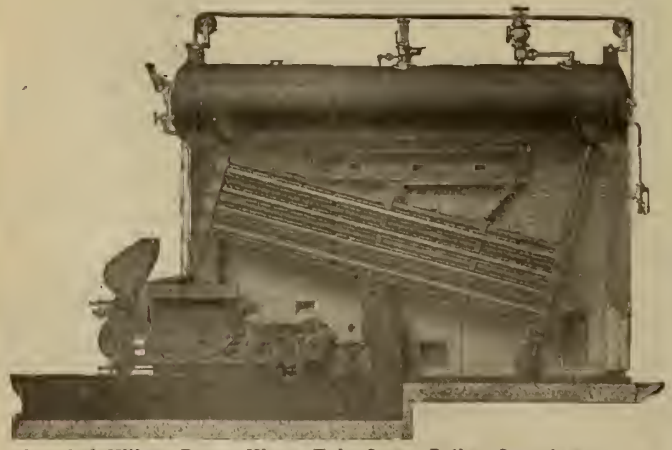

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CHAINS, SILENT
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CHAINS, SPROCKET WHEEL
Morse Chain Co., Ithica, N.Y.
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Goldie & McCulloch Co., Galt.
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Goldie & McCulloch Co., Galt.
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Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
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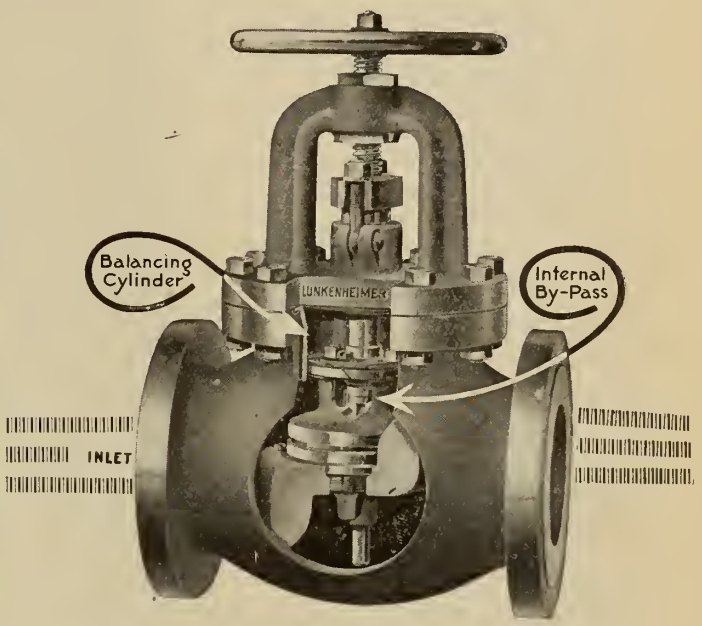

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GASOLINE PUMPS, SELF MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont

GASOLINE TANKS
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
The Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Babcock & Wilcox, Montreal.
Green's Economiser, Ltd., Toronto.
The Jos. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.
Wilson Mfg. Co., J. C., Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Montreal.
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equipment Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal, P.Q.
Leonard & Sons, E., London, Ont.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar Boico Supply, Ltd., Toronto, Ont.
Victoria Foundry Co, Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GAUGES, DRAFT
Jas. W. Hays Corp., Michigan City, Ind.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS (OIL AND GASOLINE)
S. F. Bowser Company, Limited, Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

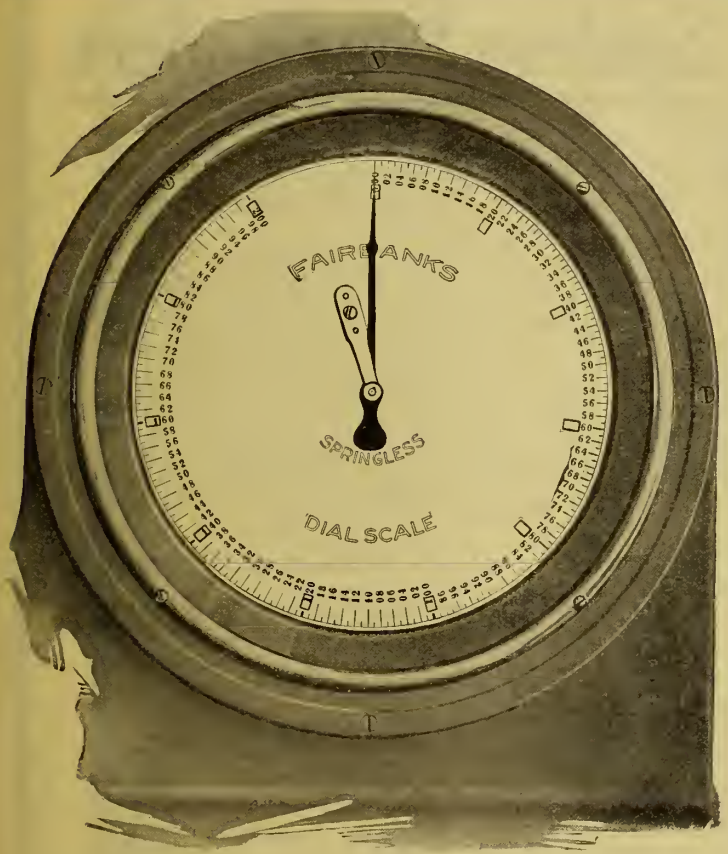
HANGERS
Can. General Electric Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
The Mason Regulator & Eng. Co., Ltd., Montreal
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal
Royles, Ltd., Irlam, Manchester, England.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
The Mason Regulator & Eng. Co., Ltd., Montreal
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



Cut Time and Labor Costs

—stop and figure out the time wasted in weighing and computing weights. It amounts to considerable in a year.

Fairbanks Dial Scales

eliminate all the waste time and labor it is possible to save. They put your weighing on an efficient basis. The plainly graduated dial does this.

Ask us about these scales, and the work they will do in your plant.

The Canadian Fairbanks-Morse Co., Limited

ST. JOHN, QUEBEC, MONTREAL,
OTTAWA, WINNIPEG, SASKATOON,
CALGARY, VANCOUVER, VICTORIA.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Scale in Your Boilers

Clean Tubes Mean Coal Saving

And easier firing, less ash-handling, fewer shut-downs, prevention of bagged or burned tubes, fewer repairs, and less frequent wash-outs. METLSKIN can pay for itself in a short time.

is an unprofitable boarder. Its appetite is enormous and it consumes far more than it is worth. Why not give it TWO MONTHS' NOTICE, and put an end to your loss thereafter?

THE SIXTY-DAY TEST OF METLSKIN is open to any reliable concern that is troubled with boiler-scale, pitting or corrosion. A small daily dose of METLSKIN, for a period of two months, will bring down the most tenacious scale, and absolutely convince you that A CLEAN BOILER IS NOT ONLY POSSIBLE, but EASY.

SEND A POSTCARD for the METLSKIN booklet and learn about Our Offer, Guarantee Bond, and Prices.

METLSKIN is neither "Compound" nor "Cure-all."

METLSKIN CO., Inc.

Rochester, N. Y.

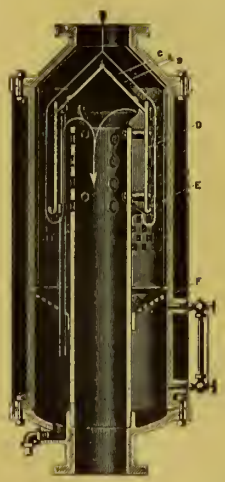
Canadian Representatives:

Canadian Fairbanks-Morse Co., Limited

St. John Montreal Quebec Ottawa Hamilton
Toronto Windsor Winnipeg Calgary
Vancouver Victoria Saskatoon

III IMPORTANT THINGS

TO CONSIDER ABOUT
A SEPARATOR



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

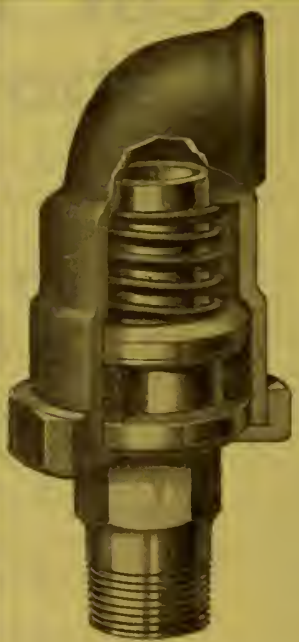
Sweet's Separators

DIRECT SEPARATOR COMPANY
218 South Geddes St. SYRACUSE, N. Y

General Sales Agents

Canadian Fairbanks-Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton
Winnipeg, Saskatoon, Calgary; Vancouver, Victoria



Tuxeda
SWING JOINTS

Provide one of the easiest ways to save coal

Every pound of steam that escapes through a leaky connection represents a certain amount of coal wasted. Do you know that an average leak will waste 3,400 pounds of steam a month? Investigate your flexible steam connections at once and then investigate the Tuxeda Swing Joint.

A Guaranteed Solution for Your Flexible Connection Problems

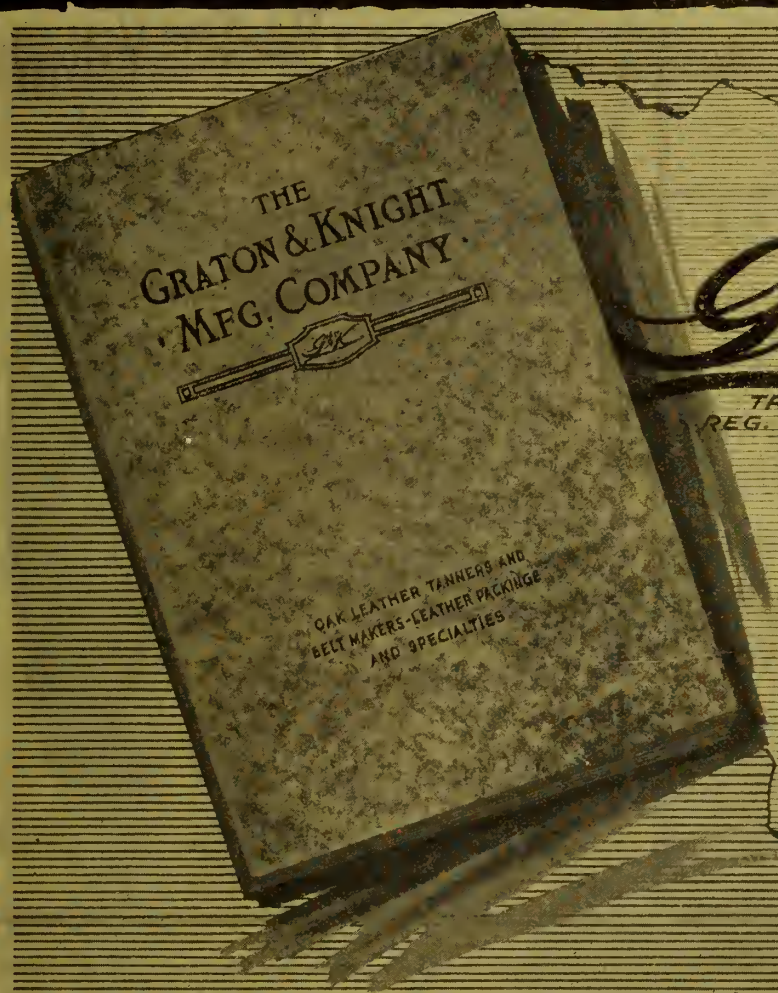
Send for Bulletin "A" to

FRANKLIN WILLIAMS, INC.

New York City

General Sales Agents: Canadian Fairbanks-Morse Co., Ltd.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



1851 G&K
TRADE MARK
REG. U.S. PAT. OFF.

More Than A Catalog

This catalog of G & K Standardized Series Leather Belting and Leather Products is practically a handbook of leather tannage and manufacture.

It is carefully compiled and indexed for easy reference to the products you want.

It contains mechanical rules, charts and tables that will help you with your transmission problems.

Belt users find this book invaluable. Write for a copy.

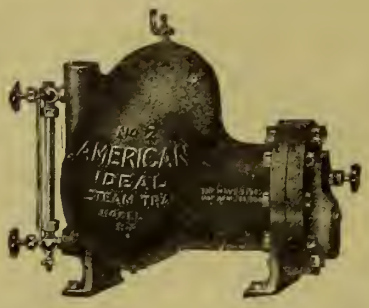
Canadian Graton & Knight, Ltd.

Oak Leather Tanners and Belt Makers.

Montreal, Canada

Canadian Representatives: The Canadian Fairbanks-Morse Co., Ltd., St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg, Victoria.
Branches and Distributors in all Principal Cities.

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL



BE INSISTENT

Standardize in your plant with
The American Ideal Steam Trap

Leak-proof Powerful Large Capacity Economical

Helps to lower coal bills
Our booklet will help you — free

Canadian Agents: CANADIAN FAIRBANKS-MORSE CO., Limited.
Montreal Quebec Toronto St. John

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York, Chicago, BOSTON, Atlanta, Pittsburgh

Voorhees Rub-Steel Valves

THE SUPERHOT GRADE

for high temperature work such as: Boiler Feeds, Locomotive Boiler Washing, Condensing Against High Heat and Oily Matter, Oil Refinery Service, Vacuum Returns on Heating System. For mild acids, etc. This Valve will not buckle under quick interchange of the temperatures.

One installation will convince YOU.

Booklet on Request

The Canadian Fairbanks-Morse Co., Limited
Sole Distributors for Canada

DURABLA
TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Etched on Every Glass

DURABLA HIGH PRESSURE GAUGE GLASS

Detailed tests, which have appeared in previous issues, have proved that DURABLA American made high-pressure gauge glass possesses the elasticity necessary to withstand sudden and radical changes in temperature; that it will remain clear; and that it has unusually high tensile strength.

It now remained to determine what DURABLA U.S.A. glass would do under actual operating conditions. The glass was placed in service in one of the largest power plants in the country on boilers where pressure of 225 pounds is maintained day and night. Under these severe conditions, the service obtained from DURABLA U.S.A. glass equalled in every respect the best service given by any foreign glass ever applied in this plant.

DURABLA U.S.A. gauge glasses are now ready for distribution in all standard sizes and are sold under the DURABLA guarantee.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

Consider the Convenience of Packing Any Size Valve From One Spool of

TRADE MARK
"PALMETTO"
REG U.S PAT OFFICE
TWIST PACKING

(Just unstrand to the desired size)

The lubricant in each strand of high tensile strength gives "PALMETTO" long life in service, making it a packing of

Economy and Great Convenience

Small stuffing boxes need the right packing, because the amount of packing is small and is more likely to burn out or harden.

Send for free working sample to test for yourself

GREENE, TWEED & CO.

Sole Manufacturers

109 Duane Street - New York

CANADIAN
FAIRBANKS-MORSE
EVERYTHING MECHANICAL

When the seat of a Pratt & Cady Renewable Seat Gate Valve becomes worn, you can insert new bronze seat rings in a very few minutes. The valve is then as good as new. And the cost is nominal compared with the cost of a new valve.

Anyone with a wrench can easily make this change. There is nothing to become loose or drop out and obstruct the line.

PRATT & CADY
RENEWABLE SEAT GATE VALVES

The gate in these valves is a double-faced, wedged-shaped casting with side grooves, by means of which it slides on guides in the valve body.

Guides in the body are of equal thickness and the wedge can be taken out of the valve and replaced with the opposite faces in contact and give an accurate fit. In making repairs this is important.

These valves being double seated can be used with the pressure applied at either end.

Gauges are used in machining all parts to insure accuracy and interchangeability.

Made of bronze and iron in all sizes. Adapted for steam, air, oil, gas or water service.

Large stock at branches insures prompt service.

May we send you our Catalog?

PRATT & CADY CO., INC.
HARTFORD, CONN.

Manufacturers of Valves, Feed Water Heaters, Hot Water Generators, Power Pumps and Asbestos Packed Cocks.

Canadian Representatives:

THE CANADIAN FAIRBANKS-MORSE CO.
LIMITED

Halifax, St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Advertise for Good-Will

"The last twenty years have witnessed a great development of advertising as a selling force," George Frank Lord, advertising manager of the E. I. du Pont de Nemours & Co., told the Pittsburgh Advertising Club.

"I venture to predict that in the next five years advertising will be recognized chiefly as a great buying force. Instead of using advertising to sell merchandise we will use it to buy customers. For the purchase of good-will it will be classified, even by accountants, not as current expense, but as a long-time investment; a sort of bond that yields dependable interest annually and amortizes itself in ten years, but keeps on returning interest indefinitely.

"If advertisers and advertising men will keep their minds fixed on this idea of buying good-will, or buying satisfied customers, instead of selling merchandise, many of the most difficult problems of advertising will disappear. Appropriations will not be based on last year's earnings, the current year's estimate, the sales department's gross margin, or the tentative impulses of the board of directors, but on clear analyses of the amount and kind of good-will needed for the ideal future of the business, the time required or available to develop it, the total amount it will be worth, and how the expenditure of that total will be made in various years.

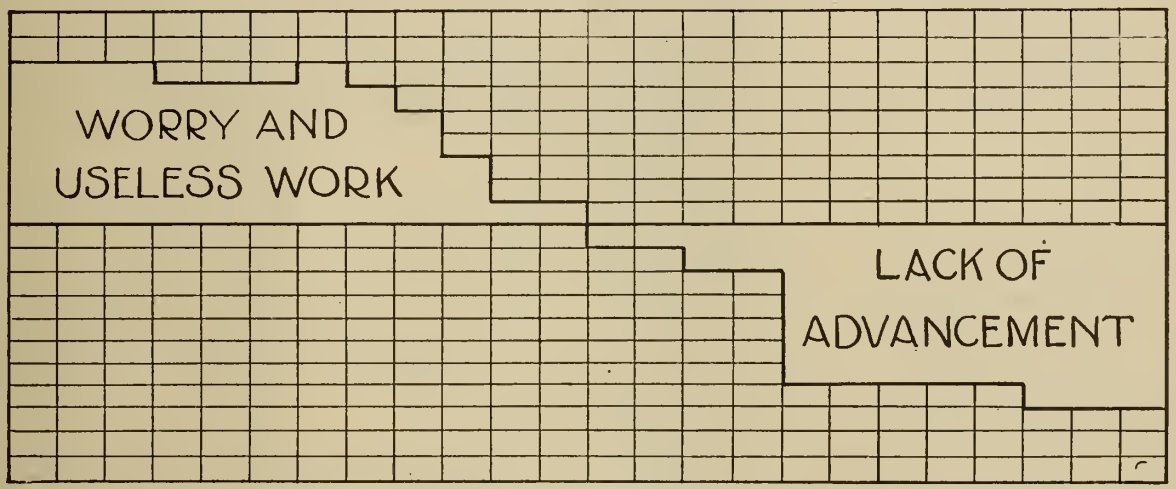
"The advertising policy will not be shifted by the weather, the crops, temporary trading conditions or changes in organization. The business itself will have a definite, enduring policy, and the advertising will express it.

"There will be no lying copy, nor merchandise that is made only to sell, and not to use; because such things do not buy customers and are destructive of good-will, the great asset the advertiser is seeking.

"Whether an advertiser formally adopts the policy of buying good-will or not, the good-will value of his advertising is all he really gets for his money. The advertising that buys satisfied customers adds to his good-will, and that which creates dissatisfied purchasers subtracts from his good-will.

"Success is merely the result of having more plus than minus in the good-will account. Since the whole history of advertising proves this is true, why should we not recognize this truth and consciously get in line with it?"

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.
HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.
HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal, Que.
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber Limited, Toronto.
Empire Mfg. Co., Ltd., London, Ont.
HOT WATER GENERATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.
HYDRANTS
Kerr Engine Co., Walkerville, Ont.
HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.
HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.
HYDRAULIC VALVES
Yarnall-Waring Co., Philadelphia, Pa.
HYDRAULIC PRESSES
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
HYDRAULIC POWER EQUIPMENT
Hamilton Co., Wm., Peterboro, Ont.
ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Norwalk Iron Works, South Norwalk, Conn.
York Mfg. Co., York, Pa.
INGOTS
Empire Mfg. Co., Ltd., London, Ont.
INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.
INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto.
Uehling Instrument Co., New York. N.Y.
INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.
INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.
INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.
INJECTORS, AUTOMATIC AND AUTO-POSITIVE
Penberthy Injector Co., Windsor, Ont.
INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Companies, Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.
INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.
INSULATORS
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.
IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.
KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, England.
KEROSENE PUMPS (SELF MEASURING)
S. F. Bowser Company, Limited, Toronto, Ont.
KEROSENE TANKS
S. F. Bowser Company, Limited, Toronto, Ont.
Green's Economiser, Ltd., Toronto.
KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.
LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
J. K. MacLaren, Ltd., Montreal, Que.
LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.
LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.
LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.
LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATORS, CYLINDER
CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Company, Limited, Toronto, Ont.
LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto.
LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
MARINE CASTINGS
Empire Mfg. Co., Ltd., London, Ont.
MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, South Norwalk, Conn.
MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithica, N.Y.
MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
METERS, AIR
E. J. Philip & Sons, Toronto, Ont.
METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.
METERS, FLOW
Republic Flow Meters Co., Toronto.
METERS, GAS
E. J. Philip & Sons, Toronto, Ont.
METERS, STEAM
American District Steam Co., North Tonawanda, N.Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto.
METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
E. J. Philip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.
MIXING VALVES
Mueller Mfg. Co., H., Sarnia, Ont.
MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal, P.Q.
Waterous Engine Works Co., Brantford.
METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.
METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Company, Limited, Toronto, Ont.
MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.
OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.
OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Company, Limited, Toronto, Ont.
OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
OIL METERS
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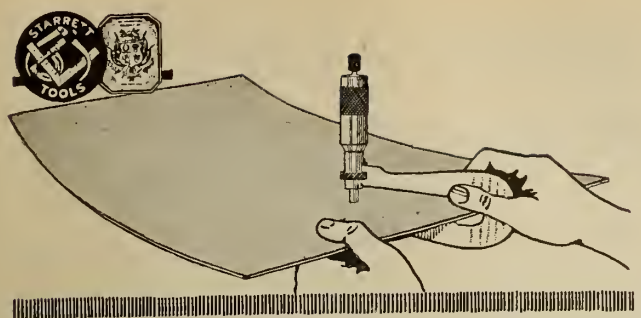

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3		5	550-110/220
2		10	2200 and 500
1		10	440-220/110
1		15	2200 and 500
1		20	550-110/220
1		20	2200-220/110
2		25	2200-550
1		25	550-110/220
1		30	550-110/220
1	30		2200/440-220/110
1	30		2300-230/460
3		40	550-110/220
1		75	220/240
3		100	13200-6600/2200
7		100	2200/1980-370/185
3		125	16000-400
3		185	33000-430
2		200	2200/550
3		333	13200-2300
3	550		13200-2200/560
3		1500	13200-575/2300
		60 Cycles	
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2		1	440-220/110
2		1	550-274/137
1		1	1040-2080-52-104
4		1	2200-220-110
6	1		6600-100
1		1½	1100/2200-220-110
6		1½	1040-2080/52-104
2		2½	2200/220-110
1		2½	1040/2080/115
2		3	2200-110
3		3	2200-220-110
2		3	2200-550
1	3		1040-2080-104-208
3		4	2200/220-110
1	4		440-110/220
3		5	2200/220-110
2		5	550-110/220
1	5		2080/104-208
1	5		1040/2080-104/208
3	5		550-110/220
1		5	110/2200-110/220
3		7½	2200/220-110
1		7½	500-110
1		10	11000-110/220
3		10	2200/220-110
3	10		4000-2000/240/120
1	10		2200-110/220
1		10	6600-110/220
2		10	11000-550/275
1	10		11000/110-220
3		15	2200/220-110
4		15	550-110/220
2		15	11000/575
1		15	600-110/220
1		15	100/2200-110/220
2		15	1040/2080
1		15	2200/1980/110/220
1		15	1100/2200-110/220
1		15	2200/1100-220/110
3		15	6600-550
2		15	2080-115/230
1	15		2080-230
13		25	11000-575
3	25		12000/2200
2	30		1100/2200-122/244
10		30	11000/575
1		30	1040/2080-104/208
3		30	2200/550-220/110
4		37½	11000/575
3		40	11000-240
3	75		22000-440
1	75		2250-375
1	90		6600-2200
2		100	2200/550-220/110
2		100	22000-11000/220/234/248
8		100	6600-1150-1092
1	100		6600/250
2		100	2420
3	100		2200/550
3		100	1600-2200
2		150	2300-382
3		125	2200-550
6		150	1100-2200.
3		200	15000/14000-2300/2200
3	200		13200-2300
6		250	22000/11000-2200/1100
3		250	11500/6600/2300
1		250	2200-480-240
3		250	11500/6600
2		250	2200-550
3		300	12000/110/220/440
3		300	25000/2200
4		350	33000/13200
2		500	23000/2300
12	500		12500/2200
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"Among the minor causes are the various classes of idlers and usurers, who in devious ways levy toll on labor and industry. Waste of time in high schools and colleges teaching dead languages and other unpractical subjects to the partial or total exclusion of vocational training, economics and useful branches of learning which would be of greater value for purposes of mind development and discipline and thereafter more useful to the individual and the country."

SAYS THE FINANCIAL POST IN REPLY:

"It is, of course, possible that there might be a dissenting voice, heard above this chorus of condemnation. A voice that might suggest, for instance, that the fact that the producer is getting $24.50 per hundred for hogs, where he formerly got $6, might, perhaps, have as much to do with the matter of increased cost as the inefficient handling that gives to the packer 5-16 of a cent per pound on bacon, or to the retailer a bare 5 cents a pound. Or the fact that the farmer is now guaranteed a price of $2.15 a bushel for wheat that formerly he sold with satisfaction for 90 cents, may be as much responsible as the half cent a loaf profit of the baker, or the cent profit of the retailer.

"It is a question, too, whether all the blame for the trying conditions of the present time should be laid at the door of established trade, any more than at any other door. There seems no good evidence for believing that the business morals of the merchant class are worse than any other, and there might be those who might reply to the stricture that our schools and colleges are not devoting their attention strongly enough to the bread and butter needs that "man does not live by bread alone."

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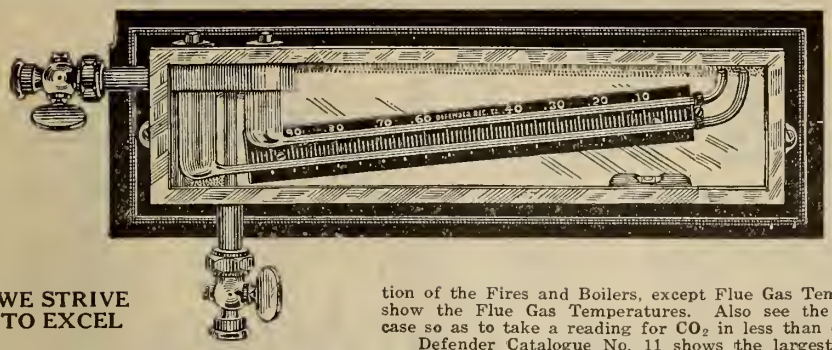

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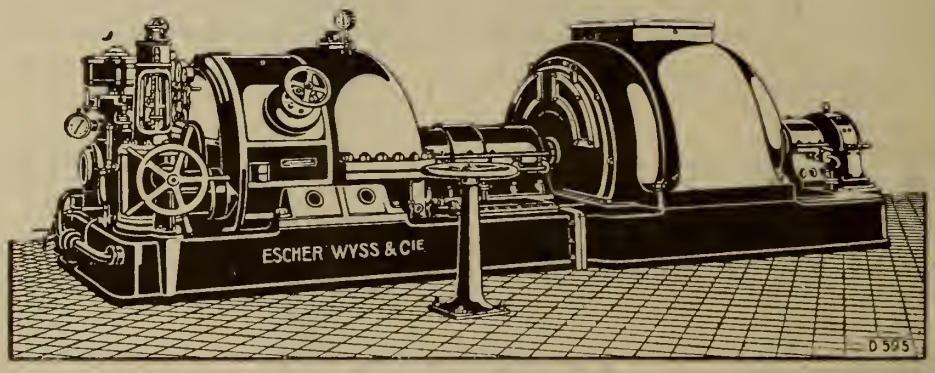

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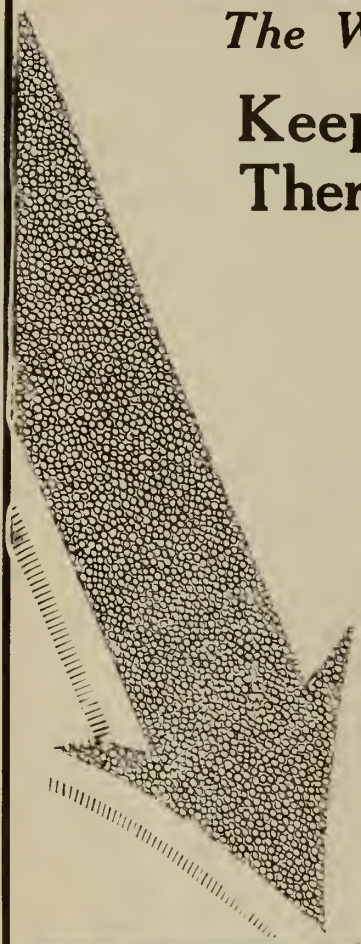

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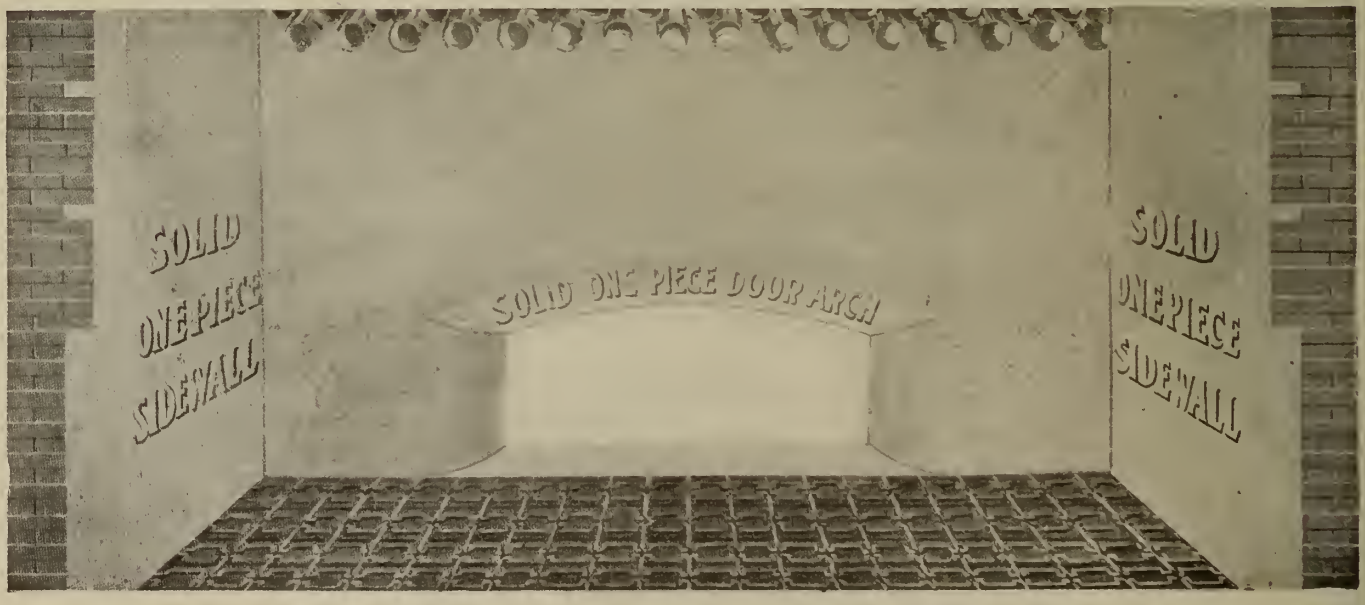

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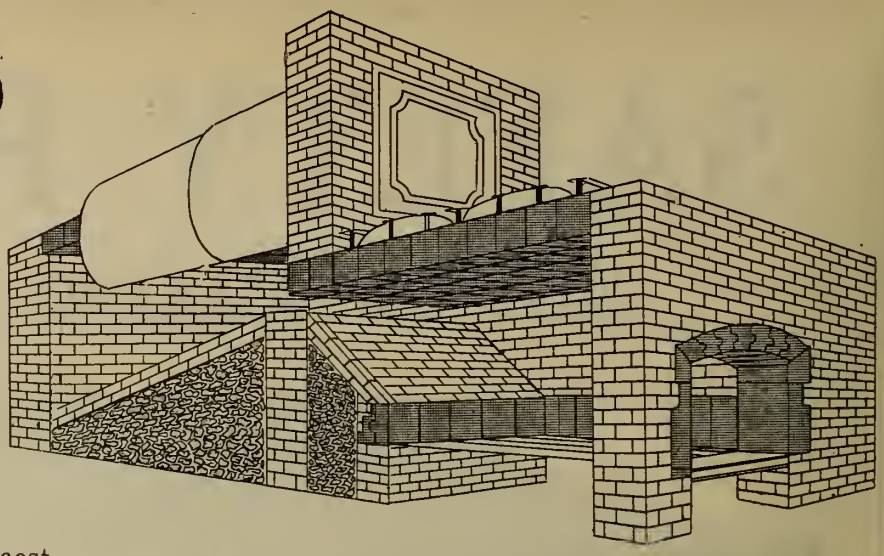

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The Bronze to Bronze feature eliminates all possibility of deterioration at the vital part. Bronze will not rust or corrode.

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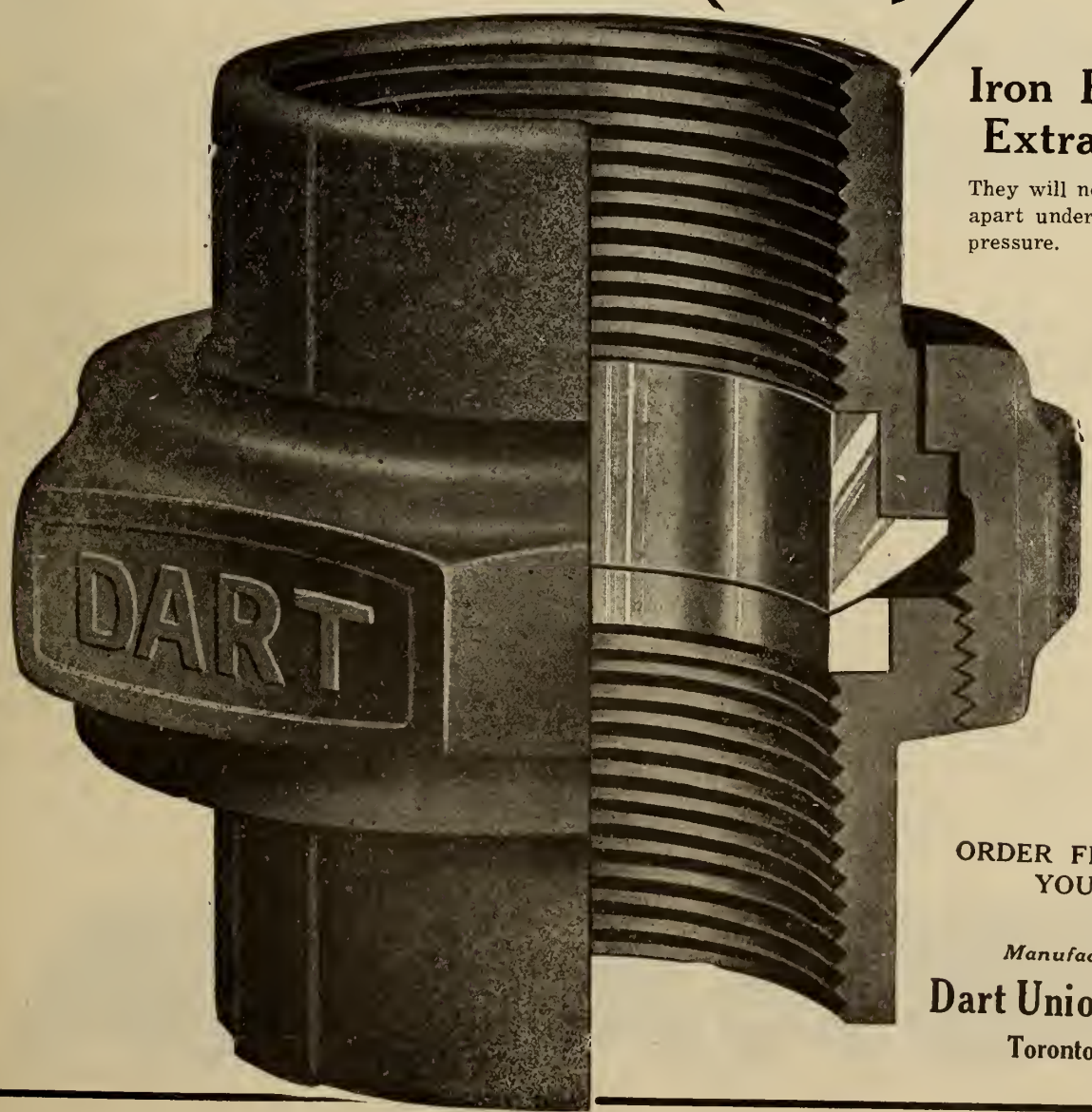

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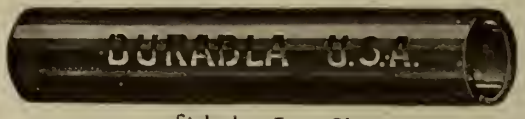

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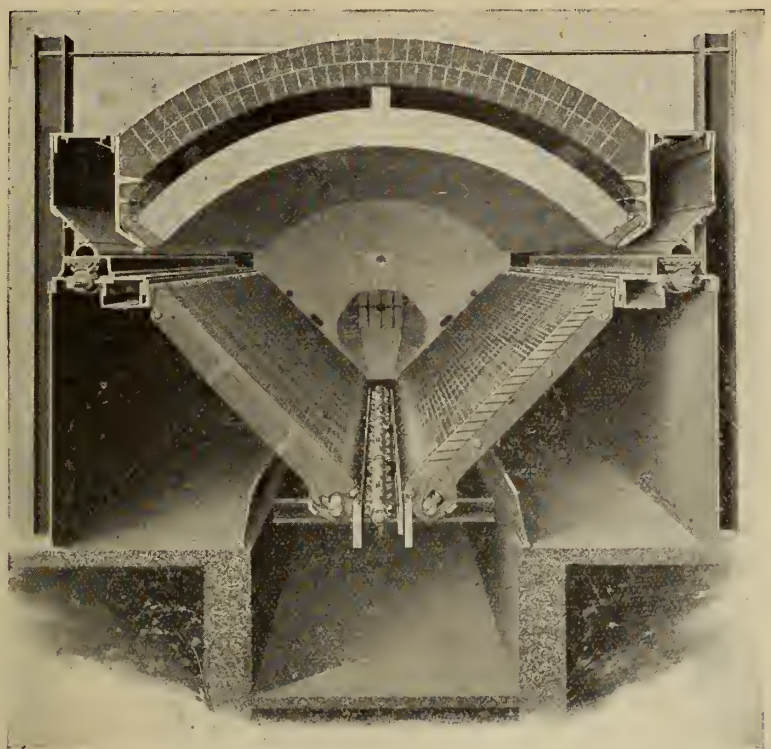

Cross section showing the construction and operation of the Murphy Automatic Furnaces. As the fuel progresses downward the alternate movement of the grates ¼" above and ¼" below the surface of the stationary grates breaks up the fuel bed —prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder.

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Yes! It burns successfully more different grades of coal than any other furnace ever devised.

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When you can't get bituminous coal you can keep the plant operating on slack—lignite—sawdust or even refuse, if the plant is equipped with Murphy Automatic Furnaces.

Why not send for catalog HM-12 and see what Murphy Furnaces are doing in plants right in your vicinity.

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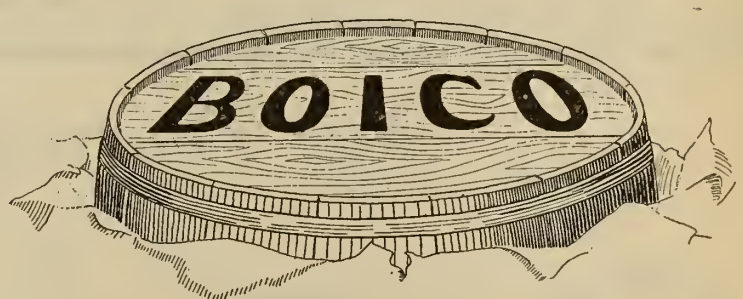

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

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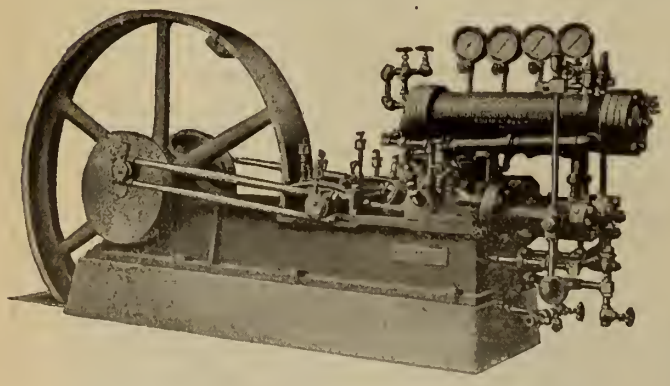

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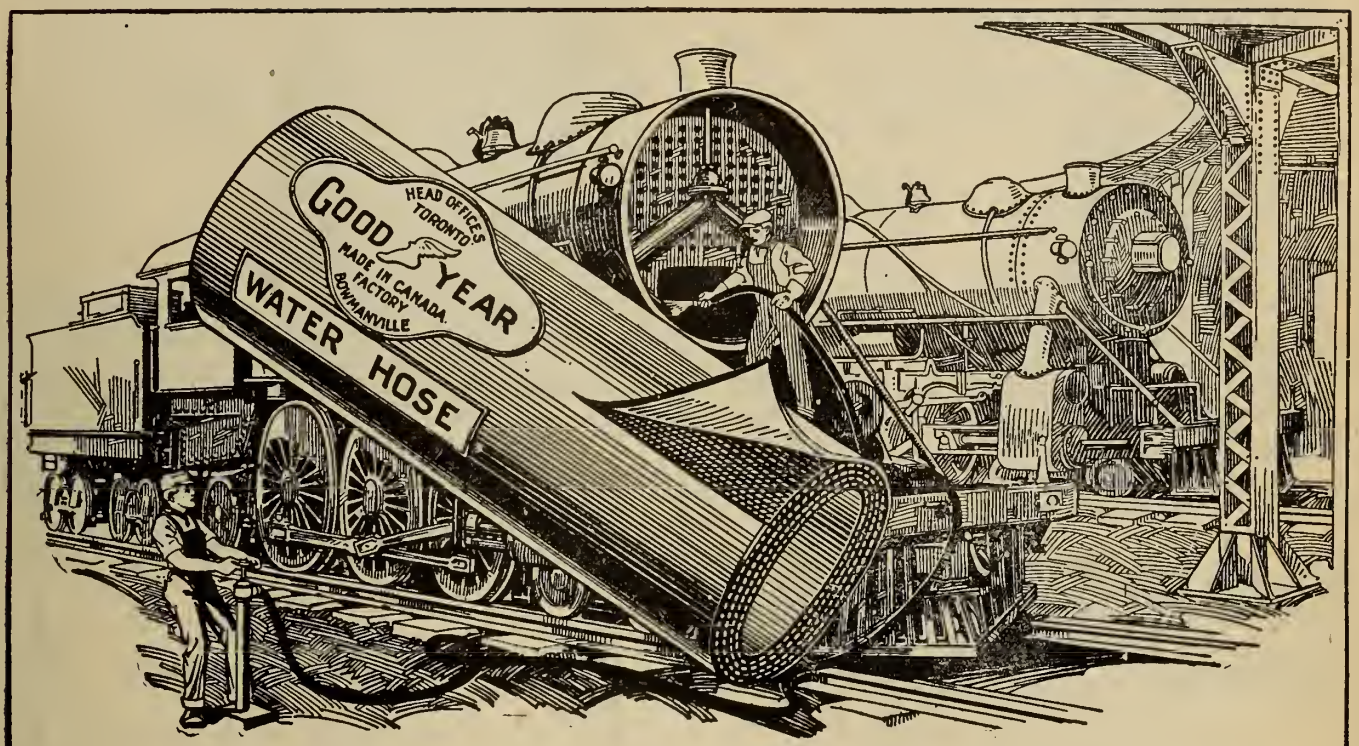
Pioneer Builders of Compressors
South Norwalk, Conn.

ANY·CAPACITY ANY·PRESSURE



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But we have seen and heard of thousands of feet of water hose which had to be discarded long before its time because the *cover* wore through.

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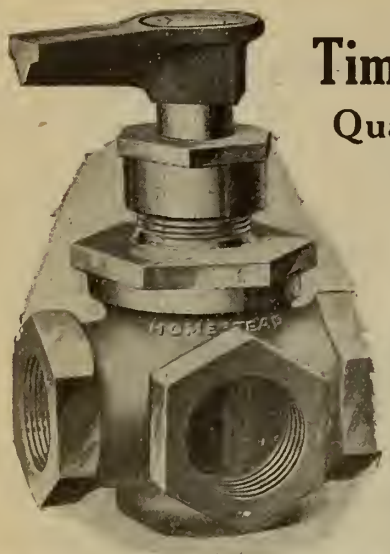

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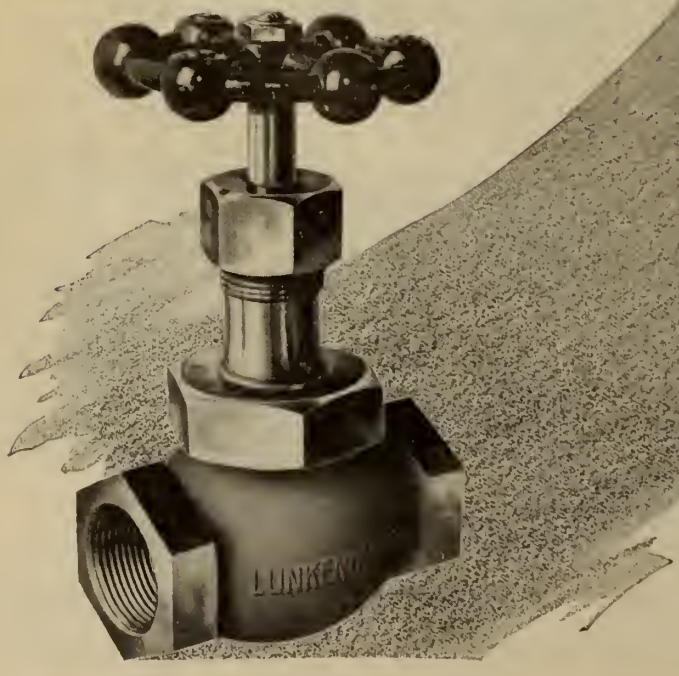

To the user they need no introduction —their high quality, reliability and serviceability having made a lasting impression.

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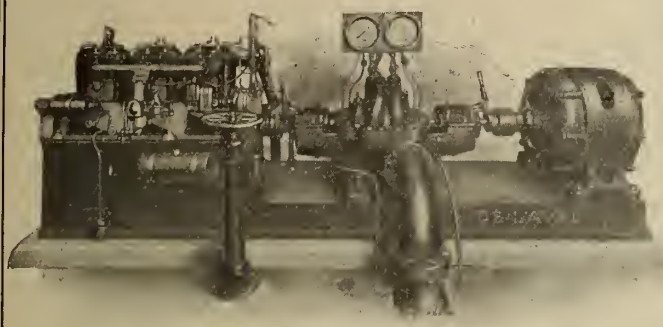
Why not control the blaze before it gains headway?



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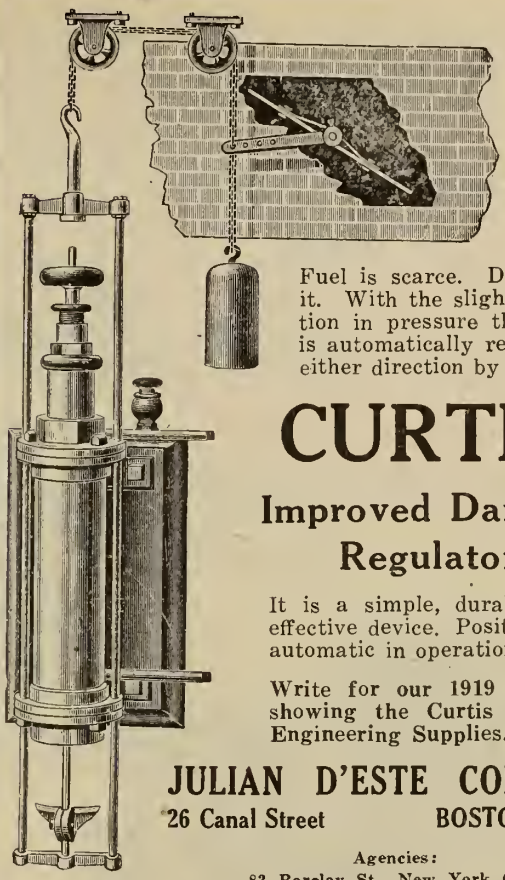
12 to 300 h.p. commercial and marine engines



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It is a simple, durable and effective device. Positive and automatic in operation.

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Write to-day for information and prices.

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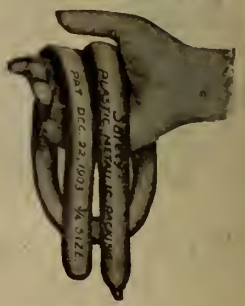

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For Manufacturing, Mining and Milling

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"Jones Underfeed Stokers" will burn low-grade fuel, keeping up your steam pressure and meeting your peak loads without installing extra boilers.

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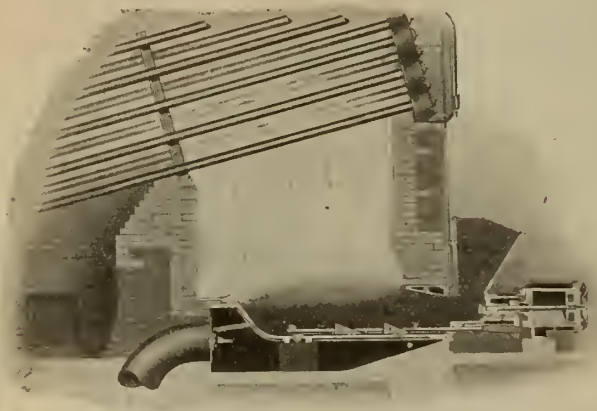

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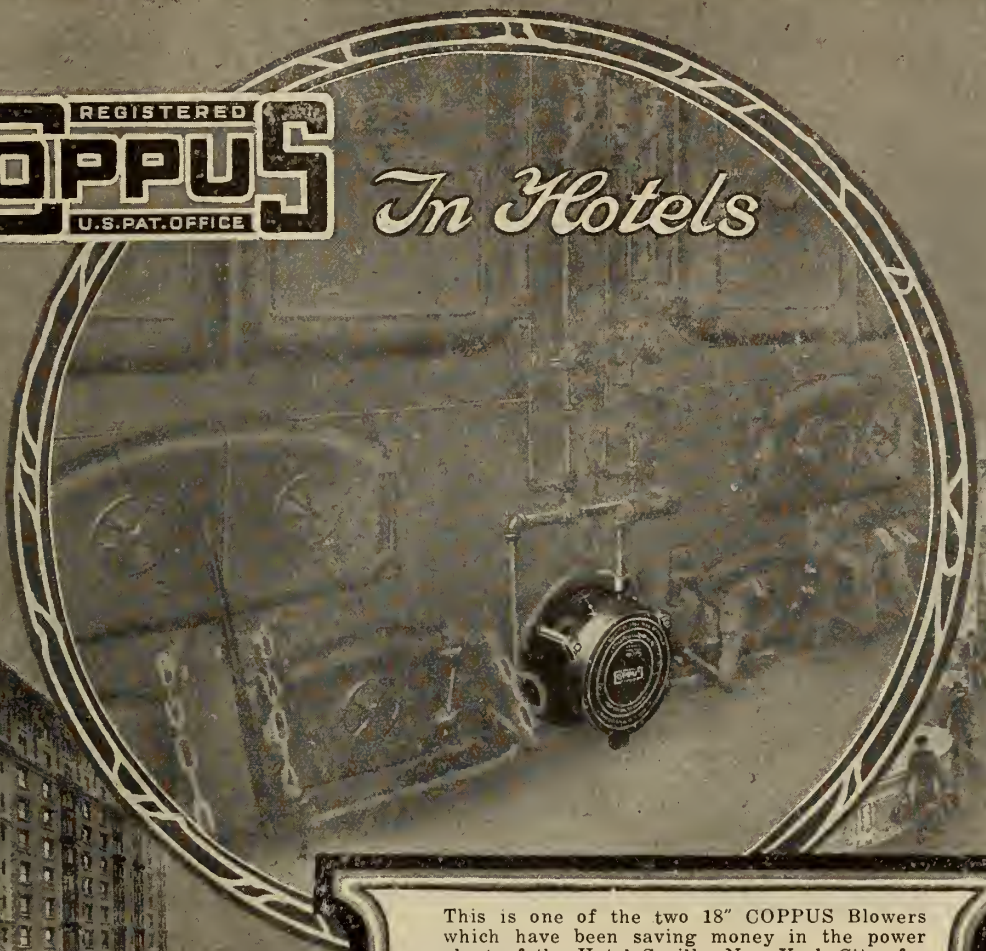

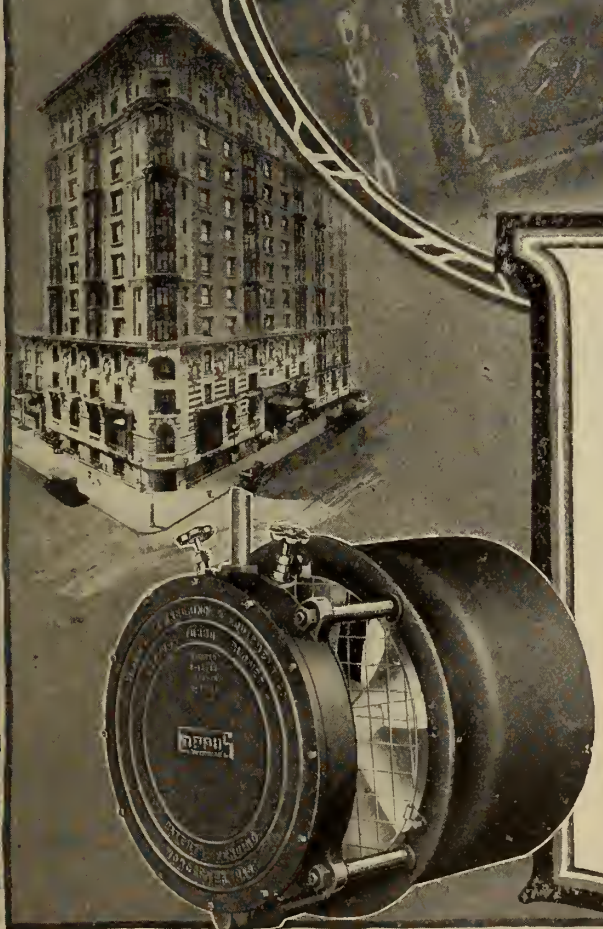

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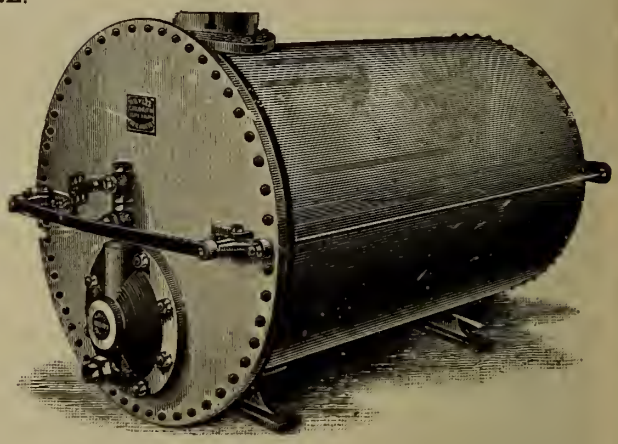

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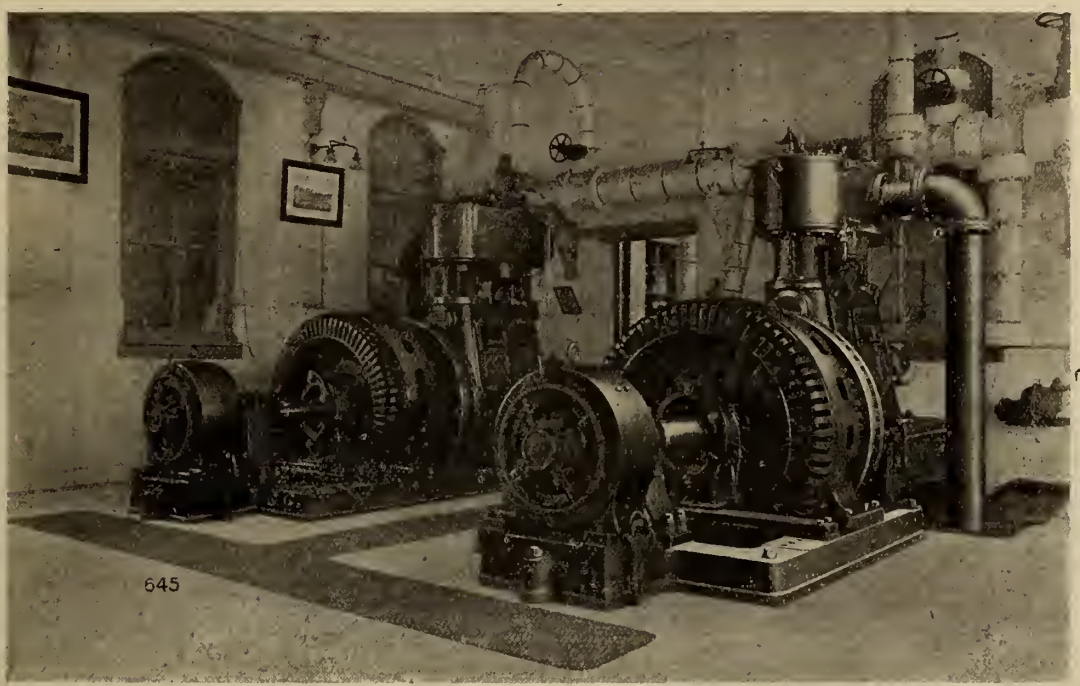

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POWER HOUSE

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The Waterpowers of British Columbia—I

The Report by the Commission of Conservation on the "Waterpowers of British Columbia" Contains Much Data of Interest. The Following Article, Published Through the Courtesy of the Commission, Presents a Summary of a Portion of the Report

IN January, 1910, the Commission of Conservation commenced the investigation of the character and extent of the various natural resources of Canada. Early in 1909 the Canadian delegation to the North American conference at Washington had compiled a general statement respecting the available water-power data. This compilation served to demonstrate the inadequacy of the information respecting this valuable natural resource. The commission, therefore, decided to prepare an inventory of the water power resources of the country, and, in so doing, avoided duplication of effort by utilizing all available information from governmental and other sources.

The commission commenced its own reconnaisance field work in the eastern provinces, and, in 1911, published "Water Powers of Canada," which represents, in summary form, the information then available for the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec and Ontario. Owing to the paucity of information available, it was not then possible to do more than describe briefly the water-power resources of the provinces of Manitoba, Saskatchewan, Alberta and British Columbia.

The conditions affecting powers in the province are unique, and do not closely correspond to those existent in other portions of Canada. This is especially true of the mainland Pacific coast. One cannot but be impresesd with the fact that coastal water-powers in British Columbia, which, to the casual observer, appear to be of comparatively small amount, nevertheless, may, when economically and fully developed, yield several-fold the estimate of power if appraised upon the same basis as similar streams in Eastern Canada. Glaciers, snowfields, and heavy rainfall abound, and, with many storage possibilities, constitute unique factors which contribute to enhance the values of powers. These conditons, on the other hand emphasize then ecessity of special and very careful engineering investigation and expert handling.

SNOW STORAGE IN THE SELKIRKS. CREVASSE SHOWING SECTION THROUGH SUCCESSIVE SEASONS' SNOW LAYERS. THE NARROW BAND IS ABOUT 2.5 FT. THICK AND REPREENTS THE SNOWFALL OF THE WINTER OF 1911-12.

Total Estimated Horsepower

Grand totals purporting to represent horsepower possibilities for large sections of a country are apt to be very misleading. They are especially misleading when used to make comparisons with other totals, when, as a matter of fact, no real basis for comparison has been established. The unique character of many of the water-power possibilities of British Columbia with its exceptional physical features, such as mountain systems, glaciers, snow-fields, and widely variant precipitation, necessarily makes it difficult to effect comparisons between the total water-power possibilities of this province and those of other areas differing markedly in physical characteristics. However, it will be interesting to present in round numbers certain totals of horse-power derivable from the various estimates presented in the tables which form part of the report.

Conventionally, the province has been divided into districts, as follows:

	24-hour horse-power.
I. Columbia River and tributaries (north of the international boundary): This comprises the portion of the province lying between its eastern boundary and the watershed of the Fraser River	610,000
II. Fraser River and tributaries: This	

AKOLKOLEX RIVER, TRIBUTARY TO COLUMBIA BELOW REVELSTOKE. OVER 300 FT. FALL IN SHORT DISTANCE.

includes practically the entire area of the great interior plateau	740,000
III. Vancouver Island	270,000
IV. Mainland Pacific Coast and adjacent islands (except Vancouver Island): This includes all the rivers north of the Fraser which drain into the Pacific	630,000
V. Mackenzie River tributaries (a rough estimate made for inclusion in this summary)	250,000
Grand total	2,500,000

The above totals include about 250,000 horse-power for plants already in operation, but they do not include about 400,000 horse-power given in the tables for power possibilities on streams like the Fraser, Thompson, Skeena and Nass rivers, on which, because of the proximity of railways, or possible interference with the salmon industry, economical development, cannot be considered under present conditions. Also, as elsewhere explained, there is still considerable territory, especially in the more northerly portion of the province, which it has not been possible to investigate fully. These areas may yet disclose a considerable amount of power. One fact to be borne in mind in conection with these totals is that, when powers are developed and the available waters are intelligently conserved, more power will be obtained than the quantities estimated upon the basis of available data would, at present, indicate.

In round figures, the total estimated 24-hour power, including an allowance for all of the entities above mentioned, may be placed at about 3,000,000 horse-power.

Water as a Natural Resource.

Water-power development is but one of the important uses to which many of our inland waters may be applied. Too frequently, in reports on water-power resources, it has been the tendency to deal with power development exclusively, without adequately considering such related subjects as domestic and municipal supply, agriculture and irrigation, navigation, fisheries and riparian rights.

Precipitation, in the form of rain or snow, virtually constitute the only source of inland water supply. Its distribution and efficient use are largely determined by the natural or cultivated properties of the ground on which it falls. Of the total precipitation on the earth, speaking very generally, about onehalf is evaporated; about one-third is "run-off," that is, it runs off over or through the ground, and, by means of the various watercourses, eventually reaches the sea; about one-sixth is taken up into plant structure or otherwise absorbed in process incident to growth. What is known as the "ground-water" serves as a balancing reservoir, being drawn upon during periods of rapid plant growth or of deficient precipitation, and being replenished during seasons of plentiful supply.

The proportion of the precipitation which runs off is that which provides the water for power development, but it must be recognized this same water may also be required to furnish a supply for domestic and municipal purposes, for irrigation, for industrial and manufacturing purposes, or for navigation and fisheries.

Many interdependent and interrelated interests are primarily dependent upon water, and, consequently, keen discrimination is necessary in determining what importance shall be attached to the development of any particular water-power. The subject of power development must be treated with due consideration for the other uses for which water may be required; therefore, in the following paragraphs, water is viewed broadly as a natural resource, and the claims of other interests upon this resource, are discussed.

Run-Off and Forests.

Much has been written respecting the influences of forest cover upon precipitation and run-off. Some of the views expressed differ greatly, due chiefly to the fact that the authors have occupied almost entirely different viewpoints, and these they have not sufficiently defined. We shall refer here to only one or two aspects of the subject.

Irrespective of whatever opinion may be held as to the effect of forests in influencing the amount of precipitation, it is conceded that no topographic feature, generally speaking, ministers more efficiently to gradual and economical run-off than do areas covered by vegetable growth, whether it be forest or such other growth as will correspondingly regulate or temper the run-off. Thus it is that failure to intelligently conserve forest areas has caused great destruction of forest floors and agricultural lands. The damage occasioned by repeated forest fires, especially if the ground is rocky and the soil cover scanty, is exceedingly bad, and contributes greatly to excesive flood run-off. The annual destruction of property by floods appears to increase rather than diminish.

ELK RIVER CANON FALLS FROM DEWDNEY TRAIL BRIDGE, ELKO, B.C.

Serious floods frequently occur as a result of a heavy snowfall upon ground which has been frozen after having first been saturated with water. When this snow melts it is very apt to augment, materially, the surface run-off, because the already frozen ground precludes the usual absorption.

Occasionally, forests may even accentuate floods. When, for example, the winter's snow is retained by a forested area until late in the spring, and then a marked rise in temperature or warm rain occurs, the real net effect of the forest cover would be to accentuate flood stages. Of course, such factors as the character of the forest floor, its porosity and depth, the nature and permeability

of the sub-soil, and others, all exert their influence.

In the case of water-power development, therefore, it is necessary to determine whether the advantages accruing from the industries which propose to use the water-powers wil be more than counter-balanced by the disadvantages resulting therefrom. Thus, for example, wood-pulp mills, if their operation might result in practically denuding the land of forest growth, had beter not be established at all; or, if established, they then should be operated under the strictest regulation and supervision, designed to perpetuate the forest growth. A deforested, eroded and scoured territory, which has lost the humus of its soil, cannot hold the beneficent rains which, instead of being retained in the ground and transmuted into plants by the various processes of growth, carry destruction in the pathways of their torrential run-off. The water is necessary to the soil, and the soil, with its plant growth, is necessary to an economical disposition of the water.

Water Power and Agriculture.

Consider, next, a little more in detail, the possible effects which the depletion of underground water by diversion for power or other purpose may have upon agriculture. Underground waters are by no means inexhaustible.

Underneath the surface of the earth is a vast body of water which may be likened to an underground lake, called the ground-water. It has been estimated—again speaking generally—that the moisture in the upper 100 feet of the ground is equivalent to a lake of water some 17 feet deep, i.e., the equivalent of about seven years' rainfall. It is into the upper surface, termed the water-table, of this ground-water that wells are sunk for domestic and other water supply. During periods of plant growth this ground-water yields, chiefly by capillary action, part of its moisture to the plants; and then during seasons of excessive rainfall is again replenished. Under normal conditions, the annual fluctuation in level of the water-table is but a few inches. Such states as Minnesota, Iowa, Wisconsin, Southern Michigan and the Dakotas have, it is stated, already experienced alarming and permanent recedence in the levels of their ground-waters, and a consequent diminution in crop production. Large sums of money have been expended by the federal and state governments in the United States, on the investigation of the occurrence and flow of underground waters, should be considered together, more recognized that proposed disposition of the run-off, and underground waters, should be considered together, because of a natural balance that exists between them.

It is easily possible to so divert some channels or water-courses as to allow much of the ground-water to be lost, and consequently cause permanent damage to a large expanse of territory. Great waste and carelessness have been manifested in many localities by the users of the underground waters. In the smaller towns, more especially in the east, where the domestic wells furnish so much of the water supply, it has frequently been observed that when some deep trench, as, for example a cut for a new sewer or a mine shaft, has been excavated, the underground waters have drained away, thus "bleeding" the adjacent territory and causing wells of the neighborhood to go dry. The lessons that may be drawn from such illustrations should not be forgotten in considering our valuable underground waters, when viewed locally or with respect to their provincial or larger areas.

Of this ground-water, the late Dr. W. J. McGee, secretary of the United States Inland Waterways Commission, and expert in charge of soil water investigations of the United States Department of Agriculture, states:

"It is the essential basis of agriculture and most other industries, and the chief natural resource of the country; it sustains forests and all other crops, and supplies the perennial streams and springs and wells used by four-fifths of our population and nearly all of our domestic animals. Its quantity is diminished by the increased run-off to reforestation and injudicious farming. Throughout the upland portions of the eastern United States, the average water-table has been lowered 10 to 40 feet so that fully three-fourths of the springs and shallower wells have failed, and many brooks have run dry, while the risk of crop loss by draught has proportionately increased, and the waste through the Mississippi has increased over 15 per cent."

In connection with his work for the Department of Agriculture, Dr. McGee assembled the records of some 35000 wells scattered throughout the United States, and as a result of his research has made the following statement:

"Second in order, but first in significance, among the results of the inquiry is a clear quantitative indication that the subsoil-water level is, and has been since the settlement of the country, lowering at a considerable rate. The rate of change varies from region to region and state to state, ranging from a slight rise in irrigated districts to a lowering of about 3.5 feet per decade. In the 31 states forming the half of the country best adapted by natural conditions to feeding and clothing a great people, the average lowering since settlement would appear to be no less than 9 feet, i.e., from well within, to about the limit of capillary reach from the surface. The data, indeed, indicate that lowering generally was more rapid within the first generation after settlement than later, yet the figures used in the estimates are derived from the reduced rate of the last two decades rather than the more rapid lowering of earlier decades. It would appear also that the actual loss of water attending the lowering is 10 per cent. of the aggregate volume within the first hundred feet from the surface — a national loss of substance comparable with the destruction of forests and the uses and

ICE RIVER GLACIERS TRIBUTARY TO HORNTHKO RIVER. THE FOOT OF THIS GLACIER IS ONLY BETWEEN 300 AND 400 FEET ABOVE SEA LEVEL.

waste of petroleum and natural gas, and far exceeding the consumption and waste of coal and metal. In the light of the relation of subsoil water to productivity, its rate of lowering can only be regarded as a measure of advancing national impoverishment."

In the face of such facts the claims which the ground-water supply has upon its proportion of the rain-fall cannot be ignored. Certainly, watercourses and the sources of their supply should not be so disturbed as to cause a serious permanent depletion, or pollution, of the underground waters. Upon this point, therefore, it is necessary that the amounts, movements, and functions of the ground-water in any district be studied in connection with any general scheme devised for the utilization of water in that particular territory. It must be evident, therfore, that efforts to have the underground waters properly and efficiently used, deserve the fullest support.

STORAGE IN GLACIERS. FROM A SHOULDER OF MOUNT MOLOCK LOOKING SOUTH. NOTE THE WELL-FORMED MEDIAL MORAINE.

The underground waters of Canada, in some places, are now being tapped, and, not infrequently, wasted. In the United States, many states have enacted laws designed to conserve such waters. A main feature of such laws has been the regulation of the flow by actually limiting the size of the pipe through which ordinary domestic and farm water supply may be taken. Sometimes the law states that the supply shall be taken through a half-inch pipe, which shall be furnished with a stop valve. In some state the penalties for violation of the law relating to underground water are severe; for example, in South Dakota:

"If any person complains that the proprietor of an artesian well, or the party controlling such well, is in the habit of letting the waters go to waste, the township supervisor, county commissioner, road overseer, alderman, or other city officers, may enter upon the premises where the well is located in order to determine whether the complaint is justified, and may institute criminal prosecution in case violation of the law is ascertained. If the well is without valves to regulate the flow and prevent waste, the person owning the well may be fined up to one hundred dollars, or be imprisoned not more than three months in jail, or both."

Laws regulating the use of underground waters are needed in Canada. At present, farmers and others are tapping these underground waters and, in some cases where "gushers" have been struck, the valuable waters are permitted to run to waste continuously. This should not be allowed.

Navigable Inland Waters of British Columbia.

In British Columbia there are numerous lakes and many stretches of river which are navigable. By a navigable stream is here meant one which can be navigated by the ordinary flat-bottomed river boat, generally a stern-wheeler. On many of the lakes, steamers of larger size can be used, whilst some swift-flowing rivers, not navigable by stern-wheelers, may be ascended by fast motor craft of shallow draught. There are stretches, not at present navigable, which may be made so by the construction of suitable works. The erection of dams and other works for power development will, at a number of places, improve the rivers for navigation, both by drowning out rapids and by increasing the depths at shallow places. Lockage provisions in all dams should, of course, be fully safeguarded.

Water Power and Fisheries.

Serious consequences to the fishing resources result from obstructions which prevent the free passage of salmon and other fish. This subject is vital in its bearing upon power development, and yet it is frequently passed over.

Practically all of the Pacific Coast streams of British Columbia and their tributaries are annually frequented by vast numbers of Pacific salmon, consequently the salmon fishing industry is one of the most important interests to be safeguarded in the carrying out of works which will materially affect the inland waterways.

There are two main features to the problem of safeguarding the fishing interests in connection with power development: First, to permit a sufficient number of adult salmon satisfactorily to pass all obstructions in order to reach and deposit their own ova upon the spawning beds of the streams; and second, to ensure that the young salmon are afforded a satisfactory passageway out to the sea.

In Canada both federal and provincial legislation has been enacted to safeguard the inland fisheries and to provide for the construction of fishways. The chief difficulty, however, as far as fishways are concerned, is that too frequently proper fishways are not provided, and that such as are provided are allowed to fall into disuse. The Dominion Fisheries Act explicitly provides that fishways shall be built wherever the Minister of Marine and Fisheries determines they are necessary.

Water-power development may also conflict with fishing interests by the destruction of spawning grounds through the manipulation of the levels of lakes used as storage reservoirs. When lake levels are raised the margin of the lake, up to the proposed flowage line, should be stripped of tree growth and underbrush, to facilitate the formation of new beaches and maintain the healthy condition of the water. Here, again, the question of clearing becomes one of weighing advantages and disadvantages, but it is doubtful if any of the supposed advantages derivable from power development will offset the destruction of the source of one of our important supplies of food. Certainly, with intelligent regulation and foreeful administration, the streams of the province should not only continue to produce vast numbers of salmon, but the supply may be greatly increased.

Inland Waters and Mining.

The British Columbia laws relating to water clearly reflect the marked influence which the mining industry has exerted upon the use of water in the province. Mining, in point of value of annual production, has long been British Columbia's most important industry.

although, during recent years, its forest products have sometimes exceeded its mineral production.

Water and water-power have played a most important part in mining development. Without such power as is supplied by the West Kootenay Power and Light Co. the great mining development which has taken place in the southern portion of the province would have been impossible. Large plants have also been established on the Pacific Coast, such as those of the Britannia Mining and Smelting Co. at Howe Sound, and of the Granby Consolidated Smelting and Power Co. at Conservatory Inlet. There are also other, though smaller, hydro-electric plants situated at various mining centres throughout the province, such as those of the Hedley Gold Mining Co. on the Similkameen river, which are contributing materially to the advancement of mining operations. It is interesting to note that the hydro-electric plant of the Canadian Collieries, on the Puntledge river, V. I., has been erected practically at the pit mouth of British Columbia's largest coal mines, thus indicating that hydro-electric power has here successfully competed with cheap fuel. In the future, doubtless, the greatest advances in mining in British Columbia will be dependent upon there being available ample water-power or hydro-electric energy, and probably, many of the smaller and less accessible undeveloped water-powers will be most profitably utilized in connection with mining operations.

In Eastern Canada, as well as in Eastern United States, industries dependent upon electric energy for refining metals are realizing that, before long, they may require to remove to localities where cheap power is available. In the more settled portions of the country, power is no longer obtainable at low rates, inasmuch as it is now required for municipal, domestic, and light manufacturing purposes, which yield a much larger return.

Resume and Summary.

We have observed that precipitation is the prime source of inland water supply, and that not only water-power, but such other interests as domestic and municipal water supply, agriculture, irrigation, navigation, fisheries, mining and riparian rights, are all dependent upon the same source. Consequently, water should not be allotted for power development without due recognition to the just demands of other interests having claims upon our inland waters viewed broadly as a natural resource.

Run-off, manifested in the form of stream flow, is intimately associated with the character of the ground upon which precipitation falls and consequently, care should be taken to conserve vegetable cover; more especially is this necessary for rocky areas which have but scanty soil covering.

Subsoil waters are by no means inexhaustible. Plant growth is dependent upon having available an adequate amount of soil moisture. Nothing should be done to deplete, unduly, the ground-water storage. Effective legislation and administration should be provided governing the tapping of underground water supplies.

The use of water for irrigation tends materially to increase the permanent settlement of the country. Consequently, in most instances, when irrigation requirements and other requirements conflict, the former are entitled to precedence. Hydro-electric power developed on somewhat distant streams may, by means of high tension transmission, be used for pumping water supplies where such are not available by gravity, and may thus facilitate irrigation development.

Not infrequently navigation interests are regarded as of much greater importance than power development. Any works contemplated for the improvement of navigation should be considered in their relationship to river systems as a whole. Expenditures should be carefully watched and precautions taken to ensure that improvements, so called, are not undertaken ostensibly for navigation, when in reality they are sought for the sake of such water-power benefits as may incidentally be developed thereby.

The fishing industry in British Columbia is one which demands that the best possible methods be used for its conservation. Provision requires to be made for the upward migration of adult salmon for spawning purposes and the downward passage of the young fish to the sea. Obstructions, such as dams, rock slides, log jams, etc., may have a disastrous effect upon this industry. Fishways should be provided. The whole question of fishways requires thorough investigation. Other fish besides salmon require conservation. It is not established that satisfactory means have been devised by which fish may successfully ascend over high dams—even over dams which do not exceed twenty to thirty feet in height.

The development of the mining industry during recent years has resulted largely through electrical energy being available through the development of provincial water-powers, and the future offers bright prospects for the further application of hydro-electric power to the various branches of this industry.

The pollution of inland waters must be most jealously guarded against. Mining, factory, and industrial wastes and sewage must not be permitted to foul inland waters. Debris and other waste resulting from logging operations are apt to cause serious log jams, which are a menace to public highways, bridges and also to power development.

The tourist traffic is a valuable provincial asset, not only because of the money actually spent by travellers, but because of the opportunity afforded of drawing attention to the various natural resources of the provinces. Consequently, every reasonable care should be taken to guard against the spoiling of shorelands through submergence; and further, care should be exercised in the design and construction of power works, making them where possible, harmonize with the general natural features of their surroundings.

In connection with the use of boundary waters, problems, from time to time, may arise necessitating consideration by the International Joint Commission. In this connection, therefore, it is especially desirable that physical data appertaining to such waters should be so collected as to be available for use in connection with such problems as may arise respecting waters which are classed in the Boundary Waters Treaty as "boundary waters."

Water Power Data

One of the chief objects in securing and publishing data respecting water-powers is to enable the owners of rights to determine the possibilities and limitations of their powers, and thus arrive at sound judgment respecting their possible uses and value. Another object is to enable prospective promoters to learn the general possibilities of various powers without the necessity of making costly independent preliminary surveys. Certainly if the Crown be the owner of water-powers it is of the utmost importance that it be informed beforehand upon essential facts connected with its water resources.

Broad Classification of Water-Powers

Although the amount of water-power is essentially determined by two basic factors, one, the hydrostatic head, or verical distance through which the water may fall; the other, the amount of water which may be made to operate upon the water-wheels, yet there are many characteristic features associated with water-powers which differentiate one power from another and which, respectively, determine their commercial and economic values. These features should be well understood.

Water-powers, from one viewpoint, may be considered on the basis of their probable uses. Those capable of being employed for supplying electrical energy for municipal and community purposes, such as lighting, heating, pumping, and certain kinds of manufacturing, should be regarded as having greater economic value than those situated where power is only usable in large manufacturing plants, the supplying of the raw material for which virtually means the destruction of nature's balance in the territory where the plants operate.

Again, the uniformity of the available flow in streams varies greatly. The St. Lawrence River, owing to the vast natural storage capacity of the Great Lakes, has the most uniform flow of any large river in North America, or probably in the world. The proportion of its flood to minimum flow is about 2 to 1. On the Winnipeg River, above English River, the ratio is 6 to 1; on the Ottawa River it exceeds 15 to 1; on the Columbia River, at the Dalles, Oregon, it is 28 to 1; on the Delaware River, at Port Jervis, N.J., it is 375 to 1; in British Columbia, on the Pend d'Oreille River, it is 16 to 1; on the Kootenay River, at Bonnington Falls, it is 25 to 1; on the Fraser River, at Lytton, it is 38 to 1; on the Campbell River, Vancouver Is-

land, it is 43 to 1. On the smaller watersheds the ratio is usually greater, and on some streams draining even areas of considerable size the minimum flow is zero. Other conditions being equal, water-power developments on a river like the St. Lawrence would be of very much greater value than developments on a river subject to such great variations of flow as, for example, the Mississippi.

Another feature is the possibility of being able to make a partial development of a power-site or portion of a stream, more cheaply than the same sized development could be made if constructed as part of a comprehensive scheme designed eventually to utilize all the available power. Thus, not infrequently, a partial development unwisely planned, has precluded subsequent full development, save at almost prohibitive cost. For example, suppose a certain power site is capable of yielding 10,000 h.p. If development rights are let to A for 2,000 h.p., to B for 1,000 h.p., and to C for 1,000 h.p., and A, B and C are allowed to design and construct their individual works irrespective of each other, or of the possible development of remaining 6,000 h.p., then it will probably become quite impracticable to get anything like the remaining 6,000 horsepower because of the damage that would be caused to the plants of B and C. On the other hand, if preliminary works are constructed with a view to utilizing, as occasion demands, any amount of power up to the full 10,000 horsepower, no such contingency as has been supposed could well arise. Consequently, regulations respecting power sites should be so framed as to require that preliminary installation of dams and other main works necessary for the control of the waters be made, having regard to the possible future development of the full water power that may be made available.

It is as unreasonable not to differentiate between water powers as it would be not to differentiate between timber tracts, mineral lands, fisheries, or any other natural resources varying in quantity, quality and situation.

It should not be forgotten, when making representations regarding the amount of power that may be available for any particular site, that it is necessary to know the conditions of the river at which the stated amount of power may be produced. The minimum or primary power, as it is frequently termed, is the amount of power that may be developed during the period of lowest flow. It has been defined as the amount of power which is available for every hour of every day of every year. What is frequently termed secondary power is usually many times the primary power. As very low-water conditions generally last for but a comparatively short portion of the year, it is usually possible to develop during the greater portion of the year a considerably larger amount than the primary power. Frequently, this larger amount can be effectively utilized for industries not requiring continuous plant operation.

The pre-determination of the probable amount of power which any particular water-power site may be made to yield is a problem that calls for more extensive hydrometric data that is furnished by scattered and non-consecutive measurements of stream flow, precipitation, etc. Also, it is very important that such cognate data be available as will enable a sound opinion to be formed respecting the relationship which any proposed power development may be to any other water interest or interests that may be involved. If some important relationship is overlooked, sooner or later its importance will demand recognition by those who proceeded in defiance of its just claims.

In estimating the amount of power that may be developed, hydrometric records of precipitation, temperature, run-off, etc., extending if possible over a period of fifteen or more years should be available satisfactorily to appraise the probable regimen of the water involved.

Financial Interests Should Increase Caution

Twenty years or so ago, when water-power began to be developed much more extensively owing to the advancement in the art of electrical transmission, there was not available anything like the body of streamflow and other hydrometric data that exist to-day. There was then more excuse for errors than now in engineering and oher estimates respecting the performance of water-power installations. Many large plants have proved financial failures on account of such errors. With all data now available relating to hydrological conditions, cost of construction, market possibilities, etc., it is clearly incumbent on those interested from the financial side of proposed developments, to exercise the same kind of common judgment they would display in collecting and appraising facts relating to any other set of circumstances. A financial agent could readily look over past statements of a concern and learn its lowest or highest yearly or monthly revenues, profits, etc. If he should find periods when the profits dropped to say 2 per cent. he need never be misled by the assurance of some enthusiastic promoter that profits in the concern "might be 20 per cent. and had never fallen below 5 per cent." Similarly any one interested in possible power development may now readily place himself in possession of data which will at least give some independent check upon representations that may be made respecting the physical magnitude and approximate cost of development of water power in which he may be interested.

Thus, by way of simple illustration, if a low flow of a stream has been recorded, this quantity in cubic feet per second multiplied by the total available head in feet and then divided by eleven, gives the low-water horsepower of the stream on the basis of 80 per cent. efficiency. Such a figure then constitutes a check upon any representations. Similarly, in connection with the storage benefits, no reliance should be placed upon vague statements to the effect that "ample storage is available." The flow corresponding to certain effective water storage may readily be checked. A depth of one foot on an area of one square mile is equivalent to a continuous flow of approximately 0.88 cubic feet per second for one year. Thus, a depth of ten feet of effective storage on a lake 10 square miles in area would maintain a continuous flow of 88 second-feet for a year or 176 second-feet for six months or 352 second-feet for three months. The extent to which such storage could be employed to equalize flow would, of course, depend upon how it could be coordinated to the run-off as distributed over any selected period.

Storage and Governing Factors.

Although the presence of numerous lakes does not necessarily imply the existence of considerable water-power there is nevertheless one very valuable feature likely to be associated with extensive water areas, namely: the existence of natural reservoirs where waters may be impounded for discharge under control. Obviously water-powers directly benefited by such storage reservoirs may be of much greater value than other powers not so favoured. This should be taken into special consideration when water-powers are being classified according to their economic values.

In British Columbia there are a large number of lakes. Of the known lakes, 100 are above 10 square miles in area. Many of these lie in long narrow valleys, and may rather be regarded as river expansions, as for example, the Arrow lakes, where at high water, there is a perceptible current in the shallowest parts. A large proportion of the lake area is situated in what has been termed the Lake district, which, with the exception of Babine lake and some lakes of the head waters of the Morice river, is nearly all tributary to the Nechako river.

When the subject of storage reservoirs is under consideration it should not be forgotten that Nature stores her waters otherwise than in lakes and rivers. Forest floors, extensive areas covered with plant growth and the great swamps of the country, also glaciers and snowfields, each and all constitute valuable water reservoirs. In such reservoirs there is a widespread and satisfactory distribution of waters which enables Nature to yield her supplies gradually and as required. A discreet conservation and utilization of such reservoirs will generally be found much more desirable than are some of the artificially constructed reservoirs where the liability to accidental destruction of dams or other works is always more or less of a menace.

Governments have been bestowing increasing attention upon the investigation of inland water resources and, during recent years, Canada has made great advancement in this work. Such work is essential in order to acquaint parties with the possibilities of the powers with which they may be dealing.

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An Explanation of the Construction of Formulae

A Formula is Not a Mysterious Creation of Higher Mathematics, But Merely a Convenient and Simply Remembered Way of Stating the Rules of Procedure for Every-Day Problems

By T. H. FENNER, Associate Editor

ONE would think that a formula was self-explanatory, but it is surprising how many men use these things daily, without having any clear conception of the principles involved. Machinists, power plant men, and sometimes even draughtsmen, are content to take a set of letters and apply figures to them in the solving of everyday problems, not having any idea of how these combinations of letters have been derived, or what they stand for.

To begin with, a formula is simply a convenient means of stating a rule, which would be long and clumsy to write or remember in its original form. The derivation of this rule may be lost in the realms of higher mathematics, where none but the highest of highbrows may soar. That, however, does not prevent the average man from having an intelligent idea of the various factors contained in the formula, and their relation to one another. If the aforesaid average man had this knowledge he would not look so puzzled when a formula is presented to him in a slightly different guise to that with which he is familiar.

We have said that a formula is an abbreviated form of a rule, or statement. It is that, but it is also something more. It is a statement that the multiplication or division, subtraction, addition, or, perhaps, all four operations, on one set of factors, produces a result which is the expression of another factor. For instance a man wishes to know the size of spanner necessary to slack off a 3-4 hexagon nut. There is a rule for getting the size of the spanner across the jaws. The width of the spanner across the jaw must be equal to the diameter of the nut over the flats. Now this width is 1¼ inches, which is arrived at by taking the diameter of the bolt = ¾, adding to it half the diameter, and adding ⅛ inch. This rule applies to all nuts, so should be remembered. So to make it convenient we put it in the form of a formula thus: $D + \frac{1}{2} D + \frac{1}{8} = W$, or else

$\frac{3D}{2} + \frac{1}{8} = W$, which is more convenient. Better still is $1\frac{1}{2} D + \frac{1}{8} = W$. All these three expressions give the same result, and mean that when the indicated operations are performed on one side; the resulting figure is the size or quantity required. Thus the diameter of the bolt being ¾, D = ¾, so $(\frac{3}{4} \times \frac{3}{2}) + \frac{1}{8} = 1\frac{1}{4}$.

The Use of Signs

Perhaps to begin with, it is well to get a clear understanding of the various signs employed, to denote the different operations. Many men look askance at formulae, on account of signs being present in them that they have never before encountered. There is nothing to be afraid of for anyone who has mastered the rudiments of arithmetic in any of these characters. However, it is important that the operations be performed in exact accordance with the instructions conveyed by these signs, or results will be materially affected.

The commonest signs, of course, are the plus +, and minus —. Plus before a number means that that number is a positive quantity. A minus sign means that the number following is a negative quantity. Where several numbers are involved with these signs between them it means that the sum of all the negative quantities must be deducted from the sum of all the positive quantities. The result may be either positive or negative, and here is where the man with no knowledge of algebra may be puzzled. However, if he just casts his mind to a very familiar phenomenon of our winter climate he will understand it easily. If he looks at the thermometer on his way to work he may find it reads 15 below zero, or as it is usually printed, —15. By eight o'clock it has gone up to —10, and by 9 it has reached zero. At 10 it reads 5 above, or + 5, and stays there till 1 o'clock p.m. Then it comes down 5 degrees every hour, till at 5 o'clock p.m. it reads 20 below, or —20. Now, the average temperature for the 11 hours would be found by adding the reading at every hour and dividing by 11.

Now the sum will be $-15 + (-10) + 0 + 5 + 5 + 5 + 5 + 0 + (-5) + (-10) + (-15)$.

This will give $-55 + 20 = -35$

$\frac{-35}{11} = -3.18$, or an average temperature of slightly over 3 degrees below zero.

Now, if we imagine any other body or figure or scale beside the thermometer as having a positive value, a zero point, and a negative value, there will be no difficulty with the plus or minus.

The multiplication sign is occasionally a stumbling block to the novice, as, instead of using invariably the ×, the sign is omitted altogether, or a small dot, something like a decimal point, is used. Where the signs are omitted altogether is when a literary formula is used, but the dots are used between numbers. A figure before a bracket as 3(6x9), means that the product of 6x9 must be taken 3 times. Letters denoting values when placed together, as PLAN in the well-known formula for horse power, are read as P × L × A × N, and an expression like 323.4.64 would read 323 × 4 × 64. However, this latter method is not used very generally, either the × sign being used, or the sign omitted altogether.

The division sign is written in a variety of ways. The best known, of course, is the ÷ sign, which is the one we first become acquainted with. Then there is the line used as in fractional quantities, as $\frac{2}{4}$ which means that two is to be divided by four, or $\frac{8 \times 11}{6}$ which means that the product of 11 × 8 is to be divided by six. Again a line is sometimes used as 12/2, which means 12 is to be divided by 2.

These four are what might be called the cardinal signs. There are several others which must be made familiar to the eye, and their meaning to the memory, so that when they are encountered in formulae, there will be no difficulty in arriving at the correct solution.

Of these, the various forms of brackets are among the most important, and are often stumbling blocks to the tyro. Their meaning and the way in which they are used must be thoroughly understood, or correct solutions will be a matter of chance instead of certainty. Bracket signs are classified as follows: The parenthesis (), the bracket [], the brace $\left\{ \right\}$, and the vinculum ——. The generic term covering them all is " signs of aggregation ", and the meaning conveyed by any of them is that the numbers enclosed between them are to be simplified before any other operation is performed.

Take an expression such as $A = \frac{1}{2} (h + b)$, substitute figures for the letters, say, $A = \frac{1}{2} (3 + 5)$. This means that the sum of 3 and 5 multiplied by ½ will give the value symbolized by A. Take another: $4 + 6 (8 \times 4 + 5) - 2 = A$. Now, here is where a very important rule is illustrated, in connection with the multiplication sign. Two numbers connected together by a multiplication sign must be simplified before those connected by any other signs. In this case the solution step by step is, taking inside the brackets first, the product of 8 and 4, added to five, multiplied by 6, plus 4, —2.

The work is:

$4 + 6\ (8 \times 4 + 5) - 2 =$
$4 + 6\ (32 + 5) - 2 =$
$4 + 6 \times 37 - 2 =$
$4 + 222 - 2 =$
$226 - 2 = 224.$

Now, if the rule as to multiplying is not observed, the result will be entirely different. Suppose we were in simplifying the term in the brackets to add 4 and 5 before multiplying by 8, see what we should get.

The work would then be:

$4 + 6\ (8 \times 4 + 5) - 2 =$
$4 + 6\ (8 \times 9) - 2$
$4 + 6 \times 72 - 2$
$4 + 432 - 2$
$436 - 2 = 434.$

Now, when simplifying a formula in which several terms are bracketed, always simplify the terms in the inner brackets first.

Take the formula for finding the area of a segment of a circle, or rather one of the formulae, of which there are several.

$A = \frac{1}{2}\ [lr - c\ (r - h)]$

Substituting figures $A = \frac{1}{2}\ [8 \times 4 - 3\ (4 - 2)]$

Simplifying $A = \frac{1}{2}\ [8 + 4 - 3 \times 2]$
$= \frac{1}{2}\ [32 - 6]$
$= \frac{26}{2} = 13$

Take another a little more complicated, as follows:

$$x = 4\left\{3 + [6 \times 9 - (2 + 4 + 3 \div 3)]\right\}$$
$$x = 4\left\{+ [6 \times 9 - 3]\right\}$$
$$= 4\left\{3 + [54 - 3]\right\}$$
$$= 4\left\{3 + 51\right\}$$
$$= 4 \times 54$$
$$= 216$$

The rule to observe always is to simplify the expression in the innermost bracket first of all and when simplifying any expression to perform the indicated multiplication first, and the addition and subtraction afterwards. We have not dealt with the last sign of aggregation, the vinculum, because it is not used as a rule except in connection with the root or radical signs. We will consider these, and the index signs, and then give some examples of the use of the vinculum.

The radical and index signs are used when a number is to be reduced to a primary number, or root, from a higher power, or to be raised from a root to the higher power. The radical sign $\surd$ before a number indicates that the square root of that number is to be extracted. The sign with a small figure on the side indicates that the root corresponding to the number is to be taken. Thus $^3\surd$ indicates cube root, $^4\surd$ indicates fourth root, $^5\surd$ indicates fifth root and so on.

Conversely, the small or index figure placed above a number indicates that the number must be raised to the power indicated. Thus 2^2 indicates two taken two times, 2^3 indicates two taken three times, 2^4 means two taken four times, etc. Now sometimes an index may be seen like the following: $5^2/_3$. That means that the cube root of five squared is required, and could be written $^3\surd 5^2$.

There is no need to perform the actual arithmetical operations, for there are tables published which save all that labor. All one would need to do would be to turn up the table, see the square of 5=25, and the cube root of 25=2.924, etc. Now the vinculum is used when the root of several numbers is required. For instance $^3\surd(8x9) - 7x6$ means that the cube root of the product of 8x9 minus the product of 7x6 is to be taken. Take the formula for the approximate operimeter of an ellipse, which is

$$P = \frac{\pi\surd D^2 + d^2}{2} - \frac{(D - d)^2}{8.8}$$

That is a good example of the use of the vinculum, the bracket, and the index figure, coupled with the use of a sign which is met with almost constantly. That is the Greek letter π, pronounced pi, and used to denote the figure with which the diameter of a circle must be multiplied in order to find the circumference. This is a constant quantity 3.14159, commonly written as 3.1416, or if expressed in fractions as $\frac{22}{7}$, which is not so accurate, and therefore less used. In a circle of diameter d, the circumference is πd, or $2\pi r$, where r is the radius.

There are several other Greek letters in common use by mathematicians, which cause the ordinary man to throw up his hands and retire when met with. However, there is no end of this. They are merely used as symbols and are no more mysterious than the ordinary Arabic figures.

For instance, there is the Greek letter Θ, pronounced theta. This is nearly always used to denote an angle. For instance, if we are engaged in solving some problem which involves an angle of 35 degrees, instead of writing this in full every time we came across it, the letter Θ would be employed. If we have more than one angle another Greek letter is employed for the second angle, the letter Φ, pronounced phi. Many other Greek letters are used, but probably these are sufficient for the time being. All the writer wants to show is that there is no need to look upon a formula as being unworkable because some of the signs are not familiar.

As to the derivation of formulae, the full understanding of these often entails a knowledge of first principles beyond the ken of the non-mathematical. However, many of the every-day formulae in use by machinists, power house men, etc., are easily traced back to their beginning, and it is useful practice to get in the way of doing this. It helps a man to known why a thing is, in addition to knowing that it is. The mental stimulus obtained by reasoning things out is also a benefit. For instance, many machinists know that the speed of the last shaft on a train of gears is equal to the speed of the first shaft multiplied by the diameter of all the drivers and divided by all the followers. Why should it be? Suppose we have a line shaft running 240 revs. We have a 12-inch pulley driving a 24 on the second shaft, and a 10-inch from that driving a 25 on the third shaft, and a 6-inch driving a 12-inch on a fourth shaft. Let a, b, c represent drivers and d, e, f the followers. Then

$\frac{a, b, c}{d, e, f} \times 240$ will be speed of the last shaft. That is $\frac{12x10x\ 6}{24x25x12} \times 240 = 24.$

That formula is simply a statement of the ratio of the first speed to the last as can be seen by taking each shaft separately. The first shaft goes 240 revs. The ratio of the gear on the first shaft to that on the second 12:24 or 1:2. The second shaft, therefore, goes $\frac{240}{2} = 120.$ The second ratio is 10:25 or 1:2½. Therefore the third shaft goes $\frac{120}{2\frac{1}{2}} = \frac{240}{5}$ = 48. The last ratio is 6:12 or 1:2. That gives $\frac{48}{2} = 24$ as the final speed. Now the ratio is 24:240 or 1 to 10 for the whole range. The first ratio was 1:2, the second 1:2½ and the third 1:2. Multiply these together, 2x2½x2, gives 10. Is it plain now why all the followers divided into all the drivers give the required speed? The same rule applies to the change gears on the head of a lathe. The diameter of the gear on the driving spindle bears a certain relation to the driven gear on the stud. The driver on the stud bears a definite relation to the driven on the lead screw. How is this expressed? Let the spindle driver be called "A," the driven gear on stud "C," the driver on stud "F," the driven on lead screw "D". The lead screw has "G" threads to the inch. The number of threads to be cut are "N."

Clearly, the threads cut per inch will depend on the ratio of "A" to "C" and "F" to "D." The other factor will be the pitch of the lead screw. Now if we have a gear on the spindle with 21 teeth, and the driver "F" on the stud has 60 teeth, while the driven gear "C" on the stud has 42 teeth, the driven gear "D" on the lead screw 72 teeth, we can find the ratio of the lead screw speed to spindle speed. Thus $\frac{42x72}{21x60} = \frac{12}{5}$. That is a ratio of 2 2/5 to 1, so that for every five revolutions of the lead screw we get 12 revolutions of the job. Now if the lead screw has five threads to the inch the cutting tool will travel one inch along the job while the leading screw turns five times. But while this has taken place the job has turned 12 times, thus cutting 12 threads to the inch. All this

is expressed by the formula $n = \frac{c \times h \times g}{a \times f}$.

The next time you have to cut a thread see if you can realize the relation of the spindle speed to the threads cut on the job.

Take the good old formula for horse-power, so familiar to most power house men. Horse-power is a rate of doing work. Work is force, multiplied by displacement. The steam pressure is the force and the piston speed is the displacement. Work is measured in foot pounds, horse-power in foot pounds per minute. Hence the piston speed per minute multiplied by average mean pressure is work in foot pounds and divided by 33,000 is horse-power. Thus

$$\frac{PLAN}{33{,}000} = H.P.$$

we get the familiar Now if we saw it written C P = I.H.P. it might cause wonder, but just think. In an automatic cut-off stationary engine, the only variable is the pressure. If we take the stroke cylinder area and number of strokes and multiply them together, and divide by 33,000, we get a decimal quotient, which has only to be multiplied by the pressure to give the required horse-power. Surely, a time-saver.

There is nothing new in this article to many of us, but to quite a few who have been discouraged from pursuing a line of study through encountering a strange formula, it may serve to lighten an otherwise dark spot.

The Canadian Engineering Standards Association

IT IS not generally known that we have in Canada an association known as the Canadian Engineering Standards Association.

The Purpose of the Association

The Canadian Engineering Standards Association was formed in 1919 with the object of carrying out in Canada, for the benefit of Canadian industry, work similar to that done in England by the British Engineering Standards Association, which has proved of such great industrial value. The Canadian Engineering Standards Association is not a Government institution, although it is recognized by the Canadian Government. The members, who serve on its committees gratuitously, are qualified by their technical and industrial standing to represent the interests of manufacturers, engineers and users, and are nominated by such bodies as the Canadian Manufacturers' Association, the Canadian Mining Institute, the Engineering Institute of Canada, the engineering schools of the universities, the railway services, important industrial firms and the great purchasing departments of the Canadian Government.

The association has now been incorporated by Dominion charter.

The association is supported by contributions from the technical and industrial societies interested, as well as from individual firms, and these are supplemented by a grant from the Dominion Government.

Method of Work

When a request or suggestion is received from some responsible firm or person to the effect that the formulation or revision of a Canadian standard is desirable, the association confers with the various interests likely to be affected by the establishment of such a standard, and arranges for the organization of a committee to consider the matter. This committee includes representatives of the producers and users of the standard in question together with such technical advisers as may be considered desirable. The selection of such a working committee is accomplished through the proper sectional committee of the association under the chairmanship of a member of the association. If the committee so formed recommends the adoption or modification of a standard, its findings are reviewed by the association, the main committee of which must be thoroughly satisfied that full consideration has been given to the subject before it authorizes publication by the association.

The actual discussions as regards technical details are thus carried out by specially chosen representatives of the manufacturers and purchasers, and the various interests, whether of the producer, the user, or the engineer, are safeguarded, since all these parties have a voice in the decisions reached. In this way it is clear that before a report, defining a Canadian standard is issued or modified, the effective approval of all concerned will have been obtained.

The services of the various sectional and sub-committees are of course available for the periodic revision of their reports, this being necessary in order to avoid any risk of retaining a standard in use after improvements or changes of practice have rendered it obsolete in any respect.

There is reason to believe that the success of the work done by the British Engineering Standards Association in the past has been largely due to the careful way in which its main committee has reviewed the work of its various sectional and other committees.

The C.E.S.A. standard specifications will, as a rule, contain simply the technical clauses necessary for the purchase of the product to which the specification relates, together with such tables and diagrams as may be required for their explanation.

Meaning of Standardization

In order to avoid misunderstanding it may be pointed out that the term "standardization" refers primarily to the preparation of such designs, dimensions or specifications in industrial, manufacturing, or construction work as will be generally accepted and worked to by all concerned. In the case, for instance, of a machine component, if its principal dimensions and characteristics are standardized, the number of types or patterns to be made or kept in stock commercially is at once reduced, lessening accordingly the cost of manufacture and handling, with corresponding saving and convenience to users.

An example of economy attained in this manner would be afforded if the various Canadian railway administrations would agree with the steel makers to adopt a standard Canadian section and specification for rails and track fastenings. This action would not only reduce the number of different rolls to be cut and used by the rail mills, but would enable material to be rolled for stock direct from the billets at less cost and with a certainty that they would be acceptable to any railway. The railways would simplify their practice, avoiding the use of rails and fastenings differing in form and material only in comparatively unimportant details, and would benefit by the higher and more uniform quality of the product. Some progress towards this desirable result has already been made.

Similar opportunities for substantial saving in the cost of manufactured products and for protecting the interests of the user now occur in many other Canadian manufacturing industries wherever articles and materials may be so standardized by common agreement between the producer and user as to permit their production in economical quantities while still satisfying the requirements of the purchasers. No organization has hitherto existed in Canada for bringing these various interests together and inducing them to agree on a mutually satisfactory design or specification.

The Canadian Engineering Standards Association, like the British Engineering Standards Association, does not as a body decide upon the details of its standards, but organizes and reviews the findings of a representative committee for each particular standard suggested, thus insuring that all interests are properly considered and making certain that any recommended standard has been carefully investigated before it is issued. No standard that is not based on mutual agreement arrived at in this manner is likely to receive general endorsement and adoption.

Since the commencement of their activities three months ago, great progress has been made.

Requests for action have been received and committees have been formed, or are in process of formation, dealing with the following subjects: Aircraft parts, electrical work, rails and track, wire rope, steel bridges and construction, with the view of obtaining agreement on Canadian specifications or standards which will be acceptable to all concerned.

In this work, consideration will of course first be given to any existing specifications or standards which have proved satisfactory in Canada, Great Britain, and the United States for similar work.

This association has been requested by the British Engineering Standards Association (the corresponding organization in Great Britain) to undertake the distribution of its publications in Canada, and for this purpose has been furnished with most of the reports of the British Engineering Standards Association. The list to follow does not include all the publications of the British Engineering Standards Association, but covers those of most recent issue. Copies are for sale at the prices stated.

Report No. C L 3750. "Interim Memorandum on French Metric Screw Threads for Aircraft Purposes," 15c net.

Report No. 10-1904. Revised July, 1918. "British Standard Tables of Pipe Flanges," 25c net.

Report No. 15-1912. Revised August, 1912. "British Standard Specification for Structural Steel for Bridges, etc., and General Building Construction," 25c net.

Report No. 21-1909. Revised November, 1909. "Report on British Standard Pipe Threads for Iron or Steel Pipes and Tubes," 25c net.

Report No. 37-1919. Revised January, 1919. "British Standard Specification for Electricity Meters," 25c net.

Report No. 41-1908. "British Standard Specification for Cast Iron Spigot and Socket Flue or Smoke Pipes," 25c net.

Report No. 44-1909. "British Standard Specification for Cast Iron Pipes for Hydraulic Power," 25c net.

Report No. 45-1917. Revised September, 1917. "Report on British Standard Dimensions for Sparking Plugs for Internal Combustion Engines," 25c net.

Report No. 46-1909. "British Standard Specifications for Keys and Keyways," 25c net.

Report No. 63-1913. "British Standard Specifications for Sizes of Broken Stone and Chippings," 25c net.

Report No. 65-1914. "British Standard Specification for Salt-Glazed Ware Pipes," 25c net.

Report No. 71-1917. "Report on British Standard Dimensions of Wheel Rims and Tyre Bands for Solid Rubber Tyres for Automobiles," 25c net.

Report No. 72-1917. Revised September, 1917. "British Standard Rules for Electrical Machinery." (Excluding motors for traction purposes), 25c.

Report No. 74-1917. Revised September, 1917. "British Standard Specification for Charging Plug and Socket for Vehicles Propelled by Electric Secondary Batteries," 25c net.

Report No. 75-1916. "British Standard Specifications for Wrought Steel for Automobiles," 25c net.

Report No. 76-1916. "British Standard Nomenclature of Tars, Pitches, Bitumens and Asphalts When Used for Road Purposes and British Standard Specification for Tar and Pitch for Road Purposes," 25c net.

Report No. 82-1919. "British Standard Specification for Starters for Electric Motors." (Face-plate type), 25c net.

Report No. 84-1918. "Report on British Standard Fine (B.S.F.) Screw Threads and Their Tolerances," 25c net.

Report No. 88-1919. "British Standard Specification for Electric Cut-Outs for Low Pressure, Type O," 25c net.

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Heat Value of Coal Determined by Ash Content

A Definite Relation Can be Established, for Coals of the Same Composition, Between the Ash Content and Heat Value. This Article is Published Through the Courtesy of "Combustion"

By FRANK G. PHILO

COALS having a fairly constant ratio of the various combustible constituents such as carbon, sulphur, and volatile, show quite a definite relation between ash content and heating value. Tabulation of several hundred coal analyses has shown, however, that the heating value of most coals decreases in a somewhat greater proportion than might be expected from the ash contents. This is usually due to the impurities external to the coal particles themselves, such as pyrites, bits of various rocks, etc. Pyrites, for instance, contains sulphur which, although combustible, has a very low heating value as compared with carbon. Carbonate rocks such as limestone, upon being heated, give off CO_2 which would indicate as combustible, but have no heating value.

The above references to pyrites, etc., are only made to indicate roughly why the heating value of coals decreases in a slightly greater proportion than would be expected from the increase in ash. No attempt is here made to go into the chemical side of coal analysis as the following data treats coal purely as a mechanical mixture of combustible and ash.

Some advantages of using ash content as an indication of heating value are: (1) Less laboratory equipment required, (2) less time required for the test, (3) several samples can be analyzed simultaneously, (4) less skill required on the part of the tester to do accurate work.

The writer does not advise against the use of the calorimeter for work of a very accurate character, such as boiler trials, etc. However, the ash "content" method of calculating heating value has

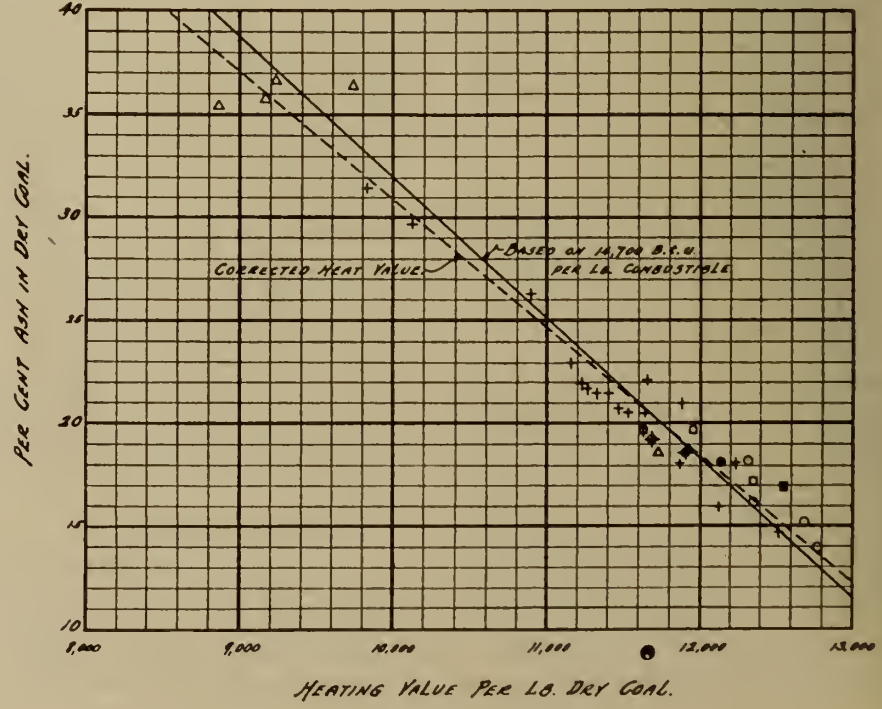


CHART NO. 1

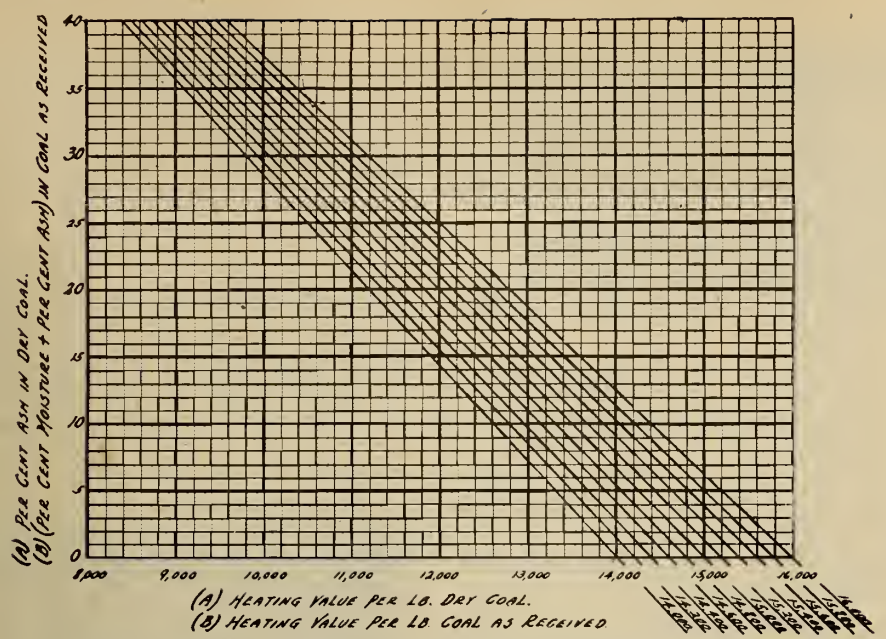


CHART NO. 2.—SHOWING RELATIONS BETWEEN PER CENT. DRY ASH AND HEATING VALUE OF COAL

proved in practice the most desirable for the operating engineer. For instance, a number of cars of coal have been delivered and are awaiting unloading. Which shall be delivered to the bunkers and which delivered to the storage yard (to which the best coal should go to cut down handling costs)? Samples are properly taken, and within a fraction of the time required by calorimeter, the ash content is determined, heating value calculated, and disposition of the cars of coal is under way.

In a station operated by the writer, the ash determination is made on each barge or car of coal before unloading. In the past year several possible interruptions of service were avoided by locating among a number of barges of coal, several barges which had an ash content of 35 to 38 per cent. These barges were consequently pigeon-holed till periods of light load and then used.

The coals shown as points on Chart 1 are No. 3 Buckwheat taken at random from deliveries from the various districts of the anthracite field. All are Pennsylvania coals. The solid line is the line of constant heating value per pound combustible, which for anthracite averages 14,700 B.t.u. per pound. The broken line is the line of actual combustible heating value, the difference between the two lines being caused by sulphur, etc., as stated above.

Having a number of coal analyses and heating value determinations by calorimeter, a similar chart may be constructed for any coal, care being taken to have all coals shown of the same class. Having the heating value per pound combustible for any class of coal, the heating value corresponding to any per cent. ash may also be determined from Chart 2.

The accompanying table and formulas may be used, if desired, in place of Chart 1.

Factors for Heating Value Determinations of Anthracite Coal

Per cent. Dry Ash	Factor	Per cent. Dry Ash	Factor
10	1.015	26	.991
11	1.014	27	.989
12	1.012	28	.988
13	1.011	29	.986
14	1.009	30	.985
15	1.008	31	.983
16	1.006	32	.982
17	1.005	33	.980
18	1.003	34	.979
19	1.002	35	.977
20	1.000	36	.975
21	.999	37	.974
22	.997	38	.972
23	.995	39	.971
24	.994	40	.969
25	.992	..	...

Heating value per lb. dry coal = HVDC.

HVDC = Factor [(100 — Dry Ash) × 147].

Heating Value per lb. coal as received = HVWC.

HVWC = B.t.u. per lb. dry coal (100 — Moisture in coal as received).

As can be seen from Chart No. 1, the use of the factor is not important for coals whose ash contents lie between 10 per cent. and 25 per cent.

Eliminating the factor: HVDC = (100 — Dry Ash) × 147.

HVWC = HVDC (100 — Moisture).

The manufacture of nitrates by the fixation of atmospheric nitrogen is rapidly becoming a world industry. In this the Japanese are keeping in line with American and European enterprise. D. Takamine has, it is said, purchased, on behalf of Japan, the American modification of the Haber process. It is intended to instal a plant to use this process for the production of synthetic ammonia. The Japanese Government has provided means for the building and maintenance, in a suburb of Tokio, of an experimental laboratory for research concerning the conditions of the fixation of nitrogen.

WATERPOWERS OF BR. COLUMBIA

(Continued from page 558)

A number of factors, such as character of use, uniformity of flow, the making of but partial development in a manner prejudicial to future complete utilization, failure rightly to differentiate between primary power and secondary power, etc., etc., have been noted and attention drawn to the necessity for reckoning with such factors.

Hydrometric data extending over a sufficient period of time should be available, and conclusions involving important procedure should not be predicted upon scattered and insufficient records. Topographic maps should also be available.

Those interested from the standpoint of the investor may let the expenditure of ordinary effort place themselves in a position, independently, to check and form a judgment respecting some of the basic engineering factors involved in any power project under consideration.

Failure rightly to assemble or interpret essential physical data has been responsible for many serious failures, and has resulted in great financial loss.

No reliance should be placed upon general statements setting forth the existence of vast undeveloped waterpowers. The total amount of waterpower capable of economic development is much less than popularly assumed and most of the valuable sites are already under development or control by various interests. Attention has been directed to the concentration of control of waterpowers as proceeding rapidly in the United States, and the need has been pointed out that those interested in the conservation of our water-powers should be alert to see that the same menace to public welfare does not operate in Canada. Much of this concentration of control has taken place during a time when general statements representing the existence of large reserves of potential water-power were being presented to the attention of the public and were receiv- general acceptance.

The importance of storage has been pointed out, and the possibilities of storage causing damage to riparian owners has been emphasized. Government provision for a flowage easement along the shores of the lakes and rivers would, to some extent, protect settlers against loss, and would protect the government itself against claim for damage by overflow.

Many of the features touched upon have been safeguarded in the comprehensive water legislation of the province of British Columbia—a subject dealt with in the following chapter.

SULPHUR IN COAL

The University of Illinois have issued bulletin No. 111 on "A Study of the Forms in Which Sulphur Occurs in Coal." This publication deals with the different forms in which the sulphur is formed and the method by means of which the values can be estimated.

Heating System in a Montreal Church

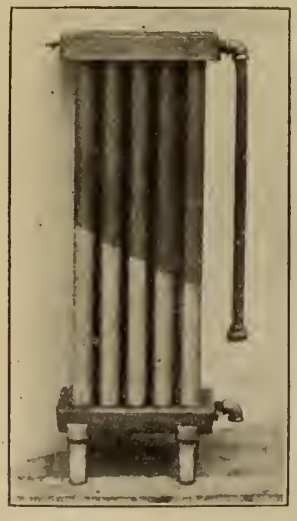
A Description of the Design and Operation of a New Type of Heating System. Rapid Circulation and Low Volume of Water Result in Economical Operation

By J. H. RODGERS

THE Montreal General Tool Company, of Montreal, has secured the contract for the heating of the new church of St. Augustine, at Notre Dame de Grace. As this is the first installation, on a large scale, of this particular method of heating, a brief description of its design and operation may be of interest.

Owing to the severe climate conditions in this section of the country, during the winter months, the heating of houses, offices, factories and other buildings, is very often a problem of no mean magnitude. Hot water and steam heating are the systems most generally adopted, but despite the recognized efficiency of these two methods, there are still many weak points that engineers are continually striving to overcome.

Some sixty years ago the first installation of a modern hot water heating system was installed, and since that time little change has been effected in the general fundamental principles of hot water heating. With the possible exception of the Honeywell method, which utilizes mercury as a medium for increasing the water circulation, no adequate system has been devised to add materially to the efficiency of existing systems. The elementary essential of successful hot water heating is to minimize the quantity of water passing through the system, and by so doing, reduce the consumption of coal, or other fuel, and thereby increase the boiler efficiency and economy. In many so-called modern systems the movement of the water through the pipes and radiators, is very sluggish, owing to the large body of water contained in the system, and it is generally understood that water at rest is a poor absorber of heat, but when in motion has a large capacity for carrying heat.



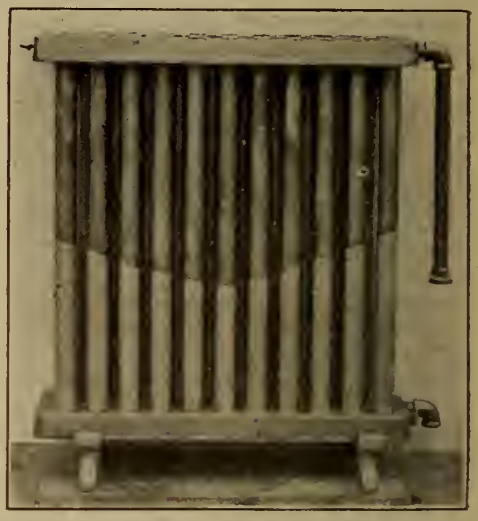
SMALL RADIATOR OF THE NEW TYPE

Working on the assumption that a water heating apparatus containing a small quantity of water, circulating rapidly, would be the most effective and economical, J. E. M. Brissette, of Montreal, has developed a type of radiator that reduces the volume of water therein to about one-quarter of that contained in the ordinary system, and at the same time adds about 75 per cent. to the radiating surface. This system is known as the "Victory" Water Heating System, and the ratio of the circulation to that of the ordinary system is practically 8 to 1, in other words the water in the Victory system circulates eight times through the system while the water in another system is passing once through the piping and radiators. By increasing the velocity of the water through the system it is changed much oftener over the heated surfaces of the boiler plates or tubes; therefore, the B.t.u. contained in the coal, or other fuel, is transmitted through the metal and more rapidly absorbed by the moving water, thus minimizing the loss of heat by excess gases passing up the stack.

The inventor of the "Victory" system of hot water heating, claims to have hit upon the most effective means of utilizing the heat units in the hot water for general heating purposes. The principle of the radiator design is to reduce the volume of water passing through the system and at the same time increase the heating surface exposed to the atmosphere. The heat distributed by the outside pipes is similar to that of the ordinary method, but the additional heating surface obtained by the use of the inner tubes, adds considerably to the effective distribution of the heat. Unlike the piping used in the ordinary systems, the seamless steel tubing used in the Victory radiators is very thin, reducing the amount of metal to be heated, thus developing heat more rapidly and more intense. Owing to the small water space between the inner and the outer tubes, the volume of the water in the system is considerably less than in many others, so that the more rapid transfer of heat, from the water to the atmosphere, causes a corresponding increase in the water circulation.

The efficiency of any radiator is its ability to waste heat; in other words, the more rapidly the temperature of the water in the system is reduced, the more effective the radiator will be, and consequently more economical.

The construction of the radiator is shown in the line drawing herewith. The size of the unit will vary to suit the conditions under which it is installed, but the general design is similar in every case. The cast iron heads are so proportioned that circulation is uniformly maintained in each and every vertical radiating pipe, and owing to the small space between the inner and the outer tubes, the film of water is very easily heated, and the movement of the water, due to the temperature change, is much more rapid than in the ordinary system. The cast iron headers (top and bottom), are made to conform to specific conditions, but the tubes are of uniform size, 1 inch and 1¼ inches, for inner and outer respectively, the lengths being made to suit the different heights required. These tubes are expanded in holes in the headers, which are previously drilled and reamed to the size desired.

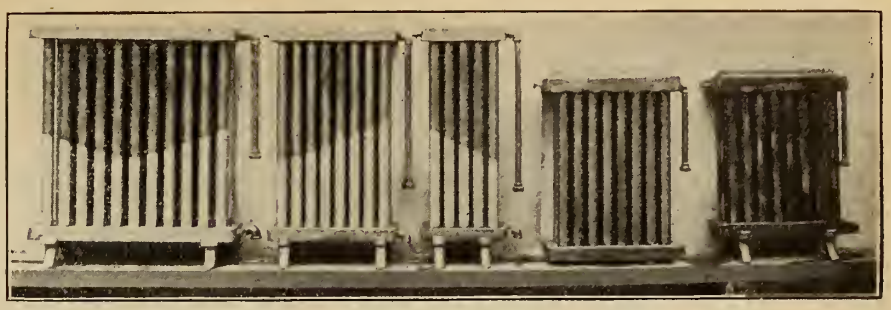


LARGE RADIATOR

The heating of the St. Augustine Church calls for 20,000 feet of radiation, and the volume of water in the entire system will be 180 gallons. For a similar radiation on other systems, the approximate quantity of water would be close to 1,800 gallons. The water in the system will circulate completely through the system, at normal heating temperature, every 15 minutes, while the larger body of water in the ordinary way would require about two hours.

Another interesting feature in connection with this particular installation will be the use of a 50 h.p. Talbot boiler, oil fired, and adapted for gravity circula-

tion. Under ordinary conditions this type of boiler operates on the contra-flow principle, but owing to the absence of forced circulation, the change to the natural method was found advisable. The Montreal General Tool Co. do not propose engaging in the heating business, their intention being to manufacture these radiators for the trade. This initial installation is solely for practical demonstration of the system on a large scale.



A GROUP OF VICTORY RADIATORS

SOME ELEMENTS OF ECONOMY IN THE BOILER ROOM

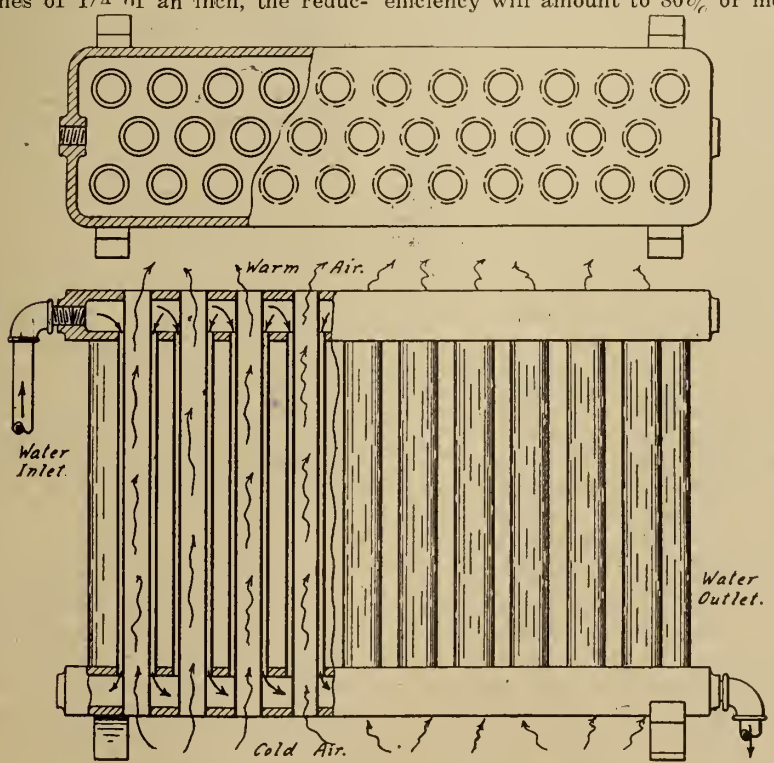
By F. A. McLean

Many a boiler is condemned and thrown out of service long before its useful life would have been ended had it been properly cared for and a few simple steps taken to keep it in good condition. Too often the fires are pulled and the water blown out of the boiler while the brick work is still hot, with the almost inevitable result that the tubes are soon buckled or split.

In many plants it is customary to scale the boilers at stated intervals of every six months or more, and while in some cases this may be all right, in the majority of instances it is not, and it would therefore be better to inspect the boilers frequently and have them cleaned as often as it seems necessary, whether it be three days or three months, instead of waiting until it is an absolute necessity. Many men do not realize the importance of keeping the tubes free from scale, but when one stops to consider that a layer of scale 1/64 of an inch thick will reduce the efficiency of the boiler 5%, while if this allowed to reach a thicknes of 1/4 of an inch, the reduction in efficiency will reach as much as 86% or more, it is readily apparent that the prevention and removal of this scale is a subject worthy of very careful attention.

There are on the market at present a number of chemical compounds which are of considerable value in preventing the formation of scale, as well as several sizes and types of scaling equipment designed for operation on steam or compressed air, the respective merits of which are well worth looking into. Sometimes a boiler is thrown into the discard or sold at a sacrifice, on the ground that it has not sufficient capacity to do the work required of it, when if it was thoroughly cleaned it would be plenty large enough for the work in hand.

With the high cost of fuel which prevails at the present time, it seems well to remember that the output of the boilers will be reduced about 9½% by a layer of soot on the heating surfaces 1/32 of an inch thick and where this is allowed to gather until it reaches a thickness of 1/4 of an inch, the reduction in efficiency will amount to 80% or more.



CONSTRUCTION OF NEW TYPE OF RADIATOR

In most plants steam is used for blowing out the boilers, and the water of condensation makes this a nasty job, and at the same time the heat of the steam makes the hose hard to hold, which probably accounts for the fact that the men in charge of the boilers do not feel inclined to clean the boilers as often as they should. Where compressed air at a presure of 80 to 100 pounds per square inch is available, it will be found of particular value for this class of work and, at the same time, it provides a ready source of power for the operation of mechanical tube scaling equipment.

Where automatic stokers are installed, it sometimes happens that they are not in as close harmony with the rest of the plant as they should be, due to the installation of a type of stoker which is either too large or too small for the boilers in use, or one which is not adapted to handling the kind of fuel available. When properly installed, the automatic stoker is a very useful piece of power plant equipment, but it is well to remember that a style which works very well with a certain type of boiler and fuel, may be a failure when used on another type of boiler, or with a different grade of fuel, and care should be taken to see that the stoker is not like the whistle on Mark Twain's steamboat, which caused the boat to stop every time it was blown.

In some plants a considerable amount of heat is lost through cracks in the brick work of the boiler setting, and it is therefore a good plan to see that this is as tight as possible. When properly fitted, dampers will often save as much as 25% of the heat which would otherwise be wasted. Some husky firemen pride themselves on the amount of coal they can shovel per hour, rather than on the amount of steam they can produce per ton of coal consumed per hour. Generally speaking, it is better to fire a little at a time instead of by fits and starts. It is interesting to note that one of the large automatic stoker manufactures in the United States estimates that fully 80% of the boiler plants of the country are overloaded, either through ignorance, or by the addition of equipment which was not thought of at the time the installation was made. This is false economy, and is not fair to the builder of the boiler. When the boilers are purchased, it is well to provide a little leeway to take care of any additions to the plant which may seem necessary at some time in the future.

The Keeping of Books in the Power Plant—I

The Subject of Accurate Cost Records is of Much Importance in Power Plant Economy. To be of Use They Must be Consulted in an Intelligent Manner and Carefully Compiled in the First Case

By ROBERT JUNE

ITEMIZED records of plant equipment, plant performance, and costs of operation, are of vital importance in the operation of all power plants if the most economical results are to be obtained. It should go without saying, but unfortunately does not in many cases, that records are of no value merely as records. If they are simply compiled and filed away without ever being consulted they are worse than useless.

Records are of value for two purposes:

(a) To give the management comparative data on the performance of a power plant from time to time so that it will be possible to tell just what power is costing.

(b) To place information in the hands of the chief engineer and his principal assistants, which will enable them to cut production and maintenance costs and to choose additional equipment when required, wisely.

The records to be kept may be divided into the following general classifications:

1. Permanent specifications of all equipment.
2. Record of load demands.
3. Costs of operation.

Taking up the first of these, it is probably safe to say that with only a very small percentage of power plants are proper permanent specifications of equipment kept on file. Yet the value of these will hardly be gainsaid by any operating man who has ever had to make repairs quickly or who has been called upon for advice in connection with power plant extensions. Probably the best system to employ is that of maintaining tabulated specifications on a series of large cards kept in a permanent index, but it is just as practical to record the data in a good-sized book, if that seems the more desirable. As typical of the statistics that should be maintained, the following are examples of boilers, feed-pumps and soot blowers:

Specification Data—Boilers

Make of boiler, Stirling.	
Total number in plant	6
Shop numbers	..
Date of installation:	
2	October, 1909
2	March, 1913
1	January, 1917
1	January, 1917
Weight of boilers	63,500 lbs.
Cost of boiler and fittings:	
2	$11,200.00
2	12,300.00
2	16,400.00
Cost of foundation and setting:	
2	$3,200.00
2	3,650.00
2	4,225.00
Rated horsepower	412
Steam pressure gauge	200
Safety valve pressure	210
Type of safety valve	(two) Pop.
Heating surface, sq. ft.	3,800
Superheating surface, sq. ft.	300
Number of steam drums, 3	36 in.
Diameter of safety valve	4 in.
Diameter of steam nozzle	10 in.
Diameter of feed pipe	2 in.
Diameter of blow-off	2½ in.
Type of stoker	B. & W. Chain Grate
Temperature of feed water	200° F.
Number of tubes	363
Diameter of tubes	3¼ in.
Length of tubes	13 to 15 ft.
Steam space	112 cu. ft.
Water space	700 cu. ft.
Draft	mechanical
Maximum draft	3 in.
Height of setting	18 ft. 2 in.
Length of setting	17 ft. 8 in.
Width of setting	16 ft. 4 in.
Thickness of walls, side	20 in.
Thickness of walls, back	15 in.
Number of fire bricks	6,860
Number of common bricks	22,400
Distance between batteries	4 ft. 6 in.
Distance from back of boiler to wall	15 ft.
Distance from front of boiler to wall	14 ft. 2 in.

Specification Data—Feed Pumps

Make of pump	Goulds
Number in plant	Three
Overall dimensions	3 x 4 x 12 ft.
Cost of installation—	
One	$1,125.00
One	1,250.00
One	1,490.00
Displacement per stroke	56/100 cu. ft.
Strokes per minute	12
Steam pressure	200 lbs.
Back pressure	½ lb.
Diameter steam cylinder	16 in.
Diameter water cylinder	10 in.
Stroke	12 in.
Diameter of suction	8 in.
Diameter of discharge	5 in.
Diameter of steam pipe	2 in.
Diameter of exhaust	4 in.
Diameter of steam drips	½ in.
Diameter of water drains	½ in.
Discharge head, lb. per sq. in.	175
Temperature of feed water	200
Pounds of water per minute	
Pounds of water per 24 hours	
Type of piston packing	
Kind of rod packing	soft
Size of rod	⅝ in.

Specification Data—Soot Blowers

Make of blower	Diarmond
Cost of installation	$720.00
Date installed	June, 1917
Type	Model "G," Revolving
Number of calorized units	3
Number of plain units	3
Type of header	Vertical
Diameter of header	2 in.
Diameter of risers	1½ in.
Make of valves	Hancock
Diameter of drains	½ in.
Location of units	see blueprint 2-395 & 2-405
Diameter of nozzles	5/16 in.
Type of nozzle	Venturi

The above records, while apparently very complete, could probably be supplemented with additional data. It has seemed desirable to give them in detail in order to illustrate the importance of maintaining such specifications as it must be evident from an examination of them that if such records are maintained on file a great deal of valuable time can be saved when it is necessary to look up points in connection with any of the equipment. Among the records of this sort to be kept are the number and type of the various motors installed about the plant; the number and size of lights; the dimensions of buildings to be heated; the amount of radiation installed for heating purposes; the number and diameter of live steam mains leading to points where steam is used in manufacturing processes, etc.

Operational Records

In previous articles we have discussed the use and the value of various measuring and recording instruments in the power plant. The records which these instruments give bear the same relation to the power plant as the accounting system does to manufacturing operations of the main plant. It is only by tabulating and studying them that improvements in economy can be effected.

Unfortunately, it is not as easy to lay out a system of records for a power plant with the same facility with which an accounting system can be laid out for a business. Everything depends upon the size of the plant and the conditions under which it operates.

With large central stations, permanent recording instruments can be installed, showing the steam flow, flue gas temperatures, CO_2, pounds of coal per minute, pounds of feed-water per minute, etc. With such records, it is extremely easy to detect errors in operational methods, and correct them.

With a small plant, however, the cost of these devices may be prohibitive. Generally speaking, however, the small power plants of the country are inadequately supplied with measuring and recording devices, and every effort should be made to rectify this condition. Improvements in operating conditions are only possible with fairly accurate knowledge of the actual conditions obtaining in the plant.

Therefore, if you are the owner or manager of a medium-sized or small power plant, see that your operating men are supplied with at least some of the fundamental instruments.

Even if they only take CO_2 and flue temperature records at intervals, they will do better work and will cut the costs of production because the instrument will tell them where "they are at."

It is very stimulating to have performance records before them, but these are of no value if they are filed without being studied. The oftener readings are taken the better. Monthly and yearly averages are not enough Daily, and even hourly, records are absolutely essential for maximum economy. Only by an intelligent analysis of daily records may the various losses be reduced to a minimum.

Load and Demand Factors

The average daily, monthly and yearly load and demand factors of every power plant should be plotted and posted where they may be conveniently studied by the operating force. The load factor is, of course, the ratio of the actual output for the period covered to the rated capacity. In order to avoid

any confusion regarding the term "rated capacity," it should be taken as the maximum load which the prime mover can sustain continuously for twenty-four hours every day without overheating. To secure the greatest return on the investment in the power equipment, the thing desired in any power plant is a high load factor, not only daily, but weekly, monthly and yearly. If this is secured, all the factors which go to make up the cost of power should be operating at maximum economy. Low average loads and high peak loads and seasonal fluctuation in power requirements, necessitate large pieces of equipment which are but little used and therefore greatly increase the fixed charges.

Where conditions of fluctuating load exist in a manufacturing plant it will often prove economical to operate only as many boilers and prime movers as may take care of the normal steady load, and to buy additional power required from the central station. This condition should be carefully studied by every operator of isolated plants.

The demand factor is the ratio of the maximum demand of all the various types of equipment to the connected load. One of the commonest mistakes made in industrial plant practices is to overestimate the maximum demands resulting from the probable use of a large part of the equipment at the same time.

Thus, if a plant has a 1,000 h.p. of motors installed, the management might assume that a prime mover capable of supplying current to operate 800 to 900, or even 1,000 h.p. would be required, whereas a 60 per cent. load factor which would only require a prime mover capable of developing 600 h.p. is the general average in industrial plants. Of course, conditions vary in different plants, but before installing a large number of boilers and prime movers to supply theoretical demands, actual demand factors for the plant should be determined as accurately as possible. This is an extremely important point as it is very uneconomical to assume that because certain h.p. of motors is installed that an equal number of prime movers is required.

Cost of Power

In two power plants, built to exactly the same specifications, that is, with the same number and make of boilers, prime movers, etc., the cost of power may, and does, vary considerably. Every plant requires individual study. Among the factors to be taken into consideration are size of plant, load factor, load variations, ratio of maximum load to economical full load, number of hours a day the plant operates, cost of fuel, oil, waste, repairs, labor, insurance, taxes, maintenance, depreciation, management, and overhead.

In determining the costs in any plant, the first items to be arrived at are the fixed charges, that is, those items of expense which do not expand and contract with the output. Insurance, taxes, interest, and to a certain extent depreciation and maintenance go on whether the plant is in operation 1 per cent. or 100 per cent. of the time. To a large extent, labor is a fixed charge, since practically the same number of men are required if the plant is operating at 50 per cent. capacity as at 100 per cent.

In studying the question of fixed charges with respect to a power plant, we are invariably driven back to a consideration of the load factor. This is true, because the higher the load the greater the operating charges, which cover such items as fuel, oil, etc., will be.

With a low-load factor, fixed charges may easily be the dominating item of expense, and any additional investment in the plant should be avoided. With a high-load factor, economy of operation is of paramount importance, and the equipment which will secure greatest operating efficiency may prove an extremely profitable investment.

Depreciation

Depreciation is an extremely difficult matter to handle correctly in any power plant.

We may as well admit frankly that it is almost impossible to estimate, with any degree of accuracy, the life of any piece of equipment.

Among the factors which enter into the question of depreciation, one of the most important is obsolescence. With the remarkable mechanical developments of the present age and the rapid growth of our industrial plants, we never know when this factor is likely to appear.

When it does come up it is apt to call for the scrapping of numerous pieces of equipment which are in splendid running order but which it is no longer profitable to operate because more economical machines are available.

Inadequacy is another factor resulting frequently from expansion of plants, community growth, etc. In addition to the two factors just mentioned, the possibility of destruction, due to fires, flood, etc., are to be considered.

The natural wear and tear on equipment may be estimated within reasonable limits.

It is safe to assume, for instance, that a brick or concrete building will last 40 years; a water-tube boiler, 25 years; a high-speed engine, 20 years; a generator, 20 years; condensers, heaters, pumps, etc., 20 years; motors, 15 years; conveyors, 15 years, etc. Then, if desired, a proportionate amount of depreciation can be charged off each year. This is the method generally used.

It can hardly be termed satisfactory or accurate. In making this statement we must admit the difficulty of substituting a better method.

Personal observation, however, may indicate to the individual plant manager points where he can make more accurate allowance for depreciation without a flat charge of a certain percentage each year.

For instance, the moment a piece of equipment is put into service it becomes a used article, and as such, probably commands not to exceed 60 per cent. of the value of a new article. After this initial 40 per cent. depreciation there is a period of several years when the value of the equipment will decline slowly. After that there is apt to be another rapid fall as new and improved equipment comes on the market, so that at the end of five years it is worth only 20 or 30 per cent. of its original cost.

This 20 or 30 per cent. valuation, however, is quite likely to be maintained for a considerable period of time, even if new and highly-improved equipment may be obtained on the market. At the end, say, of six years from the date of the original instalment of the equipment, it is quite possible that if the depreciation on the equipment shall have been so charged off the books of the company that it represents only 20 or 30 per cent. of the original valuation, and it will be more economical to operate the old equipment than to instal new, whereas if the old equipment was held at 70 per cent of its original valuation it might be more economical to scrap the old equipment and replace it with the new and improved type.

The method to be employed in charging off depreciation is a matter for individual study, and is largely dependent upon the earning power of the power plant.

The point cannot be emphasized too strongly, however, that in the present age the chances are all in favor of obsolescence overtaking a piece of equipment long before the expiration of its natural life.

The "Railway Review" says that in the Dalen System of acetylene gas lighting for railway cars, inverted incandescent gas mantles are used, but instead of the air necessary for combustion being added in a bunsen mixture at the burner itself there is an automatic mixing device attached to the storage tanks beneath the car floor. This arrangement renders the completeness of combustion independent of the rate of combustion at the burner which can thus be satisfactorily run either fully or partly turned on. Owing to the constant pressure, low and high power lights can be operated off the same system. Flashing, causing the destruction of mantles, is quite done away with and the atmosphere is kept much purer.

The Southern California Edison Co., of Los Angeles, has carried out a series of experiments on rock removal for tunnel projects, using alternating and direct-current arcs and various types of gas blowpipes. From a cost point of view the best three-phase run cost one farthing per pound of rock removed. The single-phase arc did not show quite such good results. With direct current the cost worked out to one-eighth of a penny per pound of rock removed. Experiments were also made with various types of welding and cutting blowpipes using oxy-acetylene, oxy-hydrogen, and oxygen with natural gas. The oxy-acetylene flame concentrates the heat best at the tip of the white cone. When moved across the rock at the proper speed, the stone clipped off readily because of uneven expansion, but when the entire flame was virtually a neutral flame the rock became molten and the surface glassy and impenetrable. Assuming oxygen to be as cheap as one-eighth of a penny per cubic foot, the cost of oxygen alone was greater than five-eighths of a penny per pound of rock removed.

A Third Class Certificate Requires—

A Knowledge of the Engineering Subjects Given Below Should Enable Any Engineer to Pass Satisfactorily the Examinations Set for the Third Class Certificate

THE applicant for a third-class certificate must hold a fourth-class certificate and should, of course, be familiar with all the knowledge required for the successful passing of the fourth-class examination.

The requirements which he will otherwise have to meet insofar as training and experience are concerned may be summarized as follows: He must be at least 21 years of age and must be able to furnish evidence that he has had at least two years' experience as fireman, oiler, or assistant to the engineer. Note that any one of the three last named positions held for a period of two years will enable him to try the examination. Testimonials must be produced as to length of service, and they must be signed by his employer, in the case of shop time, and by his employer or chief engineer in the case of engineer's or firemen's time. These testimonials must state the kind of work the candidate has been employed on, and for how long; and give evidence as to his experience, sobriety and general good conduct for at least twelve months preceding the date of application for examination.

Sixty per cent. of the marks awarded for the correct answering of the questions on the examination paper are necessary for success, and while the examination is a written one, the applicant may be required to answer questions, asked him in an interview, regarding his knowledge of the operation of a steam plant.

The applicant for a third class certificate should have a good grounding in arithmetic. This includes addition, subtraction, multiplication and division. A knowledge of decimal fractions is also desirable but not absolutely essential. He should know how to square a number and how to find the square root when the number is given.

He should have an elementary knowledge of combustion, that is he should know that certain substances unite with the oxygen of the air and give off heat in doing so. He should know that carbon burns to either of two gases—carbon monoxide (CO). or carbon dioxide (CO_2)—and that only when burned to the latter is the heat value of the fuel fully utilized. He should, in this connection, know that an insufficient supply of air will result in the production of the former gas and that while excess air usually results in complete combustion, it also wastes fuel through its cooling effect. It should also be known that the gas hydrogen exists in fuels, combined with the carbon and that when this element combines with oxygen water is formed and heat is given off.

An elementary knowledge of heat should be possessed by the applicant. He should know how temperature is measured and should be able to give intelligent answers regarding the Fahrenheit thermometer. He should also know how heat, in contradistinction to temperature, is measured, and should in this connection be familiar with the British thermal unit (B.T.U.). That is, he should know that it is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. He should also know that water boils at certain definite pressures depending upon the pressure to which it is subjected. This does not mean that he should be familiar with the exact figures beyond the one that it boils at 212/ Fahr. when under atmospheric pressure. He should also know that while the temperature remains stationary heat is required to evaporate the steam and that this heat, a definite amount per pound of water evaporated at various pressures, is commonly called the latent heat of evaporation.

A knowledge of the manner in which a steam engine works is necessary. This includes an elementary knowledge of steam working expansively, and how it does work in its expansion. He should be familiar with the general physical properties of materials with which he comes into contact in his daily work. This does not mean the memorizing of tables of tensile strength, etc. Nor does it mean ability to figure out the strength of shafts, beams, etc., but only a working knowledge of materials such as is desirable in their general use. He should be familiar in a general way with these materials, such as iron and steel, lead, copper, brass and bronze, brick and firebrick, wood and concrete.

The regulations respecting the Act specify that questions will be asked "Relating to the different kinds and manners of constructing boilers to generate steam, including the strength of materials used in constructing the same." Any questions asked relative to the last part of the above extract will necessarily have to be of a simple nature, and, needless to say, will not embrace boiler design in its usual meaning.

Hydraulics is mentioned as being one of the subjects upon which the applicant will be examined. The subject of hydraulics is a very wide one but the portion of it with which we are concerned is relatively narrow and simple. Simple facts relating to pressure and head, and friction in connection with the flow of liquids or gases through pipes and fittings will be about all that is required. An understanding of what head and pressure are is necessary, and a knowledge of the fact that flow produces friction is equally desirable. Fittings are mentioned, since their presence in a pipe-line causes friction and a loss of head or pressure when flow occurs.

In all that has been mentioned above and in that which follows it must be understood that the information given is supplementary insofar as the third class applicant is concerned, to that given for the fourth class examination, and published in POWER HOUSE for Oct. 5, 1919. That is to say, the applicant may find on his paper questions relating to information which a fourth class engineer should possess and which he also should have a complete knowledge of.

He should be familiar with the construction, insofar as familiarity with names and the shapes of the parts are concerned, of a steam boiler, with its manhole and handholes, shell, dome, staying, etc. That is, he should be able to describe them accurately and to describe their functions.

He should also be familiar with the maintenance of these various parts and of the boiler as a whole and should be able to describe how to go about minor repairs. Superheaters will also come under consideration, and he should have a similar knowledge of their construction and maintenance.

Feed water equipment is a necessary part of any boiler room and an important one. In consequence the applicant will be liable to be asked concerning feed water heaters, pumping equipment and piping with its valves. The proper method of operating any of this equipment is important as is also the question of repairs and emergency breakdown service.

Feed-water heaters will include both the open and closed types. The pumping equipment will embrace the various forms of steam pumps and injectors while the piping and valves are self-explanatory.

The blow-off is an important feature and the best construction and arrangement should be known together with the proper method of using it and the means to be taken to keep both blow-off valves and piping in proper working order.

The third class applicant should have a sound knowledge of the safety valve. He need not know how it is proportioned and what its proper size should be, but he should know how it is constructed, what its function is, how to operate it and how to maintain it in a proper working condition. In connection with its construction he should be able to describe accurately the various types such as ball and lever, spring loaded and dead weight.

The water gauge and try-cocks also come in for consideration, and he should possess a similar amount of information to that required for the fourth class certificate.

He should also be familiar with the pressure gauge and its syphon, and should understand how to care for it and how to read it.

The third class applicant should be familiar with the various methods of coal storage and supply, and it would be of advantage to him if he were acquainted with the various types of conveyors, both for coal and ash handling, and it would also be of advantage if he were possessed of such a knowledge of their construction as would enable him to intelligently care for them.

He should know how to store coal properly in open piles and in bunkers, and in connection with the storage of coal he should know that coal is liable to spontaneous combustion. He should be able to give intelligent answers relative to the prevention of this occurrence and to its control and mastering. He should be acquainted with the best methods of firing and the proper way to fire different fuels.

He should be familiar with the various parts of a boiler setting and should know the construction, function and proper method of operation and maintenance of the various parts, particularly those having to do with combustion. He need not know how grate surface enters into the capacity of the boiler for generating steam, but he should know how to fire properly and keep both grates and other parts of the setting in working order.

He should know how to regulate the air supply.

The third class certificate is the first one in which the applicant is required to know anything about engines. Since the upper limit of the boiler horse-power which will be placed under his charge, unless he is given this grade automatically when the act comes into force, will be 150 horse-power, the details of the larger sizes of engines will be of little interest to him. What he should know will embrace the more common types of engines seen in power houses up to 150 boiler horse-power.

He should have a good knowledge of the construction and functions of the various parts of a steam engine, such as the cylinder, piston, piston rod, crosshead and connecting rod. He need not know how these are designed for this is properly a function of the designing engineer, but he should know how to properly care for an engine under his charge, how to lubricate it, how to pack the glands and how to make necessary minor repairs. The proper adjustment of loose or tight bearings also should be known.

He should know something about valves and their operation. He need not be familiar with valve diagrams but he should know what lap and lead are and how the position of the eccentric relative to the crank affects the lead of the valve. If he understands what functions these various questions play in the running of the engine, so much the better.

The action of the steam in the cylinder naturally enters into this phase of his knowledge and accordingly he should know what goes on in the cylinder.

Governors are a necessary part of any engine and it is a vital part of the engineer's knowledge that he should understand what they are for and how they operate, in an elementary way. Their proper maintenance in a safe operating condition should not be overlooked.

The condenser is a part of the prime mover element in many power plants and for this reason the third class engineer should have a general knowledge of their construction, their function and their proper operation. The surface and jet pipes are the two principal types used in Ontario, but if he knows something about the syphon or barometric type, so much the better.

Piping and accessories enter into the construction of any power plant and in addition to knowing how to look after piping and the various accessories the third class engineer should know how such accessories as expansion devices, valves, traps and separators function, and he should know how to maintain them at their proper working efficiency and how to effect repairs.

He should know what heat insulation is for, how it functions and how to take reasonable precautions to keep it in order.

Hydraulics is mentioned in the regulations respecting the Act as one of the subjects with which the third class engineer will be required to be conversant, and for the purposes of examination this will probably be confined largely to the subject of pumps and pumping machinery. The engineer should have a good working knowledge of the more common types and should be able to describe how they function. He should also be able to tell how to get them into proper adjustment and how to repair them. The more simple facts relating to the theory of hydraulics, such as head and pressure, friction loss in pipes and fittings, etc., also should be known.

Distribution of Boiler Room Load

By JOSEPH HARRINGTON in "Power Notes"

ONE of the characteristics of the steam boiler is that it has a certain capacity corresponding to its best efficiency. With certain types of firing the capacity-efficiency curve has a very sharp peak, which means that the range of capacity at which the boiler can operate efficiently is very limited. When operating at less or more than this given capacity, efficiency drops off very rapidly. Without question, a flat capacity-efficiency curve is something much to be desired; and the best forms of stokers flatten out this curve very materially as compared with others, and with hand-firing.

It is a matter which astonishes the firemen when steam flow meters are installed, to see how differently the various units are operating. One boiler will have its flow meter hand clear around on the peg, and the next boiler, without an appreciably different-looking fire, will be loafing along below rating. In an hour or two, this conditions may be reversed; and if this condition persists, there is a distinct waste of coal at all times.

It is up to the careful operator, therefore, to take such steps as will assure him that the various boilers in his plant are carrying about the same load, which naturally should be somewhat within range of the most efficient operation. If the plant is large enough to warrant it, one or more boilers should be taken off the line when the load gets down to a point where the average is less than the economical capacity for the unit. Too often do we see every boiler kept in service in little more than banked condition, and operating at 30 or 40 per cent. efficiency. It would be far better to run half the number of boilers at twice the rating at an efficiency of 60 or 70 per cent. Standby losses in this case are less than the operating losses.

Now the question instantly arises as to how the operator can tell what load the various units are carrying; and the answer is only by some indicator which shows either the amount of water going into the boiler or the amount of steam coming from it. From my standpoint, either method is satisfactory; but it must be determined for each individual boiler. Only in this way can one tell what is doing. Even the indications of draft are not entirely satisfactory, for the simple reason that a draft reading is an indirect indication. When carefully worked out, with gages to show the loss through the fire and through the boiler, and checked against coal and water rates, the draft indications will show very closely the condition of the fire and the rate of steaming; but there is certainly an advantage in an absolutely direct indication.

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The Horse Power Rating of a Boiler

SOME misunderstanding seems to have arisen relative to the horsepower rating of boilers under the Ontario act grading certificates. The Act defines a boiler horse-power as follows: The equivalent to the evaporation of 34 lbs. of water per hour from and at 212° F., 15 sq. ft. heating surface for return tubular boilers, 12 sq. ft. heating surface for locomotive type boilers, and 10 sq. ft. heating surface for water tube boilers. The figure 34 lbs. specified in the act, in the first place is not strictly correct as the rate of evaporation now fixed by the A.S.M.E. as standard for one horse-power is 34½ lbs. of water evaporated from and at 212° F. per hour.

Any figure giving the number of square feet of heating surface per horse-power can only be an approximation of the supposed capacity of the boiler for doing work since it does not take into consideration the grate surface and the fuel burned, both of which, of course, have a very important influence on the evaporative capacity of the boiler.

The figure of 10 sq. ft. per horse-power has long been used by manufacturers and others as has also the figure 12 sq. ft. That of 15 sq. ft. for horizontal return tubular boilers mentioned in the Act is the figure which will be used for the purpose of administering the Act and the manufacturers' rating, no matter what it is, will not necessarily count unless it happens to be on the same basis.

If a manufacturer rates his boilers on a basis of 10 sq. ft. per boiler horsepower and an engineer has a plant of 300 boiler horse-power under him, determined on the above rating, for the purpose of grading under the act, it will only be of $300 \div 15 \times 10 = 200$ boiler horse-power capacity.

It must be remembered that the term boiler horse-power, in speaking of heating surface, is only relative and of no fixed value, unlike the mechanical horse-power. On the other hand, the rating of a boiler in terms of its evaporative capacity and on a basis of 34½ lbs. from and at 212° F. is the more sensible and logical method, and has some basis of scientific logic behind it.

System in the Power Plant

HOW often do you or your men test the safety valves—once each shift, one a day or once in every little while, say a week or two? And how often are other vital points around the power plant inspected, or how often are the fires drawn and the boilers cleaned down and inspected?. In short have you any systematic method of going about your duties while on shift or directing others in the performance of routine work?

System is a wonderful smoother of the rough spots in our everyday world, and while it acts as a lubricant it brings in returns measurable in dollars and cents.

It is for this reason that business demands system in the performance of the routine work of accounting and management and it is for the saving effected in time and money, and for the results achieved, that the engineer may well inject a bit of system serum into the management of his power plant.

The Future of Stationary Engineering

MUCH speculation is frequently indulged in over the prospects of Hydro-Electric power completely ousting the small steam plant devoted to the generation of power. This tendency, it is true, has been very marked in Ontario at least during the past decade and the boiler in many cases has been relegated to the position of a heating device and not one of the links in the generation of power from coal through the medium of steam.

To say this change has not affected the engineer's status would be incorrect. It has, and in many cases to the engineer's disadvantage. This should not be the case and the remedy lies in his own hands; education and the keeping abreast of developments in the engineering field will not only enable him to hold his own, but will enable him to be of more value than before.

Stationary engineering embraces an ever-widening range of subjects and the engineer of to-day must know much more than engine and boiler management. Electrical engineering and refrigeration are two subjects which the engineer will have to be acquainted with to an ever-increasing degree.

The Old Family Group

IT is not pleasin' unto me, in fact, it grieves me sore, to see some things a-passin' we loved in days of yore—folks seem to be all changed about in this here awful age, a-tearin' here and there, by gum, in one mad, giddy rage.

It causes me to shed a tear the way they've put the boots to them there photos that we called the old-time family groups.

I love to gaze upon them things, their faces and their gowns—their countenance set for the pose, all freed from grins and frowns. They set there lookin' back at me, that group took years ago, poor things not knowin' that them groups was out-of-date and slow.

Why, when they go out nowadays to get their likeness took, folks try to look like some front page from out a "movie" book. The women get a yard or two of fly-nets round their bones, by far too flimsy and too thin to venture from their homes. They gaze up at the rafters, 'cause the photo man says so; they're dressed in some partic'lar style with no place much to go. And when their friends grab off the prints they snicker and they grin; the things they say they constitute a high crime and a sin. But to their faces they cry out, "Oh, excellent! Oh, fine! Prunella, dear, your profile shows a snout that is divine!"

Likewise when Dad goes out to sit before the camera man, he has to have an egg shampoo, also a meal of bran—he looks as great men look each day, as though he'd like to feel just how 'twould be before the night to swing a million deal. Why, if Dad pulled that picture face when trudgin' 'bout the house, we'd swear he was recoverin' slow from some hard cider souse.

Of course, we've got to be in style like all the other folks; it aint no use in laggin' like a lot of has-been blokes. But all the same, them family groups look powerful good to me, when Dad was young and handsome and Maw was twenty-three. I like to look at them, I do, just settin' there, by heck, without no care or worries a-campin' on their neck. No cheese cloth wrapped about Maw's chest, nor yet upon Dad's jaw is fixed an attitude to state he's gone and bust the law.

Ah, yes, I know it's out-of-date to have a family group, but for them photos nowadays I don't care one durned whoop. Lead back the good old family group with pleasant face and sweet, with palm trees rustlin' in the rear and foostools 'round their feet.—ARK.

A Real Imagination

WE are indebted to "The Locomotive" for bringing this gem of pure imaginative effort to light. It is supposed that it was written by a member of the air service at Scott Field to his father and was found near the Southern Railroad Station.

"I have been appointed Mess Sergeant of the Flying Detachment, Scott Field, and to show of what my work consists, I will give some few examples of our tasks and efficiency.

"The kitchen range is 500 feet wide and 3,000 feet long, takes 27 experienced firemen to keep the heat at the necessary temperature. 400 cooks on duty at all times, 1,000 mechanical stokers for kitchen police and 1,000 assistant kitchen police who look after the stokers.

"Two hundred washing machines are used for washing the potatoes. 27 pile drivers mash them, 14 steam shovels shovel eggshells away from the kitchen door. Twenty-two Liberty motors are used in the coffee mills. Dirty dishes are hauled out to 11 blast furnaces, as the dishes are all paper and are burned after each meal. Hot cakes are mixed with 19 concrete mixers and 46 men with bacon rinds attached to their feet continually skate over the large griddle to keep it greased.

"Soup is made in an artificial lake, which keeps 34 dump trucks busy hauling the necessary ingredients. Cooks use steel boats and are dressed in asbestos clothing. Every few minutes they row to the centre of the soup lake and drop depth bombs to properly stir the mixture. Sixty-seven fire engines are used to pump soup to the 954 tables. Bread is cut by 11 high-powered band saws. A perforated endless conveyor properly salts and peppers the victuals. Twenty large street sprinklers are used to place syrup on cakes. Coffee is made in a 600-gallon tank and pumped to the tables through pipes by 17 centrifugal pumps. Ten five-ton rollers are used to roll the batter. To save labor and cost six-inch mains have been installed from 20 of the country's largest dairies for the supplying of milk.

"Radio telephones are used by the Mess Sergeant, who also uses a motor cycle in travelling around the dining hall and kitchen. All cooks wear gas masks. Ford trucks haul the silverware. Now, dear father, you can see just what I have to do and why I do not desire to quit the army."

The Tunnel Will Be Built

FOR years engineers have talked of the day when the tunnel would be completed between England and France. The world in general has not been much interested, probably because the world in general never thought such a thing practicable.

But work is going to start—start from both sides, the French and English Governments to find an equal share of the money and provide an equal share of the men.

Then it will be possible to take a train at London for Constantinople, for any European capital. Through the tunnel the line will be run by electric power. This will prevent trouble with engine fumes, which was one of the serious objections to the long tunnel through the Alps.

Forty-five minutes will be occupied in going through the Channel tunnel. Passengers, in fact, will pass through the tunnel almost without realizing they are passing under stormy Straits.

The tunnel will be about thirty miles long. It will not be exactly in a straight line. Beginning at a spot two or three miles on the island side of Dover, it will follow the gray chalk bed of the Channel, which is impervious to water and suitable for tunnel construction, and come out at a point between Calais and Boulogne, near the village of Marquise.

There will be, as on the London underground railways, two distinct tubes. Below them, about nine feet in diameter, will be a drainage tunnel. The whole work will take five years to complete and will employ 1,200 men on each side.

The French, who are proud of their share in the tunnel, will do half the work and find half the money. There is bound to be much friendly rivalry between the two sections of workers as to which will go ahead the faster.

According to exact calculations of the engineers, the French and British workers, who will begin construction of the tunnel thirty miles apart, will meet within an inch or two of the centre of the tunnel.

For a long time the waste steam from steam-engines has been turned to good account, but there have been difficulties in the way of using the exhaust gases from a gas-engine as they readily attack the metal of the conduits. However, the difficulty is being overcome, for a New Jersey candy factory has an installation in connection with a sixty horsepower engine which is used to heat the factory. The gases pass through an economizer made of cast-iron, with the passages to the different sections staggered so that all parts are heated for the whole length. Water circulates in jackets surrounding the gas passages.

* * * *

THE assurance of Washington that Canada will not be discriminated against in the matter of coal shows more spirit than the threat to cut Canadian power off United States when it was short here.

NEW POWER PLANT EQUIPMENT

DEAD GAS POCKETS FOR PROTECTING SOOT CLEANER ELEMENTS

IN connection with their research and development work, the engineers of the Vulcan Soot Cleaner Co., Du Bois, Pa., have brought to light some valuable and interesting information regarding the protection of soot cleaner elements by means of so-called "dead gas pockets."

Inasmuch as the temperature of combustion in a boiler furnace frequently reaches 2500°F., it is evident that soot cleaner elements cannot be placed within the immediate zone of this high temperature. Protection of some kind against both convection and radiation is necessary, especialy in steep tube boilers such as the Stirling, Erie City, Badenhausen, Connelly, Ladd, etc., which require cleaner elements at the bottom and top of the first pass. The temperature at the bottom and top of the first pass is usually high, whereas in the second and third pass it drops to a degree that does not influence the strength or properties of wrought iron or steel.

FIG. 1.

As applied to horizontal water tube boilers the temperature problem is seldom a serious one because it is the usual practice to place the soot cleaner elements at the top of the tube bank where the temperature seldom if ever reaches 1000°F., a temperature that does not affect cast iron sheaths.

To fully protect the soot cleaner elements in steep tube boilers, a patented deflecting baffle title, or row of fire brick forming a pocket in which the element is operated is placed at the bottom of the first pass as shown in Fig. 1. This pocket eliminates the direct scrubbing action of the hot gases. Space is allowed at the bottom of this baffle through which soot and ash will drop during the cleaning process. The cast iron sheathing used for further covering and protecting this element is clearly illustrated in Fig. 2.

At the top of the first pass is another patented dead gas pocket in which is located the second soot cleaner element. This element, also, is further protected by means of the special cast iron sheathing, shown in Fig. 3. This second element rests upon the circulating tubes close to the front drum as shown in Fig. 4. Contact with the comparatively cool tubes asists greatly in maintaining the element at a safe temperature.

By arching the baffle tile over the circulating tubes as shown, the hat gases, in their natural flow, do not come into direct contact with the element. The elements in both instances are placed in strategic and commanding positions, making it possible to clean easily what has heretofore been the most difficult and the most important portion of the boiler—the first pass. It is well known that in the steep tube type of boiler, most of the steam is generated in this pass, hence the importance of keeping the first pass well cleaned.

In boilers of this type, where the tubes are arranged in squares, perpendicular nozzles are used, as shown in Figs. 2 and 4. That is, the nozzle makes a right angle with the axis of the elment, hence the jet is directed between the tubes. With a nozzle blowing into every space, rotation of each element in Figs. 1 and 2 through approximately 90° thoroughly cleans the entire bank of tubes.

In the Vogt boiler there is a departure from conventional horizontal water tube boiler design, making it necessary to place two of the elements closer to the high temperature zone, as illustrated in Fig. 5. Hence the element No. 1, which is closest to the hot burning gases and glowing fuel bed, is protected by a dead gas pocket as well as by cast iron sheaths. The next element reached by the hot gases is protected by a straight diagonal baffle (also visible in Fig. 5), forming a second dead gas pocket. The third element reached is protected by a

FIG. 2.

FIG. 4.

dead gas pocket in a manner similar to element No. 1. By the time the gases reach element No. 4 the temperature of the gases has dropped sufficiently so that a dead gas pocket is not necessary to cover the element with cast iron sheaths.

Experience has proved that burned furnace gases are non-oxidizing, hence there is little, if any, hazard in exposing bare elements to the low temperature gases. The high temperature problem is, as a rule, of greater importance than the corrosion problem, but this has been effectively solved by these investigators by means of combined dead gas pocket protection, cast iron sheaths, and contact with the comparatively cool boiler tubes.

LUBRICATING AMMONIA COMPRESSORS

To perform its functions properly, a lubricating oil should have body sufficient to keep bearing surfaces apart; should reduce friction to a minimum; should remain fluid at the lowest temperatures to be met in service; should not decompose and form deposits that will gum up the machinery; should have no ingredients which can corrode or pit metal, and should have flash point high enough to insure against the presence of volatile constituents.

To avoid vaporizing too quickly under the high compression heat in an ammonia compressor cylinder, a lubricant must have a good flash, say, 325 deg. F., and as some oil in vapor form is

FIG. 3.

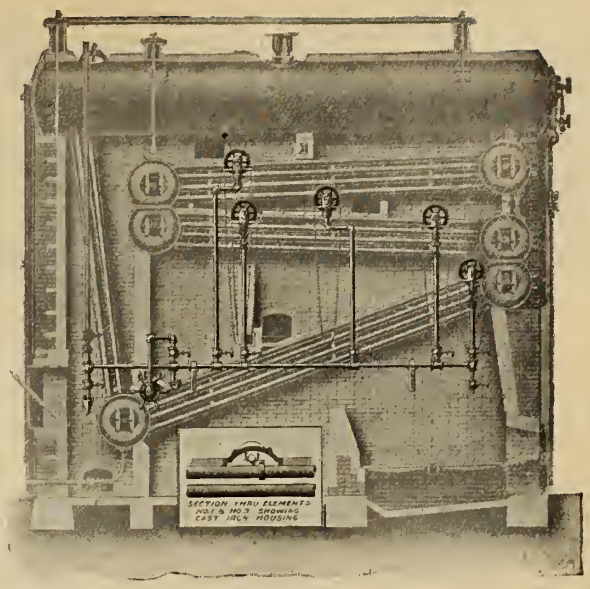


FIG. 5.

likely to be carried into condenser pipes with the ammonia gas, the cold test should be low enough so that the lubricant will not solidify in the piping and coils—5 to 10 deg. F. If it is carried on through with the liquid ammonia, it can be taken out by an oil trap, placed ahead of the liquid receiver and at the lowest point in the expansion and condenser coils. Such a trap may be made of a piece of 4-in. piping, 2 ft. long, with a draw-off connection at the bottom.

If the lubricating oil gets into the condenser coils and stays there, it can be loosened by cutting off the water from one stand at a time, allowing the coil to become hot, so that the oil is thinned and will run off into the oil trap.

Oil carried over, and collecting in the condenser and expansion coils, is a source of lost capacity, and is frequently due to locating the oil separator too close to the compressor discharge, where the gases are hot and the oil mostly in vapor form. Placing the separator near the condenser gives time for the gases to cool somewhat before reaching it, so that the oil is partly condensed and is more readily separated.

All oil used for the compressor cylinder should be measured and a record kept. Any unusual increase in the amount fed should lead to an immediate investigation to prevent filling of the system.

As hot ammonia gas has a bad effect on stuffing box packing, a liberal supply of oil should be applied to the piston rod in the stuffing box to reduce the chance for overheating.

Discoloration in the ice is not always due to oil. Two cases were mentioned in the discussion, one where firebrick was used to fill an open heater in which there were no flow pans, and the mineral matter from the brick carried over into the ice; the other where rust from a fore cooler caused the trouble, which was remedied by painting the inside of the fore cooler.—From a paper and discussion, Nat. Ass'n. Prac. Refrig. Engrs. in "Compressed Air."

SOME CONDENSED ADVICE ON COMPRESSED LUBRICATION

Explosions in air compressors and receivers occur with sufficient frequency to demand careful attention. The majority of such explosions are undoubtedly due, either directly or indirectly, to the lubricating oil used in the air cylinders. Poor working conditions of the compressor, such as leaking valves, hot and dirty inlet air, insufficient cooling water, carbon deposit in cylinder or connections, and high speeds of poorly designed compressors, all assist in producing dangerously high temperatures of the compressed air. These high temperatures are sufficient to ignite the volatile constituents of the lubricating oil, and produce violent explosions.

The Massachusetts Boiler Board recommends the following rules:

(a) Keep the temperature of the compressed air, during compression, as low as possible.

(b) Keep the piston and valves tight, and in good working condition.

(c) Take the inlet air from as cool and clean location as practicable.

(d) Use plenty of cold water, from a source which is not liable to fail, and have it visible at discharge from cylinders or coolers.

(e) Do not use kerosene or other volatile substances in the cylinder, tanks or any connections.

(f) Use mechanical or sight feed oilers for the compressor cylinder.

(g) Use the least amount practicable of the best air cylinder oil. Air cylinders require much less oil than steam cylinders.

(h) Keep the cylinder, tanks and connections as free from carbon, accumulated oil and deposits as practicable.

(i) A good cylinder oil is one which lubricates well, leaves little or no deposit, is the least volatile at high temperatures, and has a high flash point.—"Compressed Air."

ABERTHAW CONSTRUCTION CO. TAKES UP AGAIN ITS STUDY OF THE EFFECT OF VIBRATION IN STRUCTURES

Four years ago the Aberthaw Construction Co. started an investigation on the vibration of buildings, particularly manufacturing buildings. The study was intended to cover not only the causes of vibration, but also the effects on the structure, on the machinery installed, and on the quantity and quality of production.

A preliminary report was published in the fall of 1916, but our entry into the war and the many new problems which that brought, put a summary stop to the work. It is now being taken up again with the idea of following through to a point where a complete report can be published. The Aberthaw Construction Co. will therefore be glad to have engineers, manufacturers, and others having knowledge of the subject, or having had specific experiences which would throw light on any of its phases, communicate with the company at 27 School Street, Boston.

The previous work on this problem showed a wide diversity of opinion on some of its angles. It also developed that there is very little quantitative information extant which can be relied upon as giving authoritative data. It is particularly desired, therefore, that information of this character, however limited in its application, may be made available for the study.

Privy Council Awards Share.—The proceeds of the sale of the steamer "Storstad," which sunk the Empress of Ireland, will be shared by the C.P.R. The Canadian Supreme Court gave the preference to the passengers, but the Privy Council reversed the decision.

The Operators' Point of View

GRADED CERTIFICATE CORRESPONDENCE

Editor, POWER HOUSE:

The letter by "Chief" on page 527, POWER HOUSE, November 20, contains the sentiment of most of the old engineers. An illustration of my own case will show up the injustice as explained in part by "Chief." I have been an engineer for thirty years, have been 1st engineer of 500 h.p. plant and larger plants for eighteen years, and am now 1st in a 500 h.p. plant. I held 1st class papers with the Ontario Association of Stationary Engineers, and still have the last certificate, issued in 1907. I have taken two correspondence courses in engineering from a well-known school.

I believe I am a first-class stationary engineer in the fullest meaning of the word. I have sent letters on engineering subjects to POWER HOUSE since its first issue, and have had my letters printed by other engineering journals for the past twenty-five years.

With all the foregoing experience and study I am positive that I could not now, write such examination question answers as I had to do in the past to secure 1st class papers. The principal reason that would prevent me passing such an examination is my memory. When I was younger I could remember hundreds of rules without difficulty; now, however, I am compelled to refer to my text books very often to feel certain I have the problem worked out right. I understand the rules and can work out any possible engineering problem with the assistance of the text books.

Men having such experience and knowledge such as I possess should receive 1st class papers without having to pass a difficult memory test. We are willing to pass a knowledge test. The statement made by "Chief" about the mental abilities of engineers over fifty years of age are right in my case, as the new law is worded I will have to do with 2nd class papers and drop back into small plants. Should I make a change and still be 1st engineer, this will be so even if I am as good or better, as an engineer, than the youngsters who have small experience but are long on memory.

In my thirty years experience I have found not one case where changes had to be made, where new equipment had to be installed or information of a complex nature was desired that the engineer could not take the time to look up details in his text books. It is quite possible that some of the examiners who are getting along in years, would themselves fail to secure the necessary number of points in such an examination. Of course the general belief is that these gentlemen have not passed such an examination under engineers outside of the examining staff at the Parliament Buildings. It is a fine thing to have a graded certificate law for engineers, but it should be a just law. I have read enough engineering literature to make hundreds of volumes, but I am thinking this law is going to be my finish for the memory test, not the knowledge or experience test, is going to put me in the "has been" class.

By all means eliminate, as chief, the engineers who will not study engineering as it is printed, for very few men can ever be safe engineers who depend upon the knowledge gained in their own operating experience only. On the other hand, give the real old engineers 1st class papers without further examination, especially so if, like myself, they held 1st class papers in 1907.

HAL BEECHER.

INDICATOR CARD CRITICISM

Editor.—Having noticed the indicator cards, published in your issue of Nov. 20th, and the criticism of same by Arthur Smith in the Dec. 5th issue, I am tempted to give my views for what they are worth.

Mr. Smith says, "She opens too soon, closes too soon, and has too much lead. Remedy put back the eccentric." He does not say what opens too soon and closes too soon, but presume he means the steam edge of the valve. This being so, the exhaust edge would be late opening and early closing. Let us go carefully over these cards and see what information they give us. We are not informed as to the type of engine they are taken from, but from the light load card should imagine it was a high speed automatic engine.

Take the left-hand card of the top, set first. Start at the extreme right-hand bottom corner, where the exhaust line starts. The line is wavy, which may possibly be a fault of the indicator. A curved back pressure line is sometimes caused by a leaky piston, but this does not seem to be the case here. The compression line starts about the normal place if anything rather late. Admission is late, shewing that there is not enough lead. It will be noticed that the vertical line slopes upward, and at the top turns to the right with a barely perceptible rise. This shows that the piston has reached the end of the stroke before admission takes place. The steam line still further bears this out.

The line falls rapidly away, showing that the steam-port is not wide open enough to supply the steam fast enough to keep up the pressure during admission. The cut off evidently takes place at the point of the line where the slight hump is evident. Release takes place just before the expansion line crosses the compression line of the other card. The card we have ben considering, though not marked, is evidently that of the rank end.

At the head end the compression takes place slightly earlier, and near the top of the compression line, admission takes place. Lead is still slightly under that required but we get a rounded line at the top, instead of a rising line as at the opposite end. Cut off takes place later, and release is slightly earlier. The terminal pressure is a little higher than in the crank end. The cards are not bad but could be improved by making the lead more on the crank end and less on the head end. This would tend to straighten up the admission line, and make the cut-off slightly later, which would give a better distribution of steam.

It must be remembered that in an automatic engine the valves are set when the governor is at its extreme open position, giving the maximum port opening and lead. It is well to block the governor out to its extreme position for running, and see how the port openings are affected.

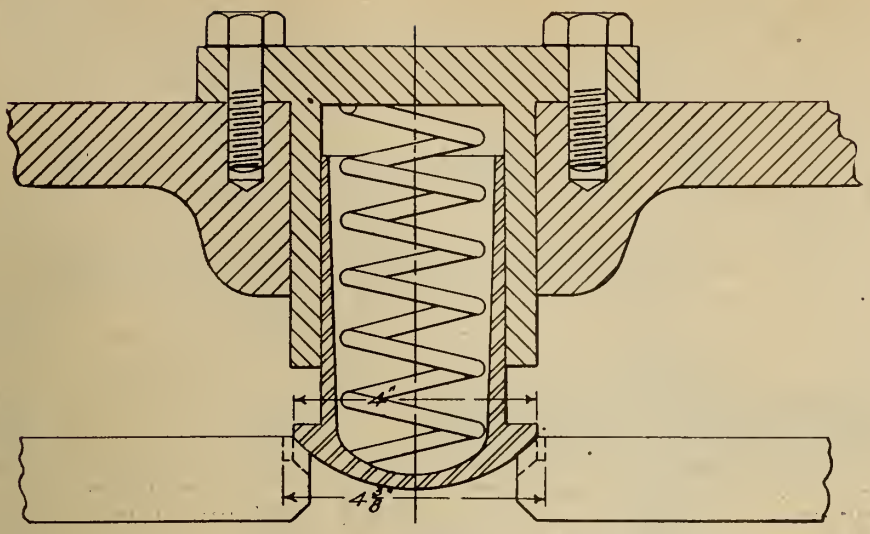
T. H. F.

SLAMMING AIR COMPRESSOR VALVES

By R. MacLaren

The discharge valves on a Brown aid compressor slammed so severely that it was impossible to sleep in the engine room. An examination showed that while originally the valve seats were flush with the valve deck through repeated refacing and wear, the seats were lowered about ⅛ in. below the surface of the deck as shown by the dotted lines in the sketch.

As the outside diameter of the seat was only a trifle greater than the outside diameter of the valve, little or no air could escape until the valve had lifted above the deck. As the ports are 3½ in. diameter and the outside diameter of the valve 4 in., and the receiver pressure 15 pounds, there would be about 44 pounds more pressure on the discharge side of the valve than on the face when the cylinder pressure reached



AIR COMPRESSOR VALVE

15 pounds, leaving the spring pressure out of the question.

To balance this air pressure the cylinder pressure had to rise to about 19½ pounds. As soon as the valve would leave its seat the 19½ pounds per sq. in. would be exerted on the entire area of the valve, with the result that the valve would be slammed back against the stop. To remedy the trouble the deck surrounding the seat was bored to a diameter of 4⅜ in. with very agreeable results.

STRENGTH OF FURNACES IN VERTICAL BOILERS

John S. Watts

THE regulations for the construction and inspection of boilers, section 63, call for "all furnaces over 42 ins. diameter, to be stayed in accordance with the rule for flat surfaces." In my opinion, formed by a long experience in building, repairing and operating boilers, this rule should be amended; as it compels the fitting of screwed stays where they do more harm than good, for the following reasons.

They tend to prevent the circulation of the water in the already confined water space around the furnace, and retain the scale and feed water deposits on the furnace plate, just where the heat is most intense. This tends to cause overheating of the furnace plate, and defeats the very object for which the stays are fitted.

A furnace without screwed stays will, if weakened by overheating or corrosion, give warning of its dangerous condition by bulging, which will warn even a careless operator that the boiler is in a dangerous condition, in time to take measures to avert the impending collapse.

On the other hand, a furnace fitted with screwed stays, will hold out, without visible signs of distress, until the plate ruptures suddenly, and a disastrous explosion occurs. This danger is accentuated by the fact that it is practically impossible to provide for thorough cleaning of the scale from the furnace shell of a vertical boiler, or to inspect it for corrosion or pitting internally.

The longitudinal expansion of the furnace shell plate is much greater than that of the boiler shell, especially in vertical boilers, the majority of which are not lagged. The screwed stays impede the free expansion of the furnace longitudinally, and the strain thereby imposed upon causes serious grooving of the furnace plate around the stays, this actually weakening the furnace instead of strengthening it, and materially shortening the life of this part of the boiler which is the most expensive part to renew.

In my experience with vertical boilers, I have never yet seen a stayed furnace cut out of a boiler, that was not badly grooved around the stay bolt holes, and generally this grooving or corrosion, reached to such a depth, as to cause one to wonder how the furnace ever held the pressure.

So far as I know, the only argument advanced in favor of the fitting of screwed stays is that we have no exact formulae, for determining the resistance to collapse of a tube under external pressure. The formulae we have, being all empirical, and based upon the results of experiments, which are too few in number to be really authoratitive. Moreover, the problem is complicated by the fact, that no furnace is ever truly circular, and the strength against collapse diminishes rapidly as the tube departs from a truly circular form.

At this point, we may call for a few moments of silent meditation to try and discover how it was that those who devised these rules, and embodied in them regulations covering such minutiae as the size of the rivet heads, could miss so important a point, as it is, to have some fixed tolerance for the departure of the furnace from the truly circular form.

Another, and in my opinion, serious weakness in the rules, is that no limit is placed on the thickness of the furnace plate.

Actual experience shows that no plate in close contact with the fire should be allowed to be more than 5-8 in. thick, and then only when nearly perfect circulation and easy cleaning and inspection can be obtained.

In a vertical boiler, I would prefer to see the maximum thickness placed at ½ in. This because, as is well known, a thick plate in contact with the fire, or very hot gasses, will soon burn or corrode away, until its thickness is ½ in. or ⅝ in., so that it is evidently useless to make the plate any thicker. In fact, it is worse than useless, as corrosion once started is apt to continue.

Now, "revenons a nos moutons": I would suggest that the rule under discussion be amended so as to allow the strength of all sizes of furnaces to be calculated by the formulae given in that rule at section 63, viz.:

$$B = \frac{C \times T'}{(L_1 + 1)\ D_1}$$

and that the length of the furnace, L, in the formulae, be the unsupported length of the furnace, i.e. the length between rows of stays.

Thus, where the desired pressure cannot be obtained by using the maximum allowed thickness of plate (½ in. in vertical boilers, ⅝ in. in horizontal type), one or more rows of stays would be fitted. The length, L, in the formulae, will then become the length from the center of the rivets, in the end seams of the furnace, to the center of the row of stays, or, the distance between the rows of stays, if more than one row is necessary.

This proposed amendment to the rule will demand screwed stays in large furnaces and for high pressures, and it may seem illogical to recommend it, after what I have said above about the grooving caused by their use. But there seems to be no better way available to gain the required strength, and the proposed rule cuts down the ill-effect of their use to the minimum.

We gain in actual strength from the fact that when stays are required by the new rule, the number to be fitted will be only about one quarter of the number demanded under the old rule. This much smaller number of stays will offer correspondingly less resistance to the circulation of the water, and to the expansion of the furnace, and therefore be less apt to set up grooving. Particulars so at the upper end of the furnace, where the expansion being cumulative from the bottom up, the amount of movement of the furnace relative to the shell is greatest. Because there will then be some two or three rows of stays, now used to stay the upper part of furnace, omitted.

But the main advantage is that, by having only one or two rows of stays, with a space of two or three feet between the rows, the furnace can, if overloaded, give warning of its condition by bulging, which it cannot do if stayed as a flat surface.

As to the safety of this rule, I cannot see why, if the rule now in use is safe for furnaces up to 42 in. diameter, as the regulations claim it is, it should not be safe for all diameters. The formula used is based on Fairbairn's rule, and he placed no limit on its scope. The British Board of Trade, and the Dominion Government laws for marine boilers, give practically the same formulae, but make no restrictions as to the diameter of the furnace, such as have been embodied in our Provincial statute.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$27 00	$.....
1¼ in.	29 00	.....
1½ in.	30 00	26 50
1¾ in.	32 00	26 50
2 in.	31 00	26 00
2¼ in.	35 00	28 00
2½ in.	43 00	32 00
3 in.	48 00	38 00
3¼ in.	.....	45 00
3½ in.	60 00	42 00
4 in.	75 00	54 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½ in...	$5 00	$5 00
Tank plates, 3-16 in.	5 25	5 25

WROUGHT PIPE

Effective Jan. 7, 1918.

Standard Buttweld.

Size.	Black Per 100 feet	Galvanized Per 100 feet
⅛ in.	$ 6 00	$ 8 00
¼ in.	4 68	6 81
⅜ in.	4 68	6 81
½ in.	6 21	7 78
¾ in.	7 82	9 96
1 in.	11 56	14 71
1¼ in.	15 64	19 90
1½ in.	18 70	23 76
2 in.	26 16	32 01
2½ in.	40 37	51 19
3 in.	52 79	66 94
3½ in.	67 16	84 18
4 in.	79 67	99 74
Standard Lapweld		
2 in.	$38 81	$35 34
2½ in.	42 12	52 36
3 in.	55 08	68 47
3½ in.	69 00	86 94
4 in.	81 75	103 00
4½ in.	93 00	118 00
5 in.	108 00	137 00
6 in.	140 00	178 00
7 in.	183 00	232 00
8L in.	193 00	244 00
8 in.	222 00	281 00
9 in.	266 00	366 00
10L in.	246 00	312 00
10 in.	317 00	402 00

Prices—Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4" and under, 60%.
4½" and larger, 50%.
4" and under, running thread, 30%.
Standard couplings, 4" and under, 40%.
4½" and larger, 20".

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At mill	list plus 5%
At warehouse	list plus 25%

Discounts off new list. Warehouse price at Montreal and Toronto

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 25
Steel bars, base, Toronto	4 25
Steel bars, 2" to 4" base	5 50
Steel bars, base, Montreal	3 75
Best grades	15%
Iron bars, base, Montreal	3 75
Reinforcing bars, base	4 50
Small shapes	5 75

SHEETS

	Mont.	Tor'to
Sheets, Black, No. 28	$6 55	$6 00
Sheets, Black, No. 10	5 15	5 45
Canada plates, dull, 52 sheets	8 50	7 10
Canada plates, all bright	8 50	8 00
Apollo brand, 10¾ oz. galvanized	....	....
Queen's Head, 28 B.W.G.	....	....
Fleur-de-Lis, 28 B.W.G.		
Gorbal's Best, No. 28.		
Colborne Crown, No. 28	....	....
Premier, No. 28 U.S.	....	7 50
Premier, 10¾ oz.	....	7 80

PROOF COIL CHAIN

B	
¼ in.	$14 35
5-16 in.	13 85
⅜ in.	13 50
7-16 in.	12 90
½ in.	13 20
9-16 in.	12 70
⅝ in.	12 50
¾ in.	12 40
⅞ in.	12 90
1 in.	12 65
Extra for B.B. chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$13 00
3-16 in.	12 50
¼ in.	11 75
5-16 in.	11 40
⅜ in.	11 00
7-16 in.	10 60
½ in.	10 40
⅝ in.	10 00
¾ in.	9 90

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	60
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	60
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	....
Royalite, per gal., bulk	22½
Palacine	25½
Machine oil, per gal.	36
Black oil, per gal.	16
Cylinder oil, Capital	62
Cylinder oil, Acme	45
Standard cutting compound per lb.	06
Lard oil, per gal.	2 60
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic.	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¼

BELTING—NO. 1 OAK TANNED

Extra heavy, single and double	30%
Standard	30, 10%
Cut leather lacing, No. 1	$2 20
Leather in sides	1 75

COAL AND COKE

Solvay Foundry Coke	....
Connelsville Foundry Coke	....
Steam Lump Coal	....
Best Slack	....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	35
Stove bolts	65
Plate washers	list plus 20
Machine bolts, 7-16 and over	40
Machine bolts, ⅜ and less	40
Blank bolts	25
Bolt ends	25
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	net
Machine screws, o. and fil. hd., brass	net
Nuts, square, blank	add $0 75
Nuts, square, tapped	add 1 00
Nuts, hex., blank	add 1 00
Nuts, hex., tapped	add 1 25
Copper rivets and burrs, list less	15
Burrs only, list plus	25
Iron rivets and burrs	40c 05
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	75
Wood screws, O.&R., bright.	77½
Wood screws, flat, brass	55
Wood screws, O.&R., brass	55½
Wood screws, flat, bronze	50
Wood screws, O.&R., bronze.	47½

MISCELLANEOUS

Solder, strictly	0 34
Solder, guaranteed	0 39
Babbitt metals	18 to 70
Soldering coppers, 3 to 6 lbs.	0 58
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 80
Red dry lead, 100-lb. kegs, per cwt.	16 50
Glue, English	0 35
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turpentine, single bbls., gal.	1 50
Linseed oil, raw, single, bbl.	2 90
Linseed oil, boiled, single bbls.	2 92
Lead wool, per lb.	0 14
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A.	list plus 43
Emery Cloth	list plus 37½
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 07
Rosin "G," per lb.	0 08
Borax crystal and granula.	0 14
Wood alcohol, per gallon	2 00
Whiting, plain, per 100 lbs.	2 50

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$42 50	$43 00
Plain sheets, base 16 oz. and heavier	46 00	44 00
Copper sheet, tinned 14 x 60 in., 14 oz.	48 00	48 00
Copper sheet, planished, base 16 oz. and heavier	46 00	45 00
Braziers' in. sheets, 6 x 4 base	45 00	44 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Warehouse price.

Brass rods, base ½" to 1" rd.	$0 34
Sheets, 24 oz. and heavier base	0 42
Brass tubing, seamless	0 46
Tubing, I.P.S., 1" base	0 48

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING.

Standard	10% extra.

WASTE.

White	Cents per lb.
XXX Extra	19½
Peerless	19
Grand	18
Superior	18
X L C R	17
Atlas	17
X Empire	15½
Ideal	16
X press	14
Colored	
Lion	16
Standard	13½
No. 1	13½
Popular	12
Keen	10½
Wool Packing	
Arrow	25
Axle	20
Anvil	15
Anchor	11
Washed Wipers.	
Select White	11
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	50
Sq. & Hex., Head Cap Screws	45
Rd. & Fil. Head Cap Screws	20
Flat & But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	45
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	40
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	25
Studs	30
Taper pins	50
Coupling bolts, pins	10
Planer head bolts, without fillets	list plus 10
Planer head bolts, with fillet	list plus 10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws	list plus 20
Collar screws	list plus 20, 30
Thumb screws	40
Thumb nuts	75
Patch bolts	add 20
Cold pressed nuts to 1½ in.	add 1 00
Cold pressed nuts over 1½ in.	add 2 00

METALS

METALS

	Montreal	Toronto
Lake copper	$24 25	$25 00
Electro copper	24 00	25 00
Castings, copper	23 50	25 00
Tin	57 50	58 00
Spelter	10 00	10 50
Lead	8 25	8 50
Antimony	10 00	10 50
Alumium	33 00	35 00

Prices per 100 lbs.

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Packing, square braided	$0 39
Packing, No. 1 Italian	0 44
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	Montreal	Toronto
Sheets, 3 lbs. sq. ft., lb.	$12 00	$13 25
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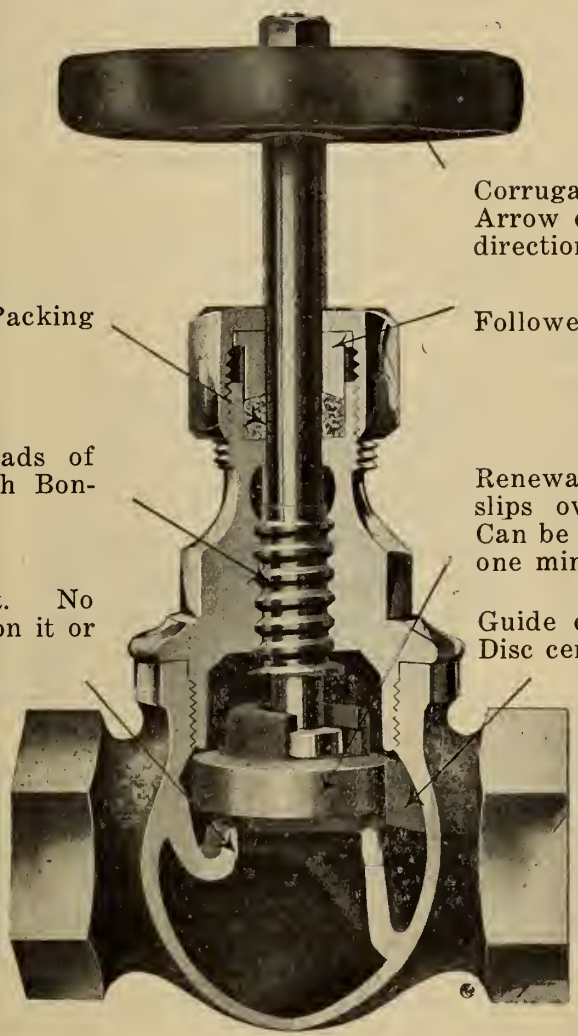
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.

Fairbanks Renewable Disc Valves



Corrugated Iron Wheel, Arrow cast on wheel shows direction valve opens.

Palmetto Twist Packing

Follower in stuffing Box.

At least Four Threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised Round Seat. No Sediment can lodge on it or injure disc.

Guide cast on Body holds Disc centrally over seat.

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Screwed or Flanged.

The disc of the Fairbanks Renewal Disc Valve can be renewed in less than a minute without removing the valve from the line, a wrench being the only tool necessary.

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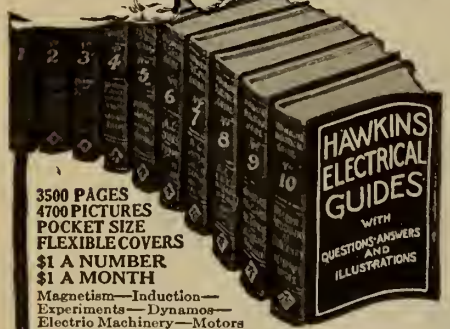

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New Lodge C. A. S. E.

Stationary engineers organized at Hanover, Ont., on October the 28th. President Bro. Moll had the pleasure of organizing a branch lodge of the C.A.S.E. No. 38, at Hanover, Ont., installing the following officers: president, Charles Falconer; vice-president, Wm. Zufeldt; recording secretary, Ed. Holler; treasurer, Chris Weis; financial secretary, Thos. Scott; conductor, Jas. Martin; door-keeper, J. J. Lang. After installing the officers and instructing them for their work, a lunch was served, after which a hearty vote of thanks was tendered to Bro. Moll for his great interest in the C.A.S.E.

Peeble's Medium and Slow Speed Alternators.

Bruce Peebles & Co., Ltd., Edinburgh, Scotland, have issued pamphlet No. 13-C, dealing with medium and sloow speed alternators. This pamphlet gives a full specification of the machines, together with a number of half-tone illustrations, also lists of ratings for 50- and 25-cycle alternators for all pressures from 200-6600 volts, a rule being given for working out the ratings of machines of other periodicities.

A New Bulletin.

"Dunham Heating Date" has just been issued, describing and explaining standard methods of figuring radiation and laying out piping. Valuable ventilating data is also included, the whole being put in very practical and concise form, getting at the real information without having to wade through a lot of preliminaries. Various details of piping connections are illustrated, and complete pipe sizing information given. This bulletin, together with several others of interest and value to the stationary and heating engineer, can be secured by writing the C. A. Dunham Co., Ltd., 1535 Davenport Road, Toronto, Ont.

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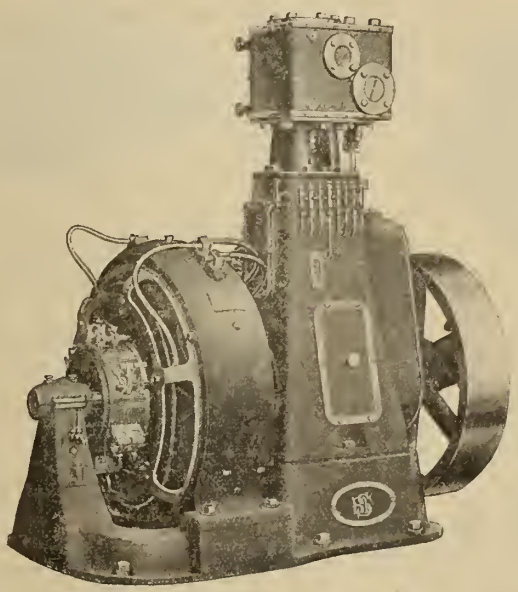

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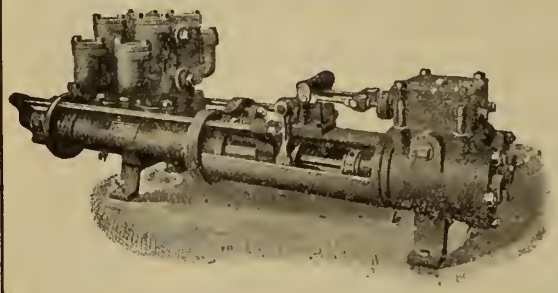

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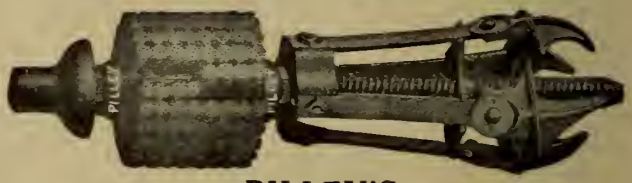

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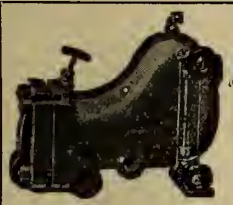

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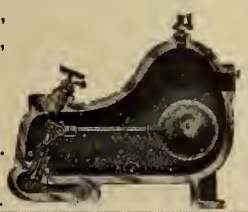

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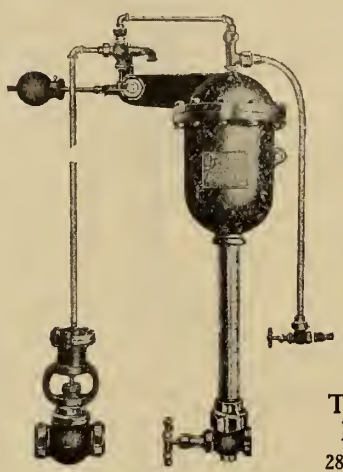

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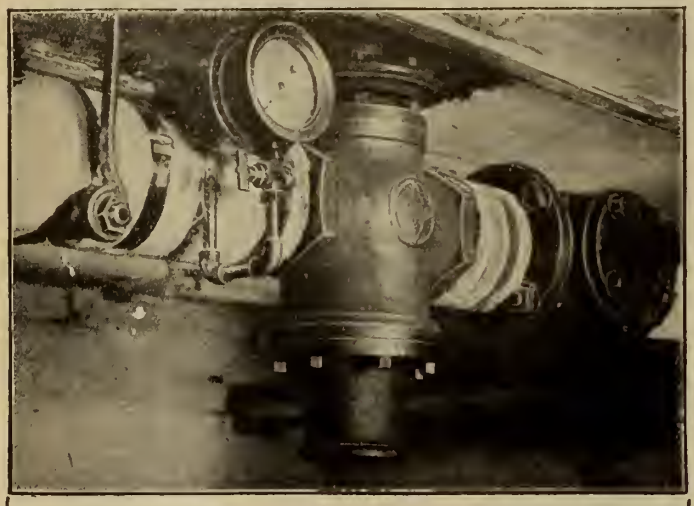

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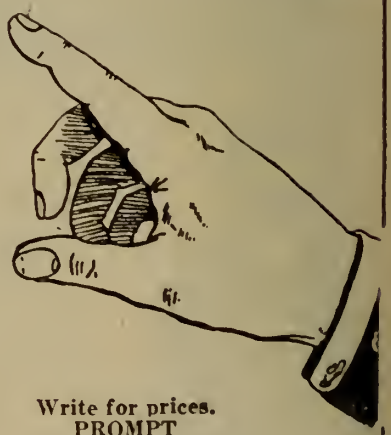

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Jointless Fire Brick Co., Chicago, Ill.

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Babcock & Wilcox, Ltd., Montreal.
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Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Jones Underfeed Stoker Co., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
McAvity & Sons, Ltd., T., St. John, N.B.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto.

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Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
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Johns-Pratt Co., The, Hartford, Conn.

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Penberthy Injector Co., Windsor, Ont.
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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.

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McAvity & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

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Empire Mfg. Co., Ltd., London, Ont.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Royles, Ltd., Irlam, Manchester, England.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto

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Can. Link-Belt Co., Toronto, Ont.

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Empire Mfg. Co., Ltd., London, Ont.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Leonard & Sons, Ltd., E., London, Ont.
McAvity & Sons, Ltd., T., St. John, N.B.
Norwalk Iron Works, South Norwalk, Ct.
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.
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Empire Mfg. Co., Ltd., London, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
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Waterous Engine Works Co., Brantford.

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Can. Link-Belt Co., Toronto, Ont.

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Morse Chain Co., Ithica, N.Y.

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Morse Chain Co., Ithica, N.Y.

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Morse Chain Co., Ithica, N.Y.

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Ernest Bernetz, Inc., Boston.
Gates Refractories, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Can. H. W. Johns-Manville Co., Toronto.
Economy Fuse & Mfg. Co. of Canada, Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New Yor, N.Y.
E. J. Philip & Sons, Toronto, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York, N.Y.

GASKETS, LEAD, COPPER AND LEATHER
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply Co., Toronto.
Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Jos. W. Hays Corp., Michigan City, Ind.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GATES, HEAD AND WASTE
J. C. Wilson Mfg. Co., Belleville, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Hall, Montreal.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Defender Automatic Regulator Co., St. Louis, Mo.
J. W. Hays Corp., Michigan City, Ind.

GAUGE, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto, Ont.
J. W. Hays Corp., Michigan City, Ind.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Defender Automatic Regulator Co., St. Louis, Mo.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, COMPENSATING GEARS, FIBRE CUT
Beveridge Paper Co., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton
Wilson Mfg. Co., J. C. Belleville.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. General Electric Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GLOVES, WORKING
R. G. Long & Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Pickering Governor Co., Portland, Conn.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto

GOVERNORS, VACUUM
Mason Regulator & Eng. Co., Ltd., Montreal.
C. A. Dunham Co., Ltd., Toronto
Smart-Turner Machine Co., Ltd., Hamilton
Can. Steam Boiler Equip. Co., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.

GOVERNORS, WATER WHEEL
Wilson Mfg. Co., J. C., Belleville.

GREASE CUPS
Alway Oiler Mfg. Co., Toronto, Ont.

GRATES, DUMPING, ROCKING, STATIONARY
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal
Carling Turbine Blower Co., Worcester, Mass.
Can. Steam Boiler Equip. Co., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal.
Sbell Bar Boico Supply, Ltd., Toronto.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.

GRATES, SHAKING AND DUMPING
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
Shell Bar Boico Supply, Ltd., Toronto.

GRATES, DUMPING, ROCKING AND STATIONARY
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS, FURNACE
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Laurie & Lamb, Montreal.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

HEATERS
Mason Regulator & Eng Co., Ltd., Montreal.
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Royles, Ltd., Irlam, Manchester, Eng.
McAvity, T., & Sons, Ltd., St. John N.B.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Mason Regulator & Eng Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

HEATING EQUIPMENT
Empire Mfg. Co., Ltd., London, Ont.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Columbus, Ohio.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Dunlop Tire & Rubber Co., Toronto.
Garlock Packing Co., Hamilton Ont
Gutta Percha & Rubber Ltd., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

HOT WATER GENERATORS
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co. Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Works S., Norwalk, Conn.
York Mfg. Co., York, Pa.

INGOTS
Empire Mfg. Co., Ltd., London, Ont.

INDICATORS, ELECTRICAL—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Can. Fairbanks-Morse Co., Ltd., Montreal
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS, AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

INSTRUMENTS, RECORDING
Defender Automatic Regulator Co., St. Louis, Mo.
Green's Economiser, Ltd., Toronto, Ont.
Taylor Instrument Co's., Rochester, N.Y.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Beveridge Paper Co., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto.

KETTLES, STEAM AND GAS
Royles, Ltd., Irlam, Manchester, Eng.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto.

KNITTED GOODS, WORKING
R. G. Long & Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

LININGS, FIRE BRICK, STEEL STACK
Green's Economiser, Ltd., Toronto.

LUBRICATORS
Empire Mfg. Co., Ltd., London, Ont.
Michigan Lubricator Co., Detroit, Mich.
Jas. Morrison Brass Mfg. Co., Toronto.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRCATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

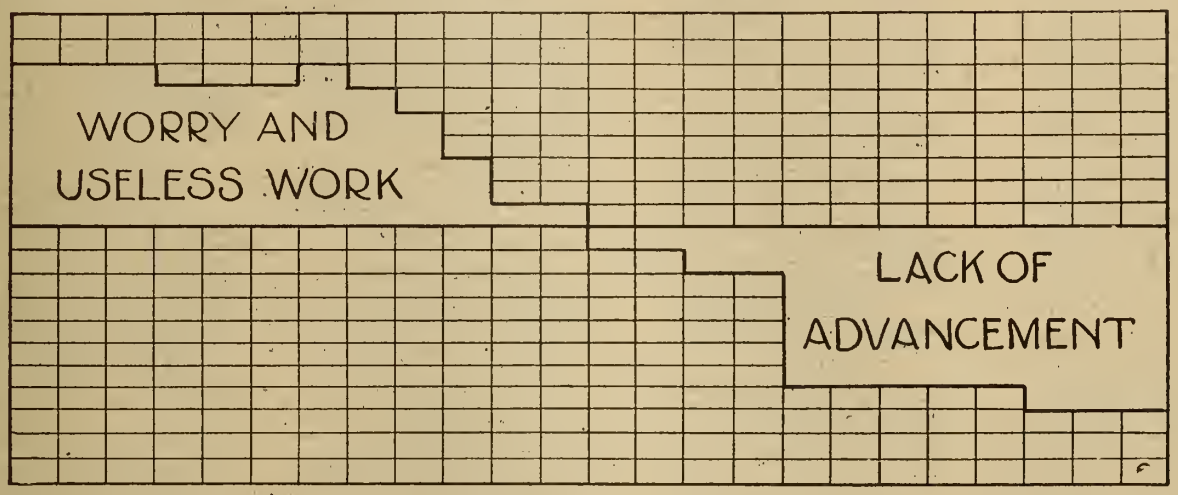
LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Jeffrey Mfg. Co., Montreal, Canada.
Can. Detroit Lubricator Co., Walkerville
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Williams Machinery Co., A. R., Toronto

Let the C.A.S.E. Smooth Out Your Load Curve



Remove The Peaks of Worry And Unproductive Labor And Build Up The Valleys By Working For Your Advancement

A man who is thoroughly grounded in the practice of his profession, who is free from personal worry and trouble, overcomes the many difficulties besetting the path of the operating engineer with little labor and in a manner ensuring his advancement.

The successful man owes his success to a wise appreciation of the advantages and mutual help offered by association with those in the same field of endeavor. To join an association having for its objectives the welfare of the engineer in things mental and material, his advancement in knowledge and skill, his protection by provision for sickness and distress is to take advantage of an opportunity indispensable to all who hope to better themselves.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary,

Canadian Association of Stationary Engineers

230 Caroline Street Hamilton, Ont.

LUBRICATORS, SIGHT FEED AND PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal.

MACHINERY, MINING (COMPRESSORS)
Norwalk Iron Works, S. Norwalk, Conn.

MACHINERY, TRANSMISSION (POWER)
Morse Chain Co., Ithaca, N.Y.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

METERS, AIR
E. J. Philip & Sons, Toronto, Ont.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto.

METERS, FLOW
Republic Flow Meters Co., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

METERS, GAS
E. J. Philip & Sons, Toronto, Ont.

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METERS, STEAM
American District Steam Co., North Tonawanda, N. Y.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Green's Economiser, Ltd., Toronto.
E. J. Philip & Sons, Toronto, Ont.
Williams Machinery Co., A. R., Toronto

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
McAvity, T., & Sons, Ltd., St. John, N.B.
E. J. Phillip & Sons, Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MOTORS
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.
Green's Economiser, Ltd., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OILS, CYLINDER
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.

OIL CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL AND GREASE CUPS
Allway Oiler Mfg. Co., Toronto, Ont.

OIL PUMPS
Allway Oiler Mfg. Co., Toronto, Ont.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.

OILERS' CRANK AND CROSS-HEAD PIN
Lukenheimer Co., Cincinnati, O.

OILER, COMPOUND FEEDERS
Lukenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

OIL FILTERS AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Darling Bros., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

ORSAT APPARATUS
Defender Automatic Regulator Co., St. Louis, Mo.

OVERALLS
R. G. Long & Co., Toronto.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Williams Machinery Co., A. R., Toronto

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Johns-Pratt Co., The, Hartford, Conn.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Dunlop Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Ltd., Toronto.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

PACKING, VALVE STEM
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS, CONDENSER AND SMOKESTACK
Beveridge Paper Co., Montreal, Que.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PAPER, INSULATING, ETC.
Beveridge Paper Co., Montreal, Que.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Wilson Mfg. Co., J. C., Belleville.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.
Williams Machinery Co., A. R., Toronto

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H, Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Bond Engineering Works, Toronto, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
Williams Machinery Co., A. R., Toronto
Wilson Mfg. Co., J. C., Belleville, Ont.

PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Beveridge Paper Co., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Allis-Chalmers, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Beveridge Paper Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss Co., Montreal, Que.
Coppus Eng. & Equipt. Co., Worcester.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, FEED WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Beveridge Paper Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Darling Brothers, Ltd., Montreal, Que.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal.
Graton & Knight Mfg. Co., Montreal.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.

Beveridge Paper Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto, Ont.
Jos. W. Hays Corp., Michigan City, Ind.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

RADIATORS
Empire Mfg. Co., Ltd., London, Ont.
Royles, Ltd., Irlam, Manchester, England.

RADIATOR TRAPS
Beveridge Paper Co., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Defender Automatic Reg. Co., St. Louis.
Can. H. W. Johns-Manville Co., Toronto.
Green's Economiser, Ltd., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
Defender Automatic Reg. Co., St. Louis.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 323 Markham St., Toronto.

REGULATORS, DAMPER
Defender Automatic Reg. Co., St. Louis.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Bostou, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Defender Automatic Reg. Co., St. Louis.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. A. Dunham Co., Ltd., Toronto, Ont.
Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg Co., Montreal, Canada.

ROOFING, RUBBER, PLASTIC, LIQUID
Beveridge Paper Co., Montreal, Que.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.
Green's Economiser, Ltd., Toronto, Ont.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
The Garth Co., Montreal, Canada.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
Wilson Mfg. Co., J. C., Belleville.

SHIRTS, WORKING
R. G. Long & Co., Toronto, Ont.

SMELTING LININGS
Beveridge Paper Co., Montreal, Que.

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

STEAM SPECIALTIES
Alberger Heater Co., Buffalo, N.Y.
Can. Fairbanks-Morse Co., Montreal.
Cole Ltd., Geo. W., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
The Garth Co., Montreal, Que.
Mason Reg. & Eug Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
Green's Economiser, Ltd., Toronto.
Jones Underfeed Stoker Co., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPPLIES, HOT WATER
Royles, Ltd., Irlam, Manchester, England.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto.

SWING JOINTS
Franklin Williams Co., New York.

SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
Audel Co., Theo., New York.
MacLean Publishing Co., Toronto.

THERMOMETERS
Defender Automatic Reg. Co., St. Louis.
Green's Economiser, Ltd., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

TRANSFORMERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
American District Steam Co., North Tonawanda.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Cole, Ltd, Geo. W., Toronto.
Williams Machinery Co., A. R., Toronto.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal, Canada.
Dunham Co., Ltd., C. A., Toronto, Ont.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co, Julian, Boston, Mass.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.
Cole, Ltd., Geo. W., Toronto.

TRUCKS, FACTORY
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Green's Economiser, Ltd., Toronto, Ont.
Pelley Packing and Fine Brush Mfg. Co., St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

TURBINES, POWER
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.

TUBES, COPPER AND BRASS
Empire Mfg. Co., Ltd., London, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE OIL
Kellogg & Co., E. H., New York. N.Y.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Canadian Allis-Chalmers, Ltd., Toronto.
Escher, Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont.
MacGovern & Co., Inc., Montreal, Que.
J. C. Wilson Mfg Co., Belleville, Ont.

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Coppus Eng. & Equipt. Co., Worcester.
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Empire Mfg. Co., Ltd., London, Ont.
Dart Union Company, Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Jefferson Union Co., Lexington, Mass.
Dart Union Company, Ltd., Toronto, Ont.

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Steam Boiler Equipt. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Kerr Engine Co., Walkerville, Ont.
Williams Machinery Co., A. R., Toronto.
Beveridge Paper Co., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.

Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
Wilson Mfg. Co., J. C., Belleville.
York Manufacturing Co., York, Pa.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
McAvity & Sons, T., St. John, N.B.
York Manufacturing Co., York, Pa.
H. Mueller Mfg. Co., Ltd., Sarnia.

AIR VALVES
Empire Mfg. Co., Ltd., London, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

VALVES, BACK PRESSURE
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Beveridge Paper Co., Montreal, Que.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
The Garth Co., Montreal, Canada.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Watson & McDaniel Co., Philadelphia.
Wilson Mfg. Co., J. C., Belleville.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Williams Machinery Co., A. R., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.

VALVES, FOOT
Shell Bar Boico Supply, Ltd., Toronto.
Empire Mfg. Co., London, Ont.
Kerr Engine Co., Walkerville, Ont.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

VALVES, HYDRAULIC
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, MULTIPORT
Can. Allis-Chalmers, Ltd., Toronto, Ont.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.

VALVES, POP
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.

VALVES, PUMP
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto.
Mason Regulator & Eng. Co., Montreal.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B

VALVES, REDUCING
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Beveridge Paper Co., Montreal, Que.
Darling Brothers, Ltd., Montreal, Que.
C. A. Dunham Co., Ltd., Toronto, Ont.

VALVES
Crane Limited, Montreal.

VALVES, BRASS
Crane Limited, Montreal.

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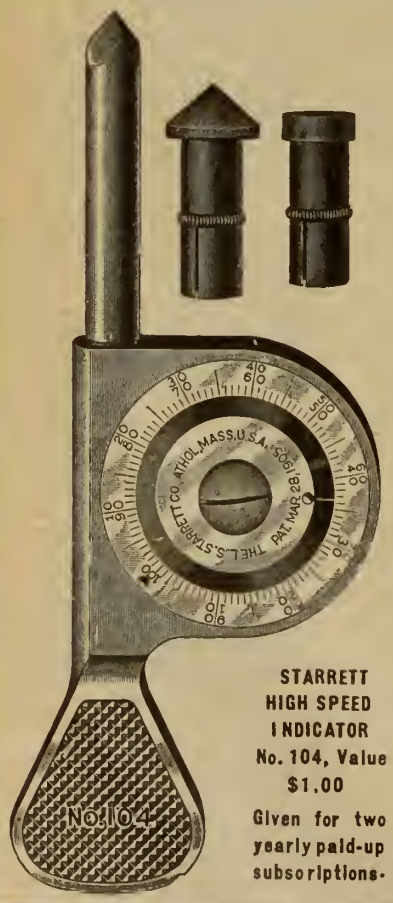

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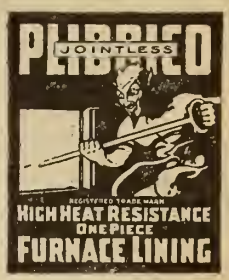

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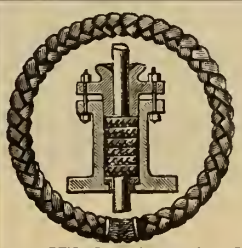

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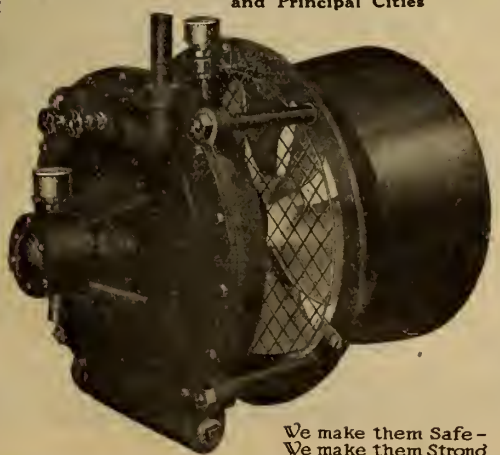

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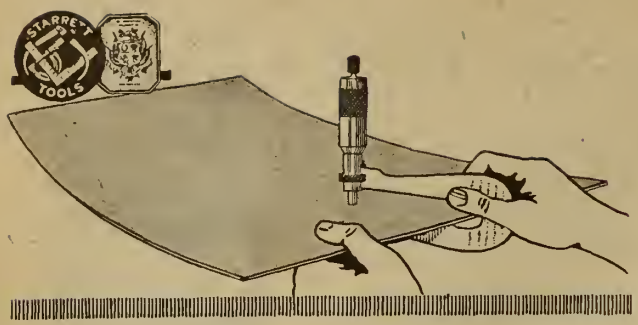

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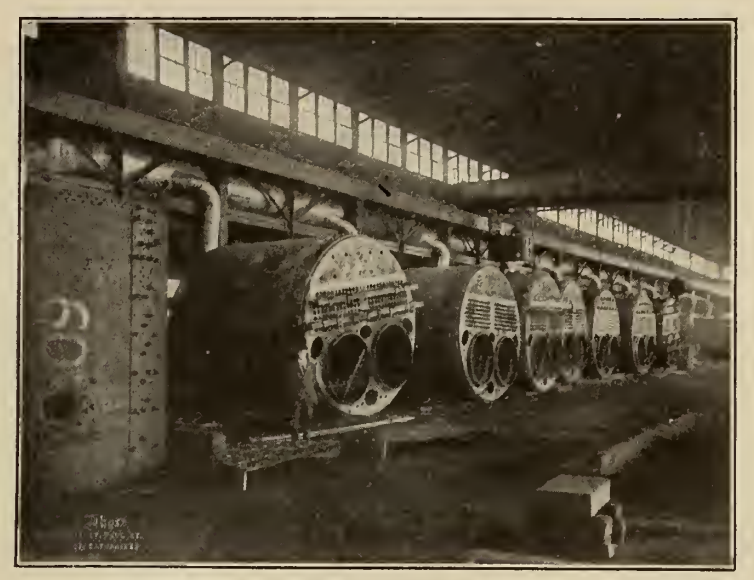

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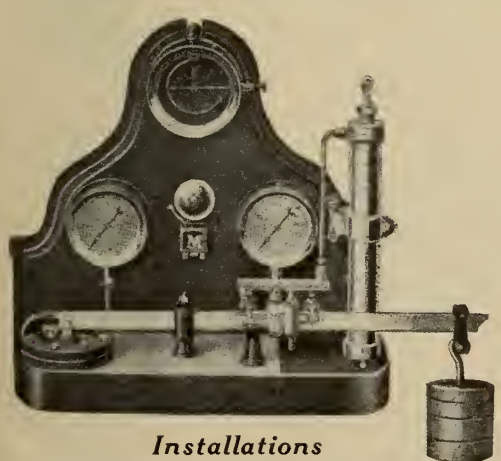

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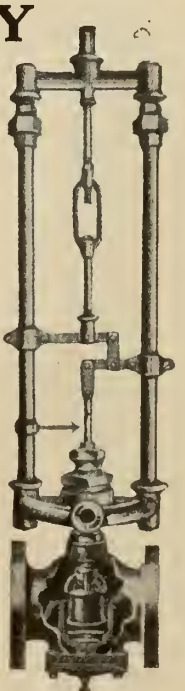

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